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PCIA Bulletin - *Focus on Health Impacts*

This quarterly newsletter provides updates on the activities of the Partnership for Clean Indoor Air (PCIA) and its Partners to improve health, livelihood and quality of life by reducing exposure to indoor air pollution, primarily among women and children, from household energy use. More than **300** governments, public and private organizations, multilateral institutions, and others are working together to increase the use of affordable, reliable, clean, efficient, and safe home cooking and heating practices. *Visit www.pciaonline.org to join!*

Some three billion people in the developing world use coal and biomass for heating and cooking over open fires, or with rudimentary stoves. These methods result in the release of dangerous particulate matter, carbon monoxide, and other toxic pollutants — as well as greenhouse gases — into the air. The resulting indoor air pollution levels are 20 to 100 times greater than standards recommended under the World Health Organization's (WHO) air quality guidelines.

Health impacts associated with exposure to indoor air pollution include acute respiratory infections (ARI), including pneumonia; chronic obstructive pulmonary disease (COPD); lung cancer (for users of open coal stoves); cataracts; tuberculosis; asthma; and adverse pregnancy outcomes (stillbirth, low birthweight).

WHO estimates that exposure to indoor smoke from burning solid fuels causes an estimated 1.5 million premature deaths each year, mainly from pneumonia in children and chronic obstructive pulmonary disease in women. In fact, indoor air pollution from household energy is ranked fourth in the list of serious threats to health in less developed countries, after malnutrition, unsafe sex, and unsafe water.

Globally, acute lower respiratory infections (including pneumonia), closely associated with exposure to indoor smoke represent the single leading cause of death in children under five years; every year, indoor air pollution is responsible for nearly 800,000 deaths due to pneumonia among children in this age group.

Special thanks to Om Kurmi and Stephen Gordon for their help in coordinating this Bulletin issue!

Additional health impacts from household energy use include burns and scalds; poisoning from the ingestion of kerosene; eye irritation; headaches; backaches from tending fires on the floor; and injuries and assaults incurred during fuel collection.

Because of the serious health impacts associated with household energy use, and the interest in this topic generated at the 4th Biennial Partnership for Clean Indoor Air Forum held in Kampala, Uganda in March 2009, this issue of the Bulletin focuses on highlighting recent research findings on some of these serious health impacts.

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☼ FEATURE ARTICLES

Indoor Air Pollution from Household Use of Solid Fuels May Contribute to Cardiovascular Disease

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Smith et al, as part of the World Health Organization's (WHO) Comparative Quantification of Health Risks study, estimated 1.6 million premature deaths and 3.6 percent of the global burden of disease in 2000 due to indoor air pollution from the use of solid fuels (1). This estimation was based on epidemiological studies that have found evidence of respiratory health effects, such as acute lower respiratory infections, chronic obstructive lung disease and lung cancer. Although increased cardiovascular disease (CVD) is arguably the most important health effect of ambient air pollution and secondhand tobacco smoke exposures, pollutant mixtures similar in many ways to solid fuel smoke, the WHO burden of disease estimates for solid fuel smoke did not include CVD. The reason for this discrepancy is that no study had been conducted on the CVD effects of household solid fuel smoke.

The RESPIRE (Randomized Exposure Study of Pollution Indoors and Respiratory Effects) project was the first randomized intervention trial of an improved chimney cookstove to reduce indoor air pollution and took place in the Western Highland region of San Marcos, Guatemala. This trial focused on respiratory outcomes, but it created an opportunity to study the potential cardiovascular health benefits of reduced air pollution exposures (2). Epidemiological studies have observed positive associations between ambient air pollutants and blood pressure (BP). Researchers working on the RESPIRE project hypothesized that the chimney stove intervention would lower BP. To test this hypothesis, two study designs were used: (1) between-groups comparisons based on randomized stove assignment, and (2) before-and -after comparisons within subjects before and after they received improved stoves.

From 2003 to 2005, personal fine particle ($PM_{2.5}$) exposures and systolic (SBP) and diastolic blood pressure (DBP) were measured among women over 38 years of age from the intervention group (49 subjects) and traditional open wood fire control group (71 subjects). Measures were repeated on up to 3 occasions per subject. During the trial period, daily average $PM_{2.5}$ exposures were 264 and 102 $\mu g/m^3$, in the control and intervention groups, respectively. The improved stove intervention was associated with 3.7 mm Hg lower SBP (95% CI: -8.1, 0.6) and 3.0 mm Hg lower DBP (95% CI: -5.7, –0.4) compared to controls. In the second study design, among control subjects measured both before and after receiving improved stoves, similar associations were observed. The authors concluded that the between-groups comparisons provide evidence, particularly for DBP, that the improved stove reduced blood pressure, and the before-and-after comparisons were consistent with this evidence. This new finding that reduced biomass smoke exposure also reduced blood pressure, a major determinant of CVD risk, suggests that previous risk assessments may have underestimated the disease burden attributable to household solid fuel use.

Based on these results from the RESPIRE project, John P. McCracken and Joel Schwartz from the Department of Environmental Health at Harvard School of Public Health, with assistance from Anaité Díaz-Artiga from the *Universidad del Valle* in Guatemala, performed a risk assessment to estimate the number of annual CVD deaths globally that may be attributable to indoor air pollution from solid fuel use. This work was sponsored by the US Environmental Protection Agency and the report, entitled "Estimation of Cardiovascular Mortality Due to Elevated Blood Pressure Attributable to Household Solid Fuel Use," was presented at PCIA's first health

Guatemalan women with improved cookstove

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research webinar held on June 23, 2009. Proceedings are available at www.pciaonline.org/proceedings.

In this report, the authors present an exposure-response analyses of RESPIRE blood pressure data and then incorporate the results to estimate the attributable burden of CVD mortality in 2004 that could have been prevented by a 50% reduction in exposure to fine particles in solid fuel smoke. The calculations were done by age and WHO subregion and took into account the prevalence of solid fuel use by subregion, population distributions of SBP, the risk ratios for four major categories of CVD (stroke, ischemic heart disease, hypertensive disease, and other cardiovascular disease – mostly heart failure), and the numbers of deaths in each of these categories. They estimated that 207,000 CVD-attributed deaths among women could have been prevented in 2004 by halving solid fuel smoke exposure. The magnitude and shape of the exposure-response relationship between solid fuel smoke and blood pressure was by far the largest source of uncertainty evaluated in this study. In addition, although it is well known that solid fuel smoke levels in some parts of the world are often many times higher than standards set to protect health, very little is known about the actual population distributions of exposures among solid fuel users globally. Notwithstanding these limitations, this risk assessment suggests that the health impact of solid fuel use may be substantially larger than previously considered.

References

1. WHO. Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors. Geneva: World Health Organization, 2004.
2. McCracken J, Díaz-Artiga A, Smith KR, Mittleman MA, Schwartz J. 2007. Chimney Stove Intervention to Reduce Long-term Woodsmoke Exposure Lowers Blood Pressure among Guatemalan Women. *Environmental Health Perspectives* 115(7):996-1001.

Biomass and HIV – an Hypothesis

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Globally, HIV now affects 30 million adults. In parts of the world where HIV infection is most common, biomass fuels are the main energy source. In Malawi, for example, the incidence of HIV in pregnant women is 33%, and 70% of hospital admissions are HIV infected. In this same region, more than 90% of households use biomass fuel. The effect of biomass fuel smoke on HIV-infected individuals has not been described but there are good reasons to suspect that there may be an effect of HIV on biomass fuel -related lung damage, and an effect of biomass fuel smoke exposure on HIV replication.

