CLEAN AND EFFICIENT COOKING TECHNOLOGIES AND FUELS

2. GROWING RESEARCH AND EVIDENCE BASE AROUND HEALTH

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2. GROWING RESEARCH AND EVIDENCE BASE AROUND HEALTH

This section outlines recent developments in the sector's evolving understanding of the health impacts associated with exposure to smoke from cooking with solid fuels, the exposure reductions necessary to reduce health impacts, and the challenges in achieving such exposure reduction.

WHY IT MATTERS	The potential health benefits of transitioning to cleaner technologies and fuels are a major motivating factor for many improved stove programs; these are also among the most challenging benefits to achieve.
BEST PRACTICES	**1.** Decide what health impacts, if any, you seek to achieve. Reducing respiratory health impacts requires near exclusive use of a very high quality biomass stove or clean fuel, whereas there are many more options to reduce burns. **2.** Determine what cooking technologies and/or fuels are required to achieve the desired impacts, and consider additional behavior change interventions such as increasing ventilation or removing infants from smoky areas. **3.** Monitor changes in indoor emissions or exposure to household air pollution to justify any claims about specific health impacts (such as respiratory disease) and to add to the sector's limited data pool

NEW DEVELOPMENTS IN UNDERSTANDING COOKSTOVES AS A HEALTH INTERVENTION

Most cookstove programs implemented through the 1990s were driven primarily by environmental concerns; concerns about health impacts from smoke exposure and burns increased over time, and in 2002 the sector experienced a tipping point around health awareness. The 2002 World Health Organization (WHO) Global Burden of Disease (GBD) ranked indoor air pollution from household energy fourth in the list of serious threats to health in less developed countries, after malnutrition, unsafe sex, and unsafe water. The 2002 GBD estimated that exposure to indoor smoke from burning solid fuels caused an estimated 1.5 million premature deaths each year, mainly from pneumonia in children and chronic obstructive pulmonary disease (COPD) in women, from breathing in particulate matter (PM) found in smoke from solid fuels. Based on these initial GBD estimates, WHO developed the first guidelines for indoor air quality that included $PM_{2.5}$

(particulate matter less than 2.5 microns in aerodynamic diameter), and CO (carbon monoxide). Prior to this, PM and CO guidelines only existed for ambient air quality. WHO has since revised its estimates (2012), attributing 4.3 million premature deaths per year to exposure to household air pollution (HAP) from cooking with solid fuels; this revised figure includes both indoor and outdoor exposure to pollution from household solid fuels. These deaths occur primarily in South East Asia (1.69m), the Western Pacific (1.62m), and Africa (almost 600,000 deaths/year). Revised indoor air quality guidelines were also released in 2014.

The GBD findings, along with concerns about climate impacts, led to an increased international effort to better measure the emissions produced by cooking devices (the level of harmful pollutants emitted from the cooking device), indoor concentrations (level of pollutants that concentrate in the kitchen that are not vented out), and exposure levels of cooks (the amount of pollutants that the cook is exposed to during a certain time period). The main pollutants that are measured include $PM_{2.5}$, and CO, although pollutants from incomplete combustion also include nitrogen dioxide, and sulfur dioxide among others. While any particles smaller than 10 microns (PM_{10}) can pass into the lungs and cause health problems, $PM_{2.5}$ is particularly dangerous as it can pass deeper into the lungs. PM causes the most ill health and it is always present along with the other pollutants. Too much CO exposure can lead to headaches, heart conditions, and death.

UNDERSTANDING THE HEALTH IMPACTS OF HAP

Exposure to HAP has been definitively linked to acute lower respiratory infections, including pneumonia (which is the single leading cause of death in children under five years); COPD; stroke, ischemic heart disease (IHD), cataracts, and lung cancer[1], which are all counted in the global burden of disease. Additional health effects shown to be associated with household solid fuel use include babies with low birth weight, intrauterine growth retardation, perinatal mortality, tuberculosis, eye irritation, and headaches[2]. People cooking with traditional fuels and stoves also report burns and scalds, poisoning from the ingestion of kerosene, backaches from tending fires on the floor, and injuries (i.e. hernias, snake bites, backaches) and assaults incurred during fuel collection. There exists some preliminary evidence suggesting that, in addition to being disproportionately exposed to cookstove emissions, women tend to have more severe physiological responses to these exposures than do men[3].

