# Assessing Exposures and Health Effects Related to Indoor Biomass Fuel Burning

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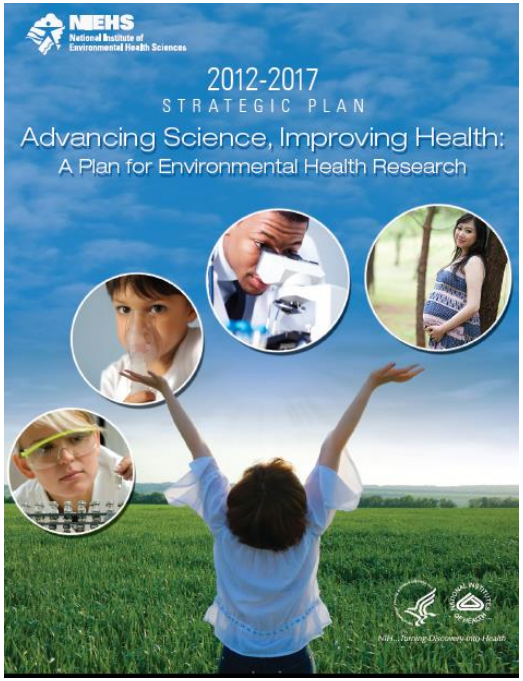
# Global challenge

- Around 3 billion people cook and heat their homes using open fires and simple stoves burning biomass (wood, animal dung and crop waste) and coal.
- Over 4 million people die prematurely from illness attributable to the household air pollution from cooking with solid fuels.
- More than 50% of premature deaths among children under 5 are due to pneumonia caused by particulate matter (soot) inhaled from household air pollution.
- 3.8 million premature deaths annually from noncommunicable diseases including stroke, ischaemic heart disease, chronic obstructive pulmonary disease (COPD) and lung cancer are attributed to exposure to household air pollution.

Source: WHO http://www.who.int/mediacentre/factsheets/fs292/en/

# Priority area for NIEHS

- WHO Collaborating Centre for Environmental Health Sciences
  - Indoor Air Pollution
- NIEHS Strategic Plan
  - Theme 2: Exposure Research
  - Theme 4: Health Disparities and Global Environmental Health
  - Goal 4: Understand how combined environmental exposures affect disease pathogenesis
  - Goal 6: Establish environmental health disparities research to understand disproportionate risk of disease