The most important effect of HIV infection in Africa is to cause increased bacterial infections and in particular, pneumonia and tuberculosis (TB). The mechanism by which HIV causes increased infections involves alteration of the inflammatory response in the lung. This inflammation impairs natural effective defense and increases the colonisation of the airways by bacteria. Biomass fuel smoke exposure also alters the inflammatory response in the lung. This is particularly well seen in the illness experienced by fire-fighters but can also be measured in chronically exposed women in Africa – see Figure 1 below. Further, HIV infection on its own

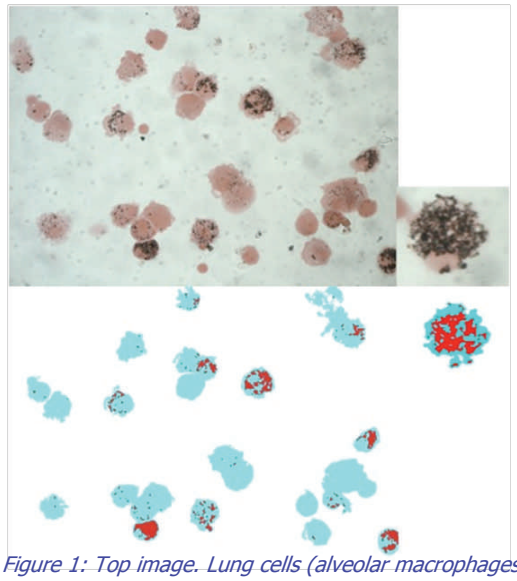

Figure 1: Top image. Lung cells (alveolar macrophages) containing black carbon particles. Computer software image analysis of top image produced bottom image.

Bottom image. Map of carbon particles in alveolar macrophages where cells are blue and carbon particles are red. Inset shows a cell and its map at a higher magnification.

This image analysis gives a carbon score which can then be used as a marker of exposure.

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is also associated with lung function impairment and in particular with the accelerated development of chronic obstructive pulmonary disease (COPD). It is therefore likely, although not proven, that HIV infection is a significant contributor to impaired lung function in much of the adult population of Africa and that it may accelerate the process leading to COPD. It is more certain that HIV and biomass fuel use are synergistic in their effect on lung inflammation and hence increased susceptibility to bacterial pneumonia.

Separate from the effect of HIV on the incidence of biomass fuel use associated pneumonia, TB and COPD, there may be another sinister synergism between HIV and biomass fuel. It is also possible that biomass fuel smoke exposure causes inflammation and that this then drives HIV replication in the lung. HIV replication rates are determined by the same mechanisms that cause inflammation, and hence HIV replication could be increased in the lung tissue by both simple biomass fuel smoke exposure and indirectly by the increased incidence of pulmonary infections in biomass fuel smoke exposed populations.

These hypotheses are being tested by the BREATHE consortium in projects in Malawi and Liverpool. The research is examining the effect that HIV has on how lung cells (alveolar macrophages) respond to infection in individuals that are heavily exposed and those that less exposed to biomass fuel smoke. The amount of carbon seen in alveolar macrophages is being correlated with different defense mechanisms of these cells as well as HIV replication rates (see Figure 1 on previous page).

Major Health Effects of Indoor Air Pollution in Children

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Over half of the world's population uses solid fuel as their main energy for domestic purposes. The burden of diseases in the developing countries due to exposure to indoor air pollution is high in both adults and children. Some of the major diseases associated with use of solid fuels in children are summarised below.

Acute respiratory infection: Respiratory infection is the fourth leading cause of deaths in the world; 7.4% of female deaths and 7.1% of male deaths annually are due to respiratory infections[1]. Acute respiratory infection (17%) is the second leading cause of under five mortality in the world after neonatal deaths (37%)[1] . In low-income countries respiratory infection is the leading cause (11.2%, 2.94 millions) of deaths [1].

Lower respiratory infections (LRI) are the major causes of morbidity and mortality causing over four million deaths per year worldwide, approximately 69% of which occur in low and middle income countries[1,2]. The percentage of total disability adjusted life years (DALYs) lost due to ALRI is 6.2%, ranked as number one in causes of death worldwide[3]. 7.1% (4.2 million) of total annual deaths in the world are due to lower respiratory infections (including pneumonia) and this is the third leading cause of deaths for all age groups. The mortality due to respiratory infection is higher in the under five and over 60 age groups. Young children exposed to solid fuel smoke have two to three times more risk of serious ARI than unexposed children after adjusting for potential confounders such as parental smoking[4]. Deaths due to respiratory diseases are highest in African countries followed by eastern Mediterranean and then south-east Asian countries[1] where most of the people are of low socio-economic status. More than 80% of the population in these areas use biomass/solid fuel for domestic purposes and respiratory deaths from respiratory tract infections could well be attributed to the high exposure from the burning of biomass/ solid fuel. Exposure to air pollutants might increase the incidence of ARI by adversely affecting specific and non-specific defences of the respiratory tract against pathogens[5]. According to the WHO (2008) the prevalence of ARI in children under 5 in Nepal in 2006 was 34.3%: deaths from pneumonia in the same age group in 2000 was 18.5%.

Several studies show possible links between ALRI and exposure to biomass smoke[6-10]. A study in Nepal of children under 2 years showed over two-fold increased risk of developing ARI among children spending time in the kitchen during cooking periods as reported by the mother[10]. Another study from rural Kenya on 93 children

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under 5 years studied ARI and ALRI (exposure and clinical examination) from 55 randomly selected households[6-11]. The study measured biomass exposure as PM_{10} and found a dose-response relationship between PM_{10} and the increase in ARI and ALRI frequency.

Mishra (2003) studied acute respiratory infection in pre-school children (under 5 years) in Zimbabwe and found that approximately 16% of the children had ARI[9] at the time of their survey. The study reported that children in households using biomass were more than twice as likely to suffer from ARI as children from households using clean fuel for domestic purposes. Another study studying 500 Gambian children under 5[12] reported that parental smoking appeared (non-significantly) to increase the risk of ALRI. However, the risk of ALRI was 6 times higher in girls than boys, perhaps due to the fact that girls are carried on mother's back more often than boys during cooking and hence are exposed more to biomass exposure.

Asthma: There is a wide variation in the prevalence of asthma worldwide[13]. Asthma has been less widely studied in the low and middle income countries compared to the developed countries and understanding of the very different risk factors in these countries associated with its development, notably the indoor environment and lifestyle, is limited. Some studies in low and middle income countries have considered possible associations with biomass/solid fuel pollutant exposures[14-16]. All these studies adopted different techniques to determine asthma and none measured biomass exposure levels. While this limits the ability to compare the studies, all show positive associations between indoor air pollution and asthma at least in children[17-20].

Low birth weight: Evidence from ambient air pollution[21-23] suggests adverse pregnancy outcomes. Intrauterine growth retardation may also be associated with ambient particle exposures even at relatively modest exposures (PM_{10} levels over 40μg/m^3 and $PM_{2.5}$ level over 37μg/m^3) [24].

Some studies from the developing world[25-27] also suggests that indoor air pollution is associated with adverse birth outcomes, independent of child's sex, birth order, mother's nutritional status, pregnancy care, mother's education, household living standard, and other factors.

A recently published study from a semirural area of Pakistan reported that cooking with wood during pregnancy was significantly associated with low birth weight and marginally lower mean birth weight compared to natural gas use[28]. The study reported the prevalence of low birth weight to be 22.7% among wood users and 15% in natural gas users ($p<0.01$) with infants born to wood users being 82g lighter than those born to natural gas users after adjusting for confounders. Research from Zimbabwe based on analysis of 3,559 childbirths in the five year preceding the 1999 Zimbabwe Demographic and Health Survey reported that babies born to mothers using biomass fuel were 175g lighter on average compared to babies born to mothers using LPG, natural gas, or electricity[29]. Similar work from Guatemala of over 1,700 women and newborn children found a prevalence of low birth weight of 19.9% in open wood fire users compared to 16.8% in homes with chimneys on their stoves and 16.0% in 365 electricity and gas users, independent of key maternal, social, and economic factors[30].

Tuberculosis: There is no published data available that show a relationship between tuberculosis and exposure to biomass smoke in children. The available data[31-33] on biomass which have similar effect to smoking suggests that there might be a causal link between exposure to biomass smoke and either an increased risk of acquiring TB or progression of TB to a clinical disease in adults. There are very few studies that have explored this link and there is heterogeneity in design, measurement of outcome and quantitative risk estimates which need to be explored further to come to a conclusion.