Burns have received particular attention in recent years. WHO reports some 265,000 deaths from fire-related burns each year globally; 95% occur in low-and middle-income countries, and a large proportion of this is presumed to be cooking-related[4]. Children under 5 in the WHO African Region have almost 3 times the incidence of burn deaths vs. infants worldwide. To better understand cooking-related burn prevalence, the Alliance, CDC, and WHO have established a burns working group to increase data on the causes and risk factors of severe burn injuries. This includes a burns registry launched in India in 2013, a WHO global burns pilot that covered 46 hospitals in 26 countries and corresponding Global Burns Registry, and field based surveillance underway in Kenya and Nepal.

The Randomized Exposure Study of Pollution Indoors and Respiratory Effects (RESPIRE) study, led by Dr. Kirk Smith from 2002-2004 (with initial findings first released in 2011) was the first of its kind randomized control trial looking at the relationship between acute respiratory infections in children and exposure to indoor air pollution. This study confirmed previous findings of a non-linear exposure-response relationship for biomass particulate matter pollution and child pneumonia. RESPIRE researchers also generated similar exposure-response curves, based on other air pollution studies, for stroke, COPD, acute lower respiratory infections (ALRI) and Ischemic Heart Disease. The study found that the introduction of a chimney stove into rural Guatemalan homes traditionally using wood fuel in open fires reduced the exposure of both

1. Lim (2013), "Global Burden of Disease Study 2010."
2. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2568866/
3. http://ehp.niehs.nih.gov/0900994/
4. http://www.who.int/mediacentre/factsheets/fs365/en/