# 2011 NIEHS-NICHD-FIC Indoor Air Pollution Workshop

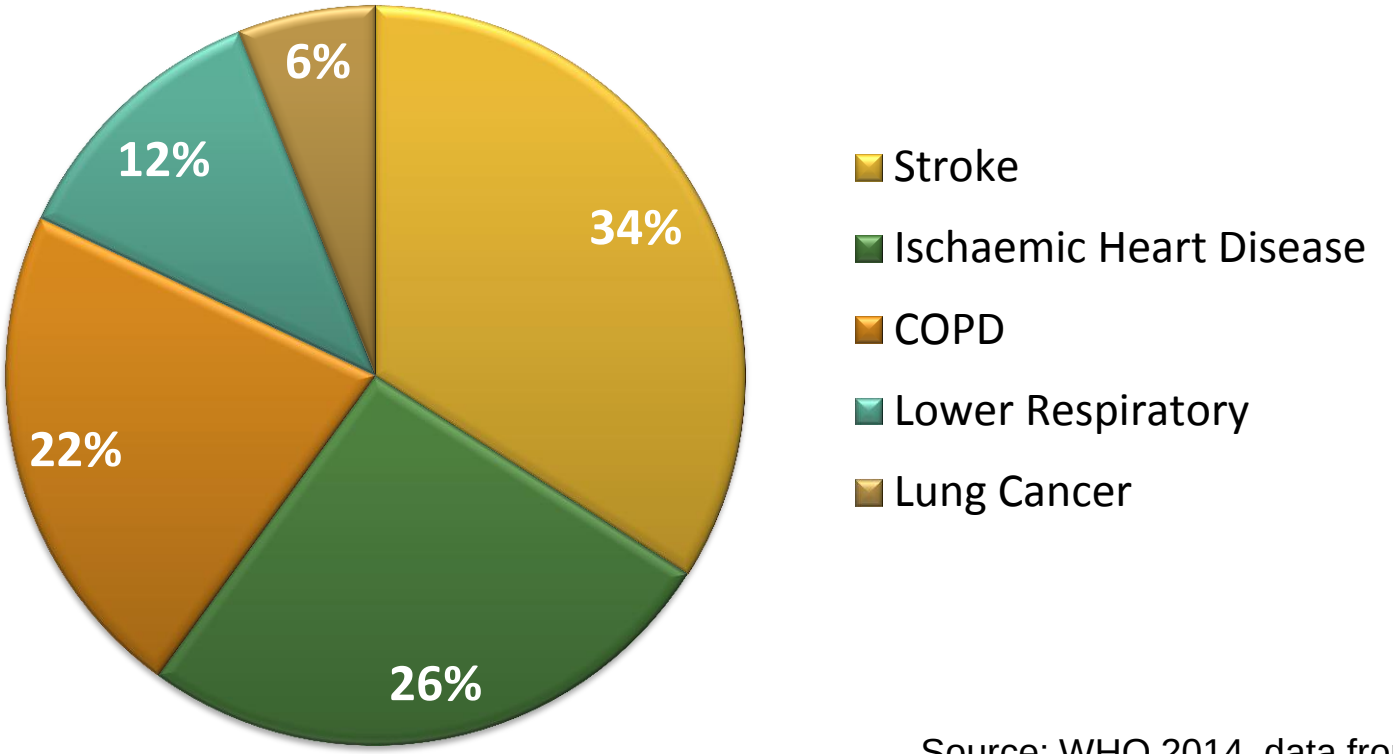
- Title: Health Burden of Indoor Air Pollution on Women and Children in Developing Countries
- Goal: Bring together experts to develop research priorities for reducing health risks from cookstove use to women and children
- Key issues
  - Cancer
  - Cardiovascular outcomes
  - Infection
  - Respiratory disease
  - Exposure assessment and biomarkers
  - Pregnancy and neonatal outcomes
  - Burns and eye injuries
  - Behavioral and empowerment

Pilar Nores de Garcia, the first lady of Peru, addressed the conference

Martin WJ II, Glass RI, Araj H, Balbus J, Collins FS, et al. (2013) *Household Air Pollution in Low- and Middle-Income Countries: Health Risks and Research Priorities*. PLoS Med 10(6)

# Stroke is the Top Health Problem Related to Household Air Pollution

## By disease, global deaths attributable to HAP:



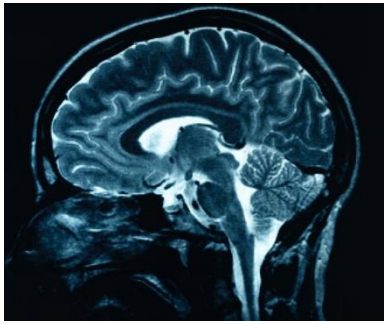

Source: WHO 2014, data from 2012

# Consideration of vulnerable populations

- Pregnant women
  - How do the complex series of immunological changes during pregnancy affect susceptibility to pollutant exposure and effects?
- In utero exposure of fetus to pollutants
  - Potential organizational effects from pollutants could lead to permanent changes
- Exposure of child during sensitive developmental windows
  - Susceptibility changes over time and could lead to different health outcomes from a single exposure

# Understanding complex exposures

- Chemical stressors
  - Polycyclic aromatic compounds (PACs), volatile organic compounds (VOCs), carbon monoxide, nitrogen dioxide, particulate matter, dioxins
- Physical stressors
  - Heat, challenges associated with collection of biomass for burning, viral load, nutritional status
- Psychosocial stressors
  - Poverty, environmental degradation, lack of access to health care, lack of empowerment




# Relevant NIEHS initiatives

- NIEHS-funded research on cookstoves and indoor air pollution has helped people in the U.S., Guatemala, Ecuador, Nepal, Pakistan, and Ghana
- Polycyclic aromatic compound mixtures assessment program will assess the toxicity of cookstove emission samples from collaborators using an *in vitro* testing battery
- Environmental Health Perspectives has facilitated communication of findings from important cookstove research including commentaries, reviews, and research articles
- More broadly – greater understanding of interactions between complex environmental exposures and adverse health outcomes will contribute to elucidating the true health impact of indoor pollution from biomass burning