References

1. WHO. Global Burden of Disease - 2004 Update. Geneva: World Health organisation 2008.
2. Monto AS, Lehmann D. Acute respiratory infections (ARI) in children: prospects for prevention. *Vaccine* 1998;16 (16):1582-8.
3. WHOLIS. WHO statistical information system: World health organisation, 2008.
4. Smith KR, Samet JM, Romieu I, Bruce N. Indoor air pollution in developing countries and acute lower respiratory infections in children. *Thorax* 2000;55(6): 518-32.
5. Reynolds HY. Defense mechanisms against infections. *Curr Opin Pulm Med* 1999;5(3):136-42.
6. Ezzati M, Kammen D. Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: an exposure-response study. *Lancet* 2001;358(9282):619-24.

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Wood Smoke and Lung Function Testing in Malawi

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Exposure to biomass smoke is a major global risk factor for the development of emphysema and chronic bronchitis - Chronic Obstructive Pulmonary Disease (COPD) but the burden of biomass associated COPD in Africa has not yet been described. The WHO Global Burden of Disease and Risk Factors Project estimated COPD to be the tenth leading cause of disability-adjusted life years in all countries, regardless of their economic status. Cigarette smoke is the most common and well-described risk factor for the development of COPD; however in countries of low and middle income 35% of people with COPD have developed the disorder after exposure to indoor smoke from biomass fuels alone. The prevalence of COPD in non-smoking women is two to three times higher in rural areas where women are exposed to biomass smoke, compared with urban women who are exposed much less. Cigarette smoking rates remain low in developing countries compared to Europe and America, especially amongst women in Southern Africa. However, non-smoking, biomass exposed women appear to develop COPD with clinical characteristics, quality of life and increased mortality similar in degree to that of tobacco smokers.

Work has begun in Malawi to look at lung function in individuals exposed to different types of biomass fuels (wood and charcoal). Lung function can be tested using mobile devices called spirometers that determine the force and duration of expiration – see Figure 1. This form of testing is sufficient to diagnose certain conditions such as COPD and asthma but requires very careful calibration of equipment, training of staff and quality control of data. Limitations of equipment, staff and quality control are the reason why so few data from Africa have been published. In a recent survey, emails were sent to pulmonary physicians in Africa. 106 were received and of these 52 (49.5%) gave a response. 19 out of 53 African countries (36%) had at least one reply with Nigeria, South Africa and Kenya having the highest response rates. The majority of doctors (34/74%) had a problem with spirometry testing– the most common complaint was lack of availability of the test.

Figure 1: Spirometry being performed at Queen Elizabeth Central Hospital, Malawi

Using lung function testing in Malawi, there were large differences between rural wood users compared to urban charcoal cookers. Rural wood fuel users tended to have worse lung function. The cause of this remains unclear but wood smoke is likely to play a significant role. In order to determine the true association of lung function impairment and smoke exposure, studies which prospectively observe the effects of tobacco smoking, malnutrition and crowding will be needed. These studies are complex and best done in the context of either large epidemiological studies or intervention studies. Large epidemiological studies of this kind are planned by the Pan African Thoracic Society(www.africanthoracic.org) and intervention studies are planned by the BREATHE consortium. The BREATHE Africa consortium will bring together a multi-disciplined consortium to study Biomarkers and Exposure, Health Effects, Mechanisms and Interventions in indoor air in several African sites, probably starting in Malawi in 2010.

Your comments are welcome!

This newsletter is published by Winrock International on behalf of the Partnership for Clean Indoor Air. To share comments, suggestions, news, and article contributions please email moderator@pciaonline.org. The deadline for contributions to next quarter's Bulletin, the topic of which is Stove Testing Protocols, Facilities and Standards Development, is **August 30, 2009**.

Indoor Air Pollution Due to Emission of Carbon Monoxide from Cooking Fuels

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Half of the world's population relies on unprocessed solid fuels, such as dung cakes, wood, crop waste or coal for cooking. In developing countries like India up to 90% of rural households depend on solid bio fuels[1], resulting in high exposures to toxic pollutants. One of the most common pollutants emitted by cooking fuels during cooking is carbon monoxide (CO). CO is odorless, colorless, and otherwise undetectable to the human senses; people may not know that they are being exposed. The initial symptoms of low to moderate CO poisoning are similar to the flu (but without the fever). They include: headache, fatigue, shortness of breath, nausea, and dizziness. High level CO poisoning results in progressively more severe symptoms, including: mental confusion, vomiting, loss of muscular coordination, loss of consciousness, and ultimately death.

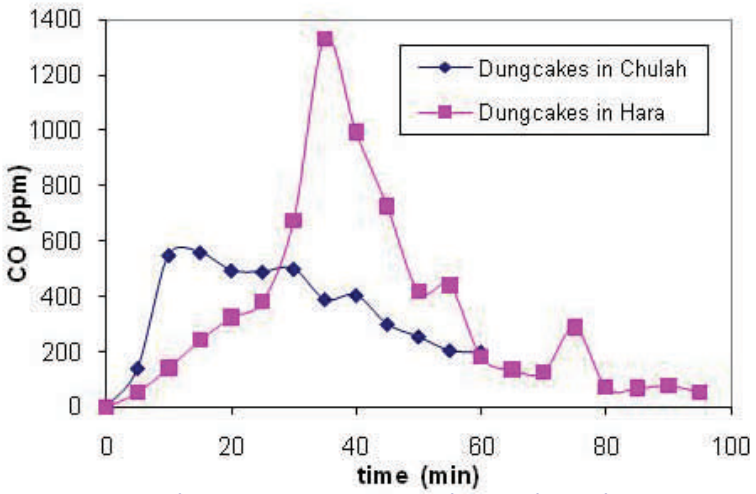
CO (ppm)	Time	Symptoms/Comments
35	8 hrs	Maximum exposure allowed by OSHA in the workplace over an eight hour period.
200	2-3 hrs	Mild headache, fatigue, nausea and dizziness.
400	1-2 hrs	Serious headache-other symptoms intensify. Life threatening after 3 hours.
800	45 min	Dizziness, nausea and convulsions. Unconscious within 2 hours. Death within 2-3 hrs.
1600	20 min	Headache, dizziness and nausea. Death within 1 hour.
3200	5-10 min	Headache, dizziness and nausea. Death within 1 hour.
6400	1-2 min	Headache, dizziness and nausea. Death within 25-30 mins.
12,800	1-3 min	Death

Table 1: Symptoms associated with a given concentration of CO over time[2]

Symptom severity is related to both the CO level and the duration of exposure. For slowly developing residential CO problems, occupants or physicians can mistake mild to moderate CO poisoning symptoms for the flu. For rapidly developing, high level CO exposures victims can rapidly become mentally confused, and can lose muscle control without having first experienced milder symptoms; they will likely die if not immediately evacuated and treated.

This article details carbon monoxide emissions from various fuel/stove combinations commonly used in rural areas of India. The emission factor was determined in a simulated kitchen for 8 types of fuel/stove combinations using the Water Boiling Test (WBT). These include various stoves (traditional, Hara, kerosene and LPG) using animal dung, various species of crop residues, wood, kerosene and LPG. The average CO emission levels ranged widely, from 9 ppm for the gas/LPG stove to 374 ppm for dung cake/traditional chulha.

The burn cycles ranged from 70 to 80 minutes for all types of fuel/stove combinations. The stoves were placed under a hood built for the study, with a sampling probe placed inside the exhaust pipe of hood. The indoor CO was measured regularly at an interval of 5 min during the complete burn cycle. Even after extinguishing the fire the concentration of CO was further monitored until its concentration reduced to the background values. Three successful tests with complete burn cycles were conducted for each fuel/stove combination.



Graph 1: CO emissions over time burning dung cakes in a Chulah and Hara stove

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Some of the results are shown in the graph on the previous page.

In the case of the Hara stove, the CO emission reaches at its peak in 30-35 minutes of burning and then decreases. This is so because we were not continuously supplying the fuel in Hara, which is normal practice in India. Rather the entire fuel was arranged in it before the fire was lit, so the fuel keeps smoldering in Hara, instead of burning with flame. Therefore average CO emissions for Hara and Chulha were 353 ppm and 374 ppm respectively.