Photo credit: Project Gaia

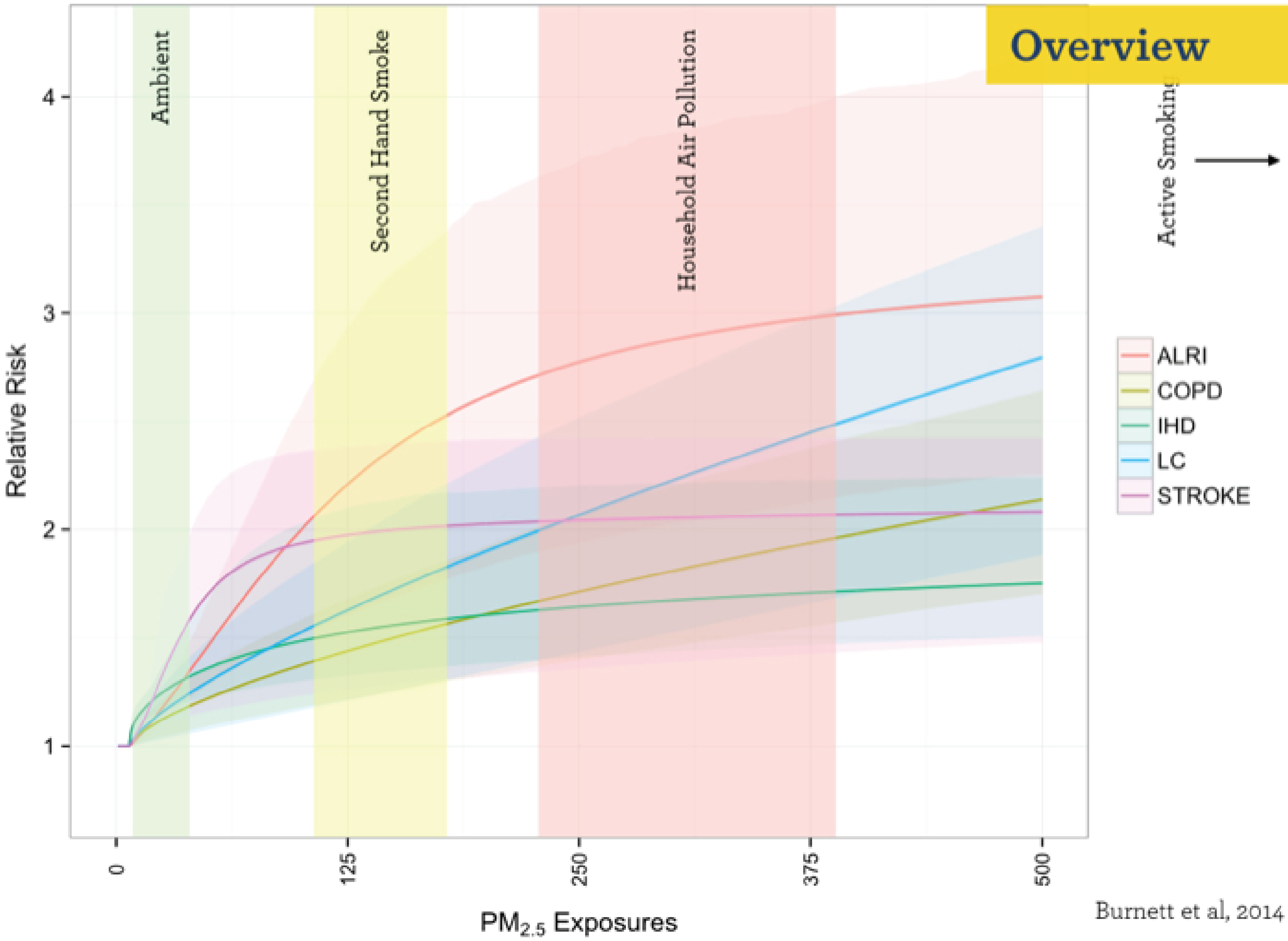
mother and child to CO (used as a proxy for $PM_{2.5}$) by over 50% and resulted in significant reduction of 1/3 for severe pneumonia, but did not reduce physician-diagnosed pneumonia in children to a statistically significant level. The reasons for no effect being detected for non-severe pneumonia could be attributable to insufficient exposure reduction.

These findings show that the greatest risk reduction occurs at lower exposure levels, and that significant reductions in smoke inhalation are required for even moderate health gains for the four diseases mentioned above.

To reach protective levels--i.e. the level set by the WHO for indoor air quality guidelines--drastic emissions reductions are required. The table below[5] shows the relative risk for ALRI, COPD, IHD, lung cancer and stoke as a function of $PM_{2.5}$ exposure[6], noting typical levels for ambient pollution, second-hand smoke and HAP. A relative risk of 1 means no added risk.

Johnson and Chiang calculated that meeting the WHO Interim 1 target for $PM_{2.5}$ requires near-exclusive use of stoves that meet Tier 4 International Workshop Agreement (IWA) 11:2012 indoor emissions levels; no more than one hour per week

5. Sumi Mehta June 2016 presentation, and http://ehp.niehs.nih.gov/1307049/
6. Exposure to particulate matter less than 2.5 microns in aerodynamic diameter



Burnett et al, 2014

of three-stone-fire burning indoors or 3 hours per week of traditional charcoal use indoors. This calculation was based on the single-zone model used for IWA 11:2012, with assumed emission sources, air exchange rate, and room volume. Additional research demonstrates the impact of increased ventilation on this model.