# Impact of biomass fuels on pregnancy outcomes in central East India

Blair J Wylie[1,2,3,4*], Brent A Coull[4,5], Davidson H Hamer[2,3,6,7], Mrigendra P Singh[8], Darby Jack[9], Kojo Yeboah-Antwi[2], Lora Sabin[2], Neeru Singh[10] and William B MacLeod[2,3]

# Effects of Woodsmoke Exposure on Airway Inflammation in Rural Guatemalan Women

Michael J. Guarnieri, Janet V. Diaz, Chandreyi Basu, Anaite Diaz, Daniel Pope, Kirk R. Smith, Tone Smith-Sivertsen, Nigel Bruce, Colin Solomon, John McCracken, John R. Balmes

Published: March 13, 2014 • DOI: 10.1371/journal.pone.0088455

Indoor Air. 2013 Apr;23(2):105-14. doi: 10.1111/ina.12003. Epub 2012 Sep 18.

# Impact of a cleaner-burning cookstove intervention on blood pressure in Nicaraguan women.

Clark ML[1], Bachand AM, Heiderscheidt JM, Yoder SA, Luna B, Volckens J, Koehler KA, Conway S, Reynolds SJ, Peel JL.

# Designs of two randomized, community-based trials to assess the impact of alternative cookstove installation on respiratory illness among young children and reproductive outcomes in rural Nepal

James M Tielsch[1*], Joanne Katz[2], Scott L Zeger[3], Subarna K Khatry[4], Laxman Shrestha[5], Patrick Breysse[6], William Checkley[7], Luke C Mullany[2] and Steven C LeClerq[2,4]

# 2014 NIEHS Cookstove Symposium

- Title: Assessing Exposures and Health Effects Related to Indoor Biomass Fuel Burning
- Goal: Bring together researchers working in the area of indoor biomass fuel burning emissions and health effects to discuss the latest science, policy, and future directions
- Cross-cutting themes:
  - Importance of multidisciplinary collaboration
  - Emissions from fuel burning are complex mixtures that require dedicated exposure and toxicity assessment approaches
  - Vulnerable populations (i.e., intersection of poverty and exposure)
  - Complexity of social, cultural, and economic factors that affect adoption behavior
  - Lab-to-field translation is critical
  - Dose-response considerations


# Moving forward

- Understanding exposures from cookstoves
  - Which chemicals pose the greatest health risk?
- Accounting for combined exposures
  - What are the other important sources of pollution that might interact?
  - How do nonchemical stressors affect health outcomes?
- Better understanding of how environmental factors lead to disease
  - Improved interventions based on greatest potential impact
- Cross-disciplinary attention
  - Exposure science, toxicologists, epidemiologists, risk assessors
- Training the next generation of environmental scientists

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# NIH HAP Investments

**Stove and fuel development and distribution**
- **DOE** grants
- **GACC** + private sector
- **USAID** grants and credits

**Field evaluation of stove distribution**
- **NIEHS R01** – Cooperative evaluation of private stove distribution program on exposure and public health measures in Rwanda

**Adoption and behavior change**
- **Implementation Science Network** (FIC/USAID/NCI) – Best practice studies and evaluation of behavior in distribution
- **NIEHS R01** – Adoption study Ghana Outcome trial

**Exposure and toxicity evaluation**
- **National Toxicology Program** Assessment of polycyclic aromatic compounds in cookstove smoke
- **NIEHS R01** – Emissions profiles and subclinical effects

**Research capacity-building**
- **GEOHealth Hubs** (FIC/NIEHS/NCI/ NIOSH/IDRC)–networked US and foreign institutional partnerships for research and training in epidemiology, exposure science, experimental design, data mgmt.

**Biomarker development**
- **Common Fund proposed project** to develop new and preliminary biomarkers for respiratory and cardiovascular outcomes in HAP studies

**Health outcomes – Proof of Principle controlled trials**

**HAP Outcomes Network** (NHLBI/NCI/NIEHS/NICHD- private foundations) respiratory infections, birth weight, asthma, COPD, lung cancer markers

**NIEHS R01s** – Ghana, Nepal (maternal and child health results in 2016)

FY 2014 2015 2016 2017 2018 2019 2020

# Thank you!

National Institute of Environmental Health Sciences

National Toxicology Program
U.S. Department of Health and Human Services

NIEHS Strategic Plan Website
http://www.niehs.nih.gov/strategicplan