The national standards set by the *Central Pollution Control Board* (*CPCB)* give a safe limit for CO of 2 ppm. As shown in Table 2, the concentration of CO during cooking with solid biomass fuels was many times higher than this prescribed limit. From the study done, we can conclude that the dung cakes were the dirtiest fuel in terms of CO emissions followed by crop residues, wood, kerosene and LPG.

Fuel	Average CO (ppm)	Max CO (ppm)
Cow dung cake in Chulha	374	560
Cow dung in Hara	353	1333
Crop Residue- Mustard stalks in Chulha	225	285
Crop Residues- Arahar in Chulha	221	485
Wood- Neem in Chulha	151	215
Wood- Acacia in Chulha	145	280
Kerosene wick stove	42	54
LPG	9	24

Table 2: Average CO and maximum CO emissions from different fuel/stove combinations during Water Boiling Test.

References

1. World Resources: A guide to the Global Environment, Oxford University Press, Oxford, 1998-99.
2. Website: - http://biology.about.com/library/blco.htm

Biomass Smoke - a Risk to Visual Impairment

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According to current WHO estimates, globally, 314 million people are visually impaired, and 45 million are blind. Some of the major causes of visual impairment including blindness are cataract, glaucoma, blinding trachoma, corneal opacities, and age-related macular degeneration. The distribution of visual impairment is not uniform worldwide; 87% of the visually impaired live in the economically less developed countries where about 80% of the total fuel for domestic purposes consists of unprocessed biomass such as wood, dung, crop residues and coal. The risk is higher for women of all age groups. The increased risk for women in developing countries may be due to their traditional role in cooking using biomass fuel. Others who are regularly exposed to biomass smoke, including children, may then also be at higher risk.

There is very limited number of published studies that looked at the association between use of biomass fuel and eye problems compared to respiratory health outcome studies. That said, it has been documented that the use of biomass fuel for domestic purposes causes eye irritation[1,2] in women doing the cooking work. A study from India[3] investigating the relationship between ocular morbidity and types of fuel reported that the use of wood as fuel for domestic cooking compared to LPG use was highly associated with cataract. The study also reported higher prevalence of irritation in the eyes due to use of coal and cow dung.

A 1992-93 National Family Health Survey data (age 30 and over) from India also reported higher prevalence (18%) of partial and complete blindness in biomass fuel users compared to the clean fuel user group[4]. The association was significant for both men and women separately. The survey also found that the association between biomass use and partial blindness was stronger than the association between biomass use and complete blindness. Similarly, a hospital based case-control study in Nepal[5] reported significant associations between biomass use and cataract compared to clean fuel use (biogas, LPG and kerosene). The study also reported that use of a chimney-less stove and lack of proper ventilation in the kitchen each increased the risk by almost two-fold. Similar findings were found in another study from India[6].

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Animal studies have shown that chemicals present in wood smoke damage the lens of eyes, causing discolouration and opacities[3,7] and also causes irritation in the eyes resulting in conjunctivitis.

All the above studies show that there may be a risk of eye problems associated with biomass fuel use but none have looked at the factors that cause the eye problems in the biomass user. The Institute of Occupational and Environmental Medicine at the University of Birmingham is planning to undertake a study in Nepal to determine the factors contributing to the impact of biomass smoke from different types of biomass fuel on ocular disease. The study will also identify the prevalence of different types of ocular diseases in relation to different types of biomass fuel in different regions of Nepal for all age groups and in both genders. We would like to test the hypothesis that the risk of cataract in women using biomass fuel to cook their food is related to the toxicity of biomass smoke.

Woman being exposed to biomass smoke in rural Nepal

References

1. Ellegard A. Tears while cooking: an indicator of indoor air pollution and related health effects in developing countries. *Environ Res* 1997;75(1):12-22.
2. Diaz E, Smith-Sivertsen T, Pope D, Lie RT, Diaz A, McCracken J, et al. Eye discomfort, headache and back pain among Mayan Guatemalan women taking part in a randomised stove intervention trial. *J Epidemiol Community Health* 2007;61(1):74-9.
3. Saha A, Kulkarni PK, Shah A, Patel M, Saiyed HN. Ocular morbidity and fuel use: an experience from India. *Occup Environ Med* 2005;62(1):66-9.
4. Mishra VK, Retherford RD, Smith KR. Biomass cooking fuels and prevalence of blindness in India. *Journal of Environmental Medicine* 1999;1(4):189-199.
5. Pokhrel AK, Smith KR, Khalakdina A, Deuja A, Bates MN. Case-control study of indoor cooking smoke exposure and cataract in Nepal and India. *Int J Epidemiol* 2005;34(3): 702-8.
6. Ughade SN, Zodpey SP, Khanolkar VA. Risk factors for cataract: a case control study. *Indian J Ophthalmol* 1998;46 (4):221-7.
7. Rao CM, Qin C, Robison WG, Jr., Zigler JS, Jr. Effect of smoke condensate on the physiological integrity and morphology of organ cultured rat lenses. *Curr Eye Res* 1995;14(4):295-301.

Burn- and Fall-Related Injuries: Major Public Health Problem in Low- And Middle-Income Countries

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Injuries due to fire burns and falls contribute about 6 percent of total injuries worldwide. Over 95% of all burn deaths occur in low- and middle-income countries (LMICs)[1]. Many studies around the world have found that more boys suffer from fall related injuries while more girls suffer from fire and burn related injuries. The greatest gender discrepancies are found in the South-East Asia Region and in other LMICs. Burn and fall related injuries are proximately associated with household activities; particularly use of open fires for domestic purposes, including fuel collection activities resulting in falls.

According to the WHO Global Burden of Disease estimates for 2004, over 310,000 people died as a result of fire related burns, of whom 30% were below 20 years. Overall, children are at high risk of death from burns, with a global rate of 3.9 deaths per 100,000 populations. Infants have the highest death rates from burns. The rate then slowly declines with age, but increases again in elderly adults. In addition, 49% of affected children suffered some form of disability after a burn, with 8% being left with a permanent physical disability.

Mortality and morbidity from burns are strongly associated with poverty. Those burns that take place in rural areas might be associated with unsafe use of biomass and inadequate pre-hospital care. The results from a community based study in Bangladesh revealed an annual disability rate of 5.7 per 100,000 children as a result of burns[2]. Burn occurs more in winter as people sit beside the fire to warm up their house and bodies, and children are more likely to play with the fire[3]. Similarly, burn injuries are also associated with the use of petroleum products for

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indoor lighting and biomass for cooking in rural areas of Nepal.

According to the WHO Global Burden of Disease project for 2004, falls killed about 424,000 people of all ages worldwide. In most countries, falls are the most common type of childhood injury seen in emergency departments. It has also been found that falls are among leading causes of morbidity and disability in children, resulting in high social and economic costs.

An injury survey from China reported that for every one death due to a fall, there were 4 cases of permanent disability, 13 cases requiring hospitalization for 10 or more days, 24 cases requiring hospitalization for between 1 and 9 days, and 690 cases where care was sought or where at least 1 day of work or school was missed[4]. In Nepal and other LMICs, it has been observed in communities that some falls occur during the collection, transportation and preparation of firewood from forests or elsewhere. While there is a need for further study in order to obtain an estimate of the cost of fall-related injuries in LMICs, it is clear that cost is substantial.

References:

1. Burn Prevention and Care, World Health Organization. Accessed from: http://www.who.int/violence_injury_prevention/media/news/13_03_2008/en/
2. Mashreky SR, Rahman A, Chowdhury SM, Giashuddin S, Svanström L, Linnan M, et al. Consequences of childhood burn: Findings from the largest community-based injury survey in Bangladesh. *Burns* 2008;34(7):912-918
3. Rahman A, Rahman AKM F, Shafinaz S, Linnan. *Bangladesh Health and Injury Study*. Govt. of Bangladesh, Dhaka, 2005
4. Peden M, Oyegbite K, Ozanne-Smith J, Hyder A, Branche C, Rahman AKM F, et al. *World report on child injury prevention*. WHO, Geneva, 2008.