Other recent research efforts have included:

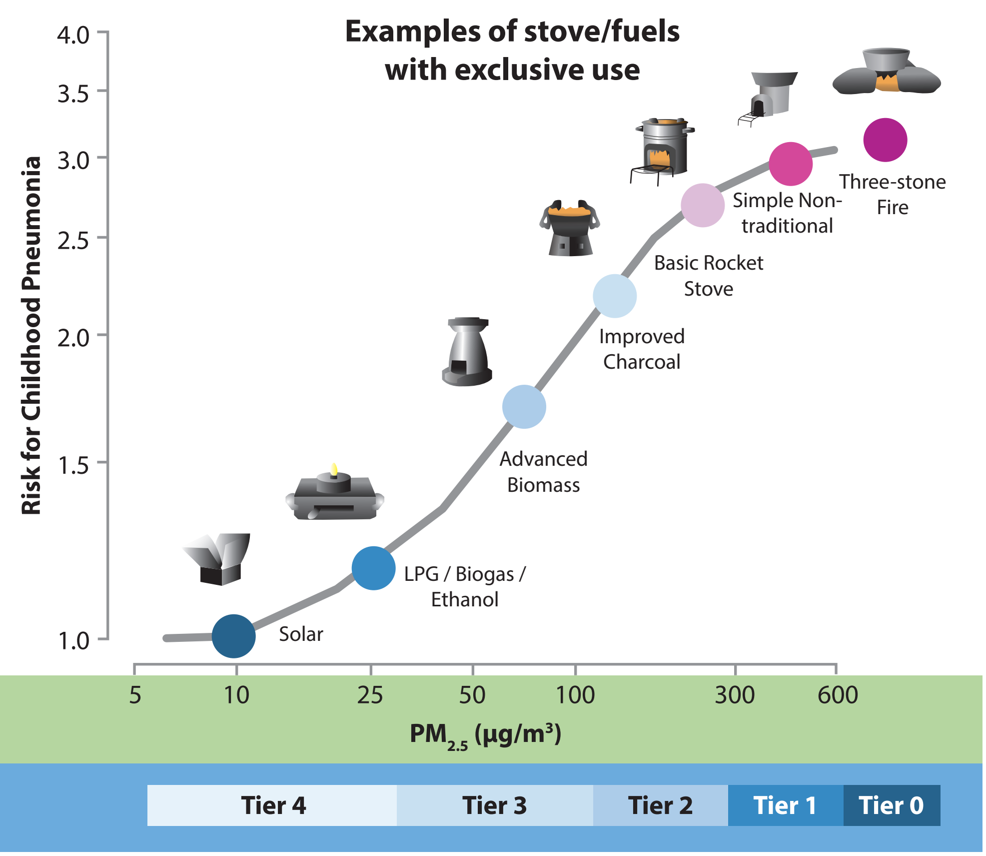
- Three randomized controlled trials supported by the Alliance and NIH on cooking and child survival in Ghana, Nepal, and Nigeria, all of which include a traditional stove component, an improved biomass stove component, and a clean fuels (LPG or ethanol) component.
- Four studies focused on clean cooking and non-communicable disease supported by the Alliance and the US Centers for Disease Control (through the Public Health Institute).
- Four studies focused on adoption, i.e., uptake and sustained use of demonstrably clean cooking supported by the Alliance, USAID (through the TRAction project), and the US Centers for Disease Control (through the Public Health Institute).
- An Alliance, WHO, and US Centers for Disease Control (US CDC) joint effort to develop an international burns registry to estimate the proportion of severe burns that is due to cooking.
- The National Institutes of Health have also been active in researching health impacts of cookstove interventions.

As the health effects of improved cookstove interventions are better understood, means for assessing these impacts have evolved. The WHO Catalog of Methods details many of these methods. The principal way by which the health impact of a specific intervention can be assessed is averted disability-adjusted life years (aDALYs): a composite metric used by health and development entities globally to measure disease burden or risk factors to evaluate interventions. The Household Air Pollution Intervention Tool (HAPIT) is a recently-developed web-based tool that allows users to estimate the impact of particular cooking system interventions on the burden of disease by generating aDALY estimates. The tool requires stakeholders to input parameters from the intervention program, including data on targeted households, intervention lifetime, and intervention cost, as well as field data, such as exposures to $PM_{2.5}$ and stove usage data, to calculate the health impacts of the intervention in aDALYs, and relative cost effectiveness. WHO is also developing a Clean Household Energy Solutions Toolkit (CHEST) with tools, guidance and other resources to be used at the local, national or regional level to support implementation of their indoor air quality guidelines. This will include guidance for needs assessments and mapping, assessments of intervention options, M&E strategies and resources, policy options and standards and testing information.

