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ARECOP

The Asia Regional Cookstove Program (ARECOP) is a forum for voicing the concerns of improved cookstove programs in the Asia Region. It influences and facilitates effective and efficient programs in improved cookstove issues.

DEAR READERS

Greetings from Yogyakarta! Things have been busy at the ARECOP Secretariat these past few months, from monitoring visits to MPA workshops to helping out with stove trainings, held right here in Yogya! The ICSP network throughout Asia is growing fast.

With the objective of creating a resource magazine that is more thorough and informative for the readers, the ARECOP Secretariat has begun adopting themes for every issue of Glow. Indoor Air Pollution, Biomass, and Improved Cookstoves was chosen as the theme for this issue. To obtain a wide range of articles and perspectives on this issue, the secretariat invited two experts in the field of improved cookstove to become the guest editors of this issue, Preeti Malhotra of the Tata Energy Research Institute in India and Auke Koopmans of FAO-RWEDP. Each guest editor suggested possible authors to use, who were then contacted and invited to submit articles. Articles were chosen that were complementary to each other and were able to give a variety of perspectives on the issue.

From the East West Center in Hawaii, USA, Sumeet Saksena writes of a study done in urban slum conditions, comparing the overlap between indoor and outdoor air pollution, the exposure to IAP felt by kerosene and wood-fuel users, and ultimately questions if a cleaner fuel necessarily means less exposure to IAP.

Kiran Dhanapala of West Virginia University has been working in the field of IAP using a new research method, known as the Stated Choice Method, which focuses on valuing the impacts of improved cookstoves on human health.

To provide readers with a brief overview of the known health impacts of indoor air pollution, Dr. MR Pandey of MSMT has reviewed health studies done