The Impact of Cook Stoves on Acute Respiratory Infection Reduction among Children and Women: A Study from Pakistan

Amna Rehana Siddiqui, Nahida Khudadad, Faisal Khan, Asif Merchant, Ms. Rebecca Gordan, Aga Khan University, Karachi, Pakistan; Aga Khan Planning and Building Services, Pakistan; Aga Khan Foundation USA
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With funding from the US Environmental Protection Agency (US EPA) a study on the impact of energy efficient stoves on acute respiratory infection was conducted in 16 villages of Ghizer District in the Northern Areas of Pakistan by Aga Khan Planning and Building Service, Pakistan with technical assistance from Aga Khan University Pakistan. The objective of the health impact study, which is part of a larger initiative to promote energy efficient products like smokeless stoves in the Northern Areas of Pakistan, is to evaluate changes in health symptoms related to eye irritation and respiratory symptoms resulting from the installation of smokeless stoves.

In the study, changes in health symptoms were ascertained using an interviewer administered questionnaire in pre- and post- intervention households. Baseline assessments were conducted in winter 2008 and in summer 2008. After the completion of the baseline study, smokeless stoves were installed in the interventions homes (219) during the summer and fall of 2008 and the post intervention questionnaire was conducted in winter 2009. The sample size for the pre-intervention baseline assessment was 429 households in the winter and 369 households in the summer. For the post intervention assessment in winter 2009, half of the 429 winter sample households were equipped with smokeless stoves.

Figure 1: Kitchen conditions in 95% of households in the study area in winter

Figure 2: Kitchen conditions in 95% of households in the study area in summer

Figure 3: Kitchen conditions as envisaged by BACIP for the study area (at least)

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This article contains data on only the 2008 winter and summer baseline studies, as data for the 2009 winter intervention study is still to be analyzed. In addition, air concentrations were measured for carbon monoxide and particulate matter <2.5 microns in a subsample of 429 houses; using every eighth house, but the article concentrates on the eye and respiratory symptoms related findings.

Symptoms	Winter 2008 N=429	Summer 2008 N=369
Cough reported by women in last month (%)	26.5	13.7
Headache reported by women in last month (%)	41.9	50.8
Eye irritation reported by women in last month (%)	25.9	18.1
Cough reported for child in last month (%)	33.2	16.0
Eye irritation reported for child in last month (%)	12.3	8.2
Cough in spouse reported in last month (%)	23.3	7.9

Table 1: Prevalence of eye and respiratory symptoms at time of studies

Study Results: The first assessment in winter 2008 enrolled 429 study participants from 16 villages in the Ishkoman Valley of the Northern Areas of Pakistan. During the second assessment of the same respondents in summer 2008, 369 participant households were enrolled, the number of participants were less in the second assessment due to summer pasture migration.

Data for eye and respiratory symptoms showed that a larger proportion of women and children in study households reported experiencing eye and respiratory symptoms during the winter as compared to the summer. Additionally, regression modeling showed a strong relationship between eye and respiratory symptoms and the reported poor condition of stoves, adjusting for house type and number of occupants.

Analysis also showed a strong relationship between low incomes, poor housing and poor stove condition when adjusted for smoking and education levels. As the living environment, including the poor reported condition of stoves, appears to be related to upper respiratory and eye irritation symptoms in women and children, improvement in the quality of life in these areas should positively affect the health of these populations.

In the summer, when asked about their beliefs regarding use of new smokeless stoves: 76% women wanted to use them, more than 90% thought that less wood would be used in smokeless stoves, 77% thought that the house would warm faster, and 95% thought that they would produce less smoke. Half of the respondents (50%) stated that their reason for not installing a smokeless stove was cost and satisfaction with their old stove.

The study being the first of its kind in Northern Pakistan provided an opportunity for the organizations to advocate for the importance of clean indoor air, through thematic regional workshops and seminars, inviting health personnel and villagers, especially women who cook for the family.

Comparison of eye and respiratory symptoms between 2008 and 2009 and between control and intervention groups will be carried out in the coming months. There are several factors that are anticipated to affect the quality of those comparisons, including differences in the timing of winter sampling in 2008 and 2009 due to weather -related logistical difficulties, and major differences in weather and temperature during the two winter seasons. The control group in the study will receive smokeless stoves from BACIP in next phase, on the same conditions as the stoves were provided to the intervention group during the study.

Table 2: Relationship between eye and respiratory symptoms in women and children by condition of stove

	Reported Stove Condition			
Eye and Respiratory Symptoms	**Good**	**Not good**	**Total #**	**P value**
Cough reported in women in past 4 weeks	35%	65%	46	
Cough not reported in past 4 weeks	78%	22%	291	0.06
Cold symptoms reported in women in past 4 weeks	52%	48%	21	
Cold symptoms not reported in past 4 weeks	78%	23%	315	0.01
Cough reported in last 4 weeks in child	57%	43%	53	
Cough not reported in past 4 weeks	80%	20%	283	0.001
Eye congestion reported in women in past 4 weeks	64%	36%	58	
Eye congestion not reported in past 4 weeks	79%	21%	279	0.01
Eye congestion reported in child in past 4 weeks	70%	30%	27	
Eye congestion not reported in past 4 weeks	77%	23%	308	0.47

Focus on India: Momentum Builds as Three Initiatives Examine Linkages between Solid Fuel Use, Climate, and Health

Simone Brant, Berkeley Air Monitoring Group
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Cooking smoke is a major challenge in India where approximately half of all households use wood as their primary source of fuel for cooking. In rural areas, over 80% of households use biomass fuel. Inefficient burning of these fuels leads to high levels of health-damaging air-pollutants, such as particulate matter, carbon monoxide and hydrocarbons.

These high levels of indoor air pollution are associated with many negative health effects. In fact, it is estimated that 28% of all deaths due to indoor air pollution in developing countries occur in India. Respiratory infections and other respiratory diseases, in particular, acute lower respiratory tract infections, tuberculosis and chronic obstructive pulmonary disease account for about 15% of total disease burden in India, including approximately 400,000 deaths in children.

While we have these general figures for the burden of disease from indoor smoke in India, there is currently no means of directly quantifying the health benefits of reducing exposure to indoor air pollution. However, several activities are currently being developed in India that are expected to make major contributions in this area.

Kalpana Balakrishnan of the Environmental Health Engineering Department of Sri Ramachandra University (SRU) in Chennai will soon be launching a longitudinal environmental health study to examine relationships between air pollution and select health outcomes. The study will recruit pregnant women from both rural and urban communities and follow the mother-child pairs over an initial period of five years. Being one of the first of such assessments in India, it will improve the understanding of relationships between exposures to indoor and outdoor air pollutants and select adverse pregnancy outcomes such as still birth, premature birth and birth defects and early childhood health outcomes including neonatal and infant mortality and acute respiratory tract infections. With a continuum of exposures being examined, it is expected contribute to the development of exposure-response relationships for several health outcomes as well as understanding of the efficacy of available interventions in exposure reduction.

Another exciting new development in India is Project Surya led by V. Ramanathan of the Scripps Institution of Oceanography at the University of

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The PCIA's first-ever Webinar was a big success!

On June 23, 2009, PCIA held its first Webinar; a Webinar is a web-based seminar, presentation, lecture, or workshop that is transmitted over the web. A key feature of a Webinar is its interactive elements -- the ability to give, receive and discuss information. This is in contrast with a Webcast, in which the data transmission is one way and does not allow interaction between the presenter and the audience.

We were very fortunate to have John McCracken of Harvard University present new research findings of the estimation of cardiovascular mortality due to elevated blood pressure attributable to household solid fuel use (see corresponding feature article on page 2). Twenty PCIA Partners from the academic and research fields participated in the Webinar. The audio and video from the Webinar is now available for viewing online at http://www.pciaonline.org/proceedings. In the coming weeks, we will also post John McCracken's answers to questions posed during the Webinar, so check back for this additional resource. Due to the tremendous success of this Webinar and based on the positive response from participants, PCIA plans to host another Health Research Webinar in August 2009. If you have an interest in health research and would like to be added to the distribution list for upcoming health research Webinars, please let us know. If you have a specific health research-related topic you'd like to hear more about or if you'd like to be considered as a speaker, please contact moderator@PCIAonline.org. We look forward to hearing from you!