BARRIERS TO ACHIEVING HEALTH IMPACTS THROUGH COOKSTOVE INTERVENTIONS

The primary challenge in achieving respiratory health impacts through cookstove interventions lies in the fact that, to achieve WHO guideline levels of exposure, users not only must use extremely clean (Tier 4 for indoor emissions) stoves and fuels, but also must use them almost exclusively. WHO's CHEST tool, referenced above, will help support implementers to incorporate this guidance in their programs, but there are still real challenges to getting this level of health impact currently.

Though Tier 4 (indoor emission) biomass stoves exist, few (if any) are commercially available in most countries (see



Citation- USAID/ TRAction and Global Alliance for Clean Cookstoves Ghana CPD Training, June 2016 results from a current round of U.S.EPA testing shown by category below). Stove categories are plotted against relative risk for childhood pneumonia). Even when Tier 4 (indoor emissions) stoves are available, stove stacking with traditional stoves, at levels far greater than 1 hour/week, is commonplace. As such, it is difficult for most current biomass cookstove interventions to provide significant respiratory health benefits. LPG and ethanol stoves/fuels are cleaner burning than biomass, and have greater potential for respiratory health protection, but stove stacking with LPG/ethanol and traditional stoves still exists, and access to LPG and ethanol (including infrastructure, distribution chains, and affordability) is still low or non-existent in many parts of the world. Global efforts to expand LPG access include the Global LPG Partnership and World LPG Association "Cooking for Life" campaign.

While health interventions aimed at respiratory health improvements require almost exclusive use of extremely clean technologies, important non-respiratory health improvements are achievable through currently available biomass stove models. These include reducing burns and scalds, kerosene poisoning, eye irritation, headaches, backaches, hernias, and other physical impacts of fuel collection. Of note, these impacts result in significantly fewer deaths and DALYs than respiratory diseases do.[7]

While there are currently no agreed-upon USAID indicators for HAP yet, emerging results from ongoing studies such as the child survival studies funded by the NIH and the Alliance (publications in progress) are promising, and will further inform the question of how 'clean' is clean enough to provide health benefits such that USG and other donors/implementers can measure progress toward health goals. The HAPIT tool described above is consistent with the latest burden of disease estimates, and calculates and compares the health benefits attributed to proposed stove and/or fuel intervention programs. This tool will continue to be updated as the existing evidence base continues to evolve.

ADDITIONAL RESOURCES:

Global Burden of Disease Methodology
http://www.healthdata.org/gbd/about
http://www.annualreviews.org/doi/abs/10.1146/annurev-publhealth-032013-182356
http://ehp.niehs.nih.gov/1307049/
http://www.who.int/publications/cra/chapters/volume2/1435-1494.pdf
http://cleancookstoves.org/resources_files/briefing-note-on-burden-of-disease.pdf

2010 Estimates – IHME (includes national burden estimates)
http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(12)62135-7/abstract
http://www.healthmetricsandevaluation.org/gbd/visualizations/country

WHO 2012 Estimates (only deaths, only air pollution)
http://www.who.int/phe/health_topics/outdoorair/databases/en/

2013 Estimates – IHME
http://www.healthmetricsandevaluation.org/gbd/visualizations/country

Household Air Pollution Intervention Tool (HAPIT)

www.cleancookstoves.org/HAPIT

7. Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012;380(9859):2224-2260. doi:10.1016/S0140-6736(12)61766-8.