In addition, we will be developing Webinars on other household energy topics in the coming months so stay tuned for future Webinar announcements!

(Continued from page 12)

California San Diego. This project was launched in March 2009 in Uttar Pradesh State. Currently in the pilot phase, this project will distribute a range of cleaner cooking technologies including solar and improved biomass cookers to villagers. The project team will then undertake an unprecedented effort to document the effects of these stoves on global and regional climate change through reductions in atmospheric concentrations of black carbon, ozone-producing gases, and methane emissions from cooking fires, and by curtailing increases in CO_2 from avoided deforestation. They will also document the direct effects of the new technologies on human health.

Additionally, Berkeley Air Monitoring Group, partnered with SRU, is currently carrying out the initial stages of a field-based impact assessment for the Shell Foundation's Breathing Space Programme. In keeping with the program's current focus on developing appropriate products, the monitoring is designed to assess the efficacy of various improved biomass stoves in reducing air pollution in homes. Recent results show significant reductions in particulate matter and carbon monoxide concentrations and fuel savings. As the technologies are refined, there are plans to expand to additional impacts over the next several years. These will include measurement of fuel savings to calculate reductions in carbon emissions and quantification of socioeconomic and health benefits in homes with improved stoves. In this case, health benefits considered will be symptoms that cause discomfort to household members such as coughing and sore eyes.

Ultimately, as sales of improved stoves grow towards the 10 million stove goal, the focus of the program evaluation will shift towards tracking the population-level impacts of the Breathing Space Programme, including estimating its effect on public health.

Over the next five years, these initiatives are expected to make major contributions to our understanding of the link between indoor air pollution, health and climate, especially in India. These advances will allow better quantification of the health benefits of reductions in indoor air pollution through improved understanding of the dose-response relationship between pollutant exposure and specific health outcomes. We will also have enhanced information on the contribution of cookstoves to global warming through emissions of black carbon and greenhouse gases and on the direct socioeconomic and health benefits experienced by people at the household level. Together, these advances in understanding should help solidify the case for the many benefits of improved cookstoves.

Funding Opportunity Alert!

The World Bank is requesting proposals for innovative pilot projects that demonstrate new approaches to modernizing biomass energy in Sub-Saharan Africa. For more information please visit www.esmap.org/beia.html.

PCIA Website Update

Please visit the website (www.PCIAonline.org) for information on PCIA activities!

Recent updates to the website include:

- **A new Featured Partners section on the homepage**
- **New proceedings, including for the 2009 Forum, and the first PCIA Webinar (see page 12 for more details)**
- **Many new Partner and project profiles**
- **Partner breakdowns by org type and region (at www.pciaonline.org/partners/stats or from Partner search page)**

We encourage you to give us feedback on these and other new features. For any website-related questions or suggestions please contact Winrock International at moderator@pciaonline.org.

www.PCIAonline.org

The Partnership for Clean Indoor Air

Improving health, livelihood, & quality of life by reducing exposure to indoor air pollution from household energy use.

ANSWERS TO QUIZ ON PAGE 18—no peeking!

1) 4th; 2) Acute lower respiratory infections, which are closely associated with exposure to indoor smoke; 3) Africa; 4) 6 times higher; 5) 87%; 6) C; 7) dung cakes; 8) 207,000; 9) burns; 10) India

☼ HAPPENINGS

Recent Partner Activity…

Congratulations to PCIA Partners and Ashden Award winners **Aprovecho Research Center, Shengzhou Stove Manufacturer**, and **Kampala Jellitone Suppliers Ltd**! For more information: http://www.ashdenawards.org/international.

Ashden International Energy Champion Award: Aprovecho Research Center and Shengzhou Stove Manufacturer, USA/China, for making affordable, efficient stoves for the masses.

The Aprovecho Research Centre in the US and Shenghou Stove Manufacturers (SSM) in China have pooled their rich experience and skills to produce a portable, cheap, robust and efficient fuel-wood stove for mass production to developing countries. The stoves replace dirty and polluting kerosene and open fires saving up to 50 percent of fuel wood and reducing 70 percent of dangerous emissions. SSM has sold over 60,000 stoves since 2007, producing them at a rate of 12,000 stoves a month and selling them to distributers in India, South Africa, Tanzania, Madagascar, Argentina and Chile. Their current production capacity is now at 50,000 stoves per month. Please contact www.Aprovecho.org for more information.

Ashden International Award for Avoided Deforestation: Kampala Jellitone Suppliers Ltd, Uganda, supported by the Waterloo Foundation, for producing non-char biomass briquettes made from agricultural waste.

Kampala Jellitone Suppliers is Uganda's first producer of briquettes made from agricultural waste. Made mainly from dried and compressed sawdust, peanut husks and coffee waste, the fuel replaces wood and charcoal helping protect the rich biodiversity of the area. Schools, hospitals and factories across the country are buying 130 tonnes a month of briquettes, along with efficient stoves for heating and cooking. The business is set to double over the next two years and is hoping to expand to other African markets. The briquettes save about 6.1 tonnes of CO2 per tonne of briquettes used. For more information please visit: http://www.pciaonline.org/node/699.

Congratulations to PCIA Partner and Tinto Alcan Prize for Sustainability winner **Trees Water & People**! For more information about the Rio Tinto Prize for Sustainability, please visit http://www.riotintoprizeforsustainability.com.

Trees, Water & People (TWP) has been announced as the 2008 winner of the US$1 million **Rio Tinto Prize for Sustainability**, awarded at the 2009 International Economic Forum of the Americas (Conference de Montreal) last month.

"We are absolutely thankful, delighted and overwhelmed with gratitude at being announced the 2008 Prize winner. We now have the opportunity to expand our community reforestation and improved cook stove programs in Honduras, Nicaragua, and Haiti," said TWP co-founder and International Director, Stuart Conway. "In particular, we will look to use the Prize to leverage additional sources of funding, and increasingly share the work we are doing with other interested organizations."

The Rio Tinto Prize for Sustainability was designed to recognize and reward not-for-profit, civil society and non-government organizations for significant contributions to the goals of economic, environmental and social sustainability. For additional information, please visit TWP's website at www.treeswaterpeople.org or directly at http://treeswaterpeople.org/about/about_rio_tinto.htm.

Upcoming Events…

International Conference on Waste & Biomass Residues Valorization
July 9-11, 2009, Ouagadougou, Burkina Faso

This conference will bring together representatives from academic institutions, companies and nonprofit organizations with the objective to promote research and development activities in developing countries on the sustainable valorization of waste and biomass residues as fertilizers, useful materials and fuels in urban and rural areas. For more information and to register, please visit: http://www.2ie-edu.org/wasteeng_africa.

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North American Biochar Conference 2009
August 9-12, 2009, Boulder, Colorado, USA

This first major biochar conference held in the United States is organized by the University of Colorado at Boulder and is designed to advance understanding of the policy, business, scientific, and technical opportunities and issues implicated by large-scale usage of biochar as both a sequestration agent and soil amendment. For more information, please visit: http://cees.colorado.edu/ibi_2009.html

4th International Bioenergy Conference - Sustainable Bioenergy Business
August 31-September 4, 2009, Jyväskylä, Finland

The Conference will focus on the factors affecting the future of the bioenergy and biobased modern technologies and business solutions, including logistic systems, management, total procurement chains, the effects of the energy markets, the influence of green marketing and other trends affecting forestry, agriculture, industry and climate. For more information, please visit: http://www.bioenergy2009.finbioenergy.fi/default.asp?sivuID=25785.

ISES Solar World Congress 2009: Renewable Energy Shaping our Future
October 11-14, 2009, Johannesburg, South Africa

The 21st Solar World Congress will be hosted by the International Solar Energy Society (ISES) and the Sustainable Energy Society of Southern Africa (SESSA). The Congress will provide the ideal international platform for sharing share the latest findings in renewable energy research and development, technology, and education and policy initiatives, including on themes of solar cooking and water heating. With major investment into either fossil or renewable energy infrastructure on the African continent, the Solar World Congress will offer a unique opportunity to introduce the latest achievements in this field and to explore other prospects. For more information, please visit: http://www.swc2009.co.za.

☼ What's New?

... In Research

Personal child and mother carbon monoxide exposures and kitchen levels: Methods and results from a randomized trial of woodfired chimney cookstoves in Guatemala (RESPIRE)
Journal of Exposure Science and Environmental Epidemiology advance online publication, 17 June 2009; doi:10.1038/jes.2009.30.
Smith KR, McCracken JP, Thompson L, Edwards R, Shields KN, Canuz E, Bruce N.

During the first randomized intervention trial (RESPIRE: Randomized Exposure Study of Pollution Indoors and Respiratory Effects) in air pollution epidemiology, we pioneered application of passive carbon monoxide (CO) diffusion tubes to measure long-term personal exposures to woodsmoke. Here we report on the protocols and validations of the method, trends in personal exposure for mothers and their young children, and the efficacy of the introduced improved chimney stove in reducing personal exposures and kitchen concentrations.

Passive diffusion tubes originally developed for industrial hygiene applications were deployed on a quarterly basis to measure 48-hour integrated personal carbon monoxide exposures among 515 children 0-18 months of age and 532 mothers aged 15-55 years and area samples in a subsample of 77 kitchens, in households andomized into control and intervention groups.

The between-group analysis of the 3355 post-baseline measurements found CO levels to be significantly lower among the intervention group during the trial period: kitchen levels: -90%; mothers: -61%; and children: -52% in geometric means. No significant deterioration in stove effect was observed over the 18 months of surveillance. The reliability of these findings is strengthened by the large sample size made feasible by these unobtrusive and inexpensive tubes, measurement error reduction through instrument calibration, and a randomized, longitudinal study design. These results from the first randomized trial of improved household energy technology in a developing country and demonstrate that a simple chimney stove can substantially reduce chronic exposures to harmful indoor air pollutants among women and infants.

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Comparative impact assessment of child pneumonia interventions

Bulletin of the World Health Organization 2009;87:472-480.
http://www.who.int/bulletin/volumes/87/6/08-050872/en/index.html
Niessen L, ten Hove A, Hilderink H, Weber M, Mulholland K, Ezzati M.

The objective of this work was to compare the cost–effectiveness of interventions to reduce pneumonia mortality through risk reduction, immunization and case management. Country-specific pneumonia burden estimates and intervention costs from WHO were used to review estimates of pneumonia risk in children under 5 years of age and the efficacy of interventions (case management, pneumonia-related vaccines, improved nutrition and reduced indoor air pollution from household solid fuels). We calculated health benefits (disability-adjusted life years [DALYs] averted) and intervention costs over a period of 10 years for 40 countries, accounting for 90% of pneumonia child deaths.

Solid fuel use contributes 30% to the burden of childhood pneumonia. Efficacious community-based treatment, promotion of exclusive breastfeeding, zinc supplementation and Haemophilus influenzae type b (Hib) and Streptococcus pneumoniae immunization through existing programmes showed cost–effectiveness ratios of 0–60 international dollars (I$) per DALY in low-income countries and less than I$120 per DALY in middle-income countries. Low-emission biomass stoves and cleaner fuels may be cost-effective in low-income regions. Facility-based treatment is potentially cost-effective, with ratios of I$60–120 per DALY. The cost–effectiveness of community case management depends on home visit cost.

In conclusion, vaccines against Hib and S. pneumoniae, efficacious case management, breastfeeding promotion and zinc supplementation are cost-effective in reducing pneumonia mortality. Environmental and nutritional interventions reduce pneumonia and provide other benefits. These strategies combined may reduce total child mortality by 17%.

Solid fuel use and cooking practices as a major risk factor for ALRI mortality among African children

J Epidemiol Community Health. 2009 May 24.
Rehfuess EA, Tzala L, Best N, Briggs DJ, Joffe M.

Almost half of global child deaths due to acute lower respiratory infections (ALRI) occur in sub-Saharan Africa, where three quarters of the population cook with solid fuels. This study aims to quantify the impact of fuel type and cooking practices on childhood ALRI mortality in Africa, and to explore implications for public health interventions. Early-release World Health Survey data for the year 2003 were pooled for sixteen African countries. Among 32,620 children born during the last ten years, 1,455 (4.46%) were reported to have died prior to their fifth birthday. Survival analysis was used to examine the impact of different cooking-related parameters on ALRI mortality, defined as cough accompanied by rapid breathing or chest indrawing based on maternal recall of symptoms prior to death.

Solid fuel use increases the risk of ALRI mortality with an adjusted hazard ratio of 2.35 (1.22; 4.52); this association grows stronger with increasing outcome specificity. Differences between households burning solid fuels on a well-ventilated stove and households relying on cleaner fuels are limited. In contrast, cooking with solid fuels in the absence of a chimney or hood is associated with an adjusted hazard ratio of 2.68 (1.38; 5.23). Outdoor cooking is less harmful than indoor cooking but, overall, stove ventilation emerges as a more significant determinant of ALRI mortality. In conclusion, this study shows substantial differences in ALRI mortality risk among African children in relation to cooking practices, and suggests that stove ventilation may be an important means of reducing indoor air pollution.

Effect of reducing indoor air pollution on women's respiratory symptoms and lung function: The RESPIRE randomized trial, Guatemala

Am J Epidemiol. 2009 May 14.
Smith-Sivertsen T, Díaz E, Pope D, Lie RT, Díaz A, McCracken J, Bakke P, Arana B, Smith KR, Bruce N.

Exposure to household wood smoke from cooking is a risk factor for chronic obstructive lung disease among women in developing countries. The Randomized Exposure Study of Pollution Indoors and Respiratory Effects (RESPIRE) is a randomized intervention trial evaluating the respiratory health effects of reducing indoor air pollution from open cooking fires. A total of 504

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rural Mayan women in highland Guatemala aged 15-50 years, all using traditional indoor open fires, were randomized to either receive a chimney woodstove (plancha) or continue using the open fire.

Assessments of chronic respiratory symptoms and lung function and individual measurements of carbon monoxide exposure were performed at baseline and every 6 months up to 18 months. Use of a plancha significantly reduced carbon monoxide exposure by 61.6%. For all respiratory symptoms, reductions in risk were observed in the plancha group during follow-up; the reduction was statistically significant for wheeze (relative risk = 0.42, 95% confidence interval: 0.25, 0.70).

The number of respiratory symptoms reported by the women at each follow-up point was also significantly reduced by the plancha (odds ratio = 0.7, 95% confidence interval: 0.50, 0.97). However, no significant effects on lung function were found after 12-18 months. Reducing indoor air pollution from household biomass burning may relieve symptoms consistent with chronic respiratory tract irritation.

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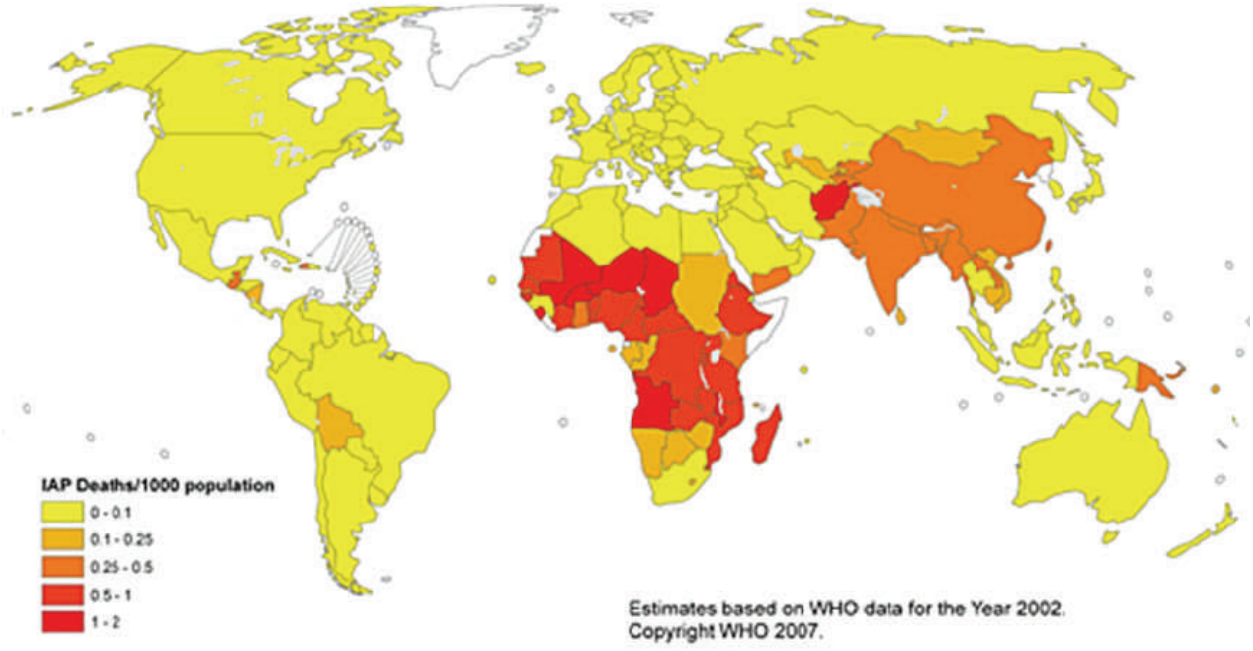
7. Johnson AW, Aderele WI. The association of household pollutants and socio-economic risk factors with the short-term outcome of acute lower respiratory infections in hospitalized pre-school Nigerian children. *Annals of Tropical Paediatrics* 1992;12(4):421-32.
8. Kumar R, Nagar JK, Kumar H, Kushwah AS, Meena M, Kumar P, et al. Indoor Air Pollution and Respiratory Function of Children in Ashok Vihar, Delhi: An Exposure-Response Study. *Asia Pac J Public Health* 2008;20(1):36-48.
9. Mishra V. Indoor air pollution from biomass combustion and acute respiratory illness in preschool age children in Zimbabwe. *Int J Epidemiol* 2003;32(5):847-53.
10. Pandey MR, Neupane RP, Gautam A, Shrestha IB. Domestic smoke pollution and acute respiratory infections in a rural community of the hill region of Nepal. *Environment International ; Vol/Issue: 15:1-6* 1989:Pages: 337-340.
11. Ezzati M, Kammen DM. Quantifying the effects of exposure to indoor air pollution from biomass combustion on acute respiratory infections in developing countries. *Environ Health Perspect* 2001;109(5):481-8.
12. Armstrong JR, Campbell H. Indoor air pollution exposure and lower respiratory infections in young Gambian children. *Int J Epidemiol* 1991;20(2):424-9.
13. ISAAC. Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema: ISAAC. The International Study of Asthma and Allergies in Childhood (ISAAC) Steering Committee. *Lancet* 1998;351 (9111):1225-32.
14. Dab W, Medina S, Quenel P, Le Moullec Y, Le Tertre A, Thelot B, et al. Short term respiratory health effects of ambient air pollution: results of the APHEA project in Paris. *J Epidemiol Community Health* 1996;50 Suppl 1:s42-6.
15. Lipsett M, Hurley S, Ostro B. Air pollution and emergency room visits for asthma in Santa Clara County, California. *Environ Health Perspect* 1997;105(2):216-22.
16. Whittemore AS, Korn EL. Asthma and air pollution in the Los Angeles area. *Am J Public Health* 1980;70(7):687-96.
17. Melsom T, Brinch L, Hessen JO, Schei MA, Kolstrup N, Jacobsen BK, et al. Asthma and indoor environment in Nepal. *Thorax* 2001;56(6):477-81.
18. Mohamed N, Ng'ang'a L, Odhiambo J, Nyamwaya J, Menzies R. Home environment and asthma in Kenyan schoolchildren: a case-control study. *Thorax* 1995;50(1): 74-8.
19. Azizi BH, Zulkifli HI, Kasim S. Indoor air pollution and asthma in hospitalized children in a tropical environment. *J Asthma* 1995;32(6):413-8.
20. Schei MA, Hessen JO, Smith KR, Bruce N, McCracken J, Lopez V. Childhood asthma and indoor woodsmoke from cooking in Guatemala. *J Expo Anal Environ Epidemiol* 2004;14 Suppl 1:S110-7.
21. Bobak M. Outdoor air pollution, low birth weight, and prematurity. *Environ Health Perspect* 2000;108(2):173-6.
22. Sram RJ, Binkova B, Dejmek J, Bobak M. Ambient air pollution and pregnancy outcomes: a review of the literature. *Environ Health Perspect* 2005;113(4):375-82.
23. Bell ML, Ebisu K, Belanger K. Ambient air pollution and low birth weight in Connecticut and Massachusetts. *Environ Health Perspect* 2007;115(7):1118-24.
24. Dejmek J, Selevan SG, Benes I, Solansky I, Sram RJ. Fetal growth and maternal exposure to particulate matter during pregnancy. *Environ Health Perspect* 1999;107 (6):475-80.
25. WHO. Indoor air pollution from solid fuels and risk of low birth weight and stillbirth: World Health Organisation, 2005.
26. Wang X, Ding H, Ryan L, Xu X. Association between air pollution and low birth weight: a community-based study. *Environ Health Perspect* 1997;105(5):514-20.
27. Rinne ST, Rodas EJ, Rinne ML, Simpson JM, Glickman LT. USE OF BIOMASS FUEL IS ASSOCIATED WITH INFANT MORTALITY AND CHILD HEALTH IN TREND ANALYSIS. *American Journal of Tropical Medicine & Hygiene* 2007;76 (3):585-591.
28. Siddiqui AR, Gold EB, Yang X, Lee K, Brown KH, Bhutta ZA. Prenatal exposure to wood fuel smoke and low birth weight. *Environ Health Perspect* 2008;116(4):543-9.
29. Mishra V, Dai X, Smith KR, Mika L. Maternal exposure to biomass smoke and reduced birth weight in Zimbabwe. *Ann Epidemiol* 2004;14(10):740-7.
30. Boy E, Bruce N, Delgado H. Birth weight and exposure to kitchen wood smoke during pregnancy in rural Guatemala. *Environ Health Perspect* 2002;110(1):109-14.
31. Houtmeyers E, Gosselink R, Gayan-Ramirez G, Decramer M. Regulation of mucociliary clearance in health and disease. *Eur Respir J* 1999;13(5):1177-88.
32. Beck BD, Brain JD, Bohannon DE. An in vivo hamster bioassay to assess the toxicity of particulates for the lungs. *Toxicol Appl Pharmacol* 1982;66(1):9-29.
33. Fick RB, Jr., Paul ES, Merrill WW, Reynolds HY, Loke JS. Alterations in the antibacterial properties of rabbit pulmonary macrophages exposed to wood smoke. *Am Rev Respir Dis* 1984;129(1):76-81.

☼ Fact Box



Above: IAP Deaths per 1,000 population,
from http://www.who.int/indoorair/health_impacts/burden_national/en/index.html

☼ Quiz on Health Impacts of Household Energy

Have you read this Bulletin carefully? Test your newfound knowledge here below!

1. In the list of serious threats to health in less developed countries, where does IAP from household energy rank?

2. What is the single leading cause of death in children under 5 world-wide?

3. In what region of the world are deaths due to respiratory diseases highest?

4. Among 500 Gambian children under 5 studied, how many times higher was the risk of ALRI in girls than in boys?

5. What percentage of the visually impaired live in the economically less developed countries?

6. What is the suspected relationship between HIV and biomass fuel use: (a) HIV can accelerate COPD development; (b) lung inflammation due to smoke exposure can drive HIV replication; (c) both.

7. Which of these fuels results in the highest CO emissions when burned: crop residues, wood, dung cakes, kerosene, LPG?

8. How many cardiovascular disease-attributed deaths among women could have been prevented in 2004 by halving solid fuel smoke exposure?

9. What type of accidental injury is commonly associated with traditional solid fuel use?

10. In which country do an estimated 28% of all deaths due to indoor air pollution in developing countries occur?

To learn more about the latest in household energy and health research findings, please visit the USAID/Environmental Health-run Indoor Air Pollution Updates blogsite: ***http://iapnews.wordpress.com****.*

The purpose of this news feed is to provide news, information and resources on indoor air pollution issues in developing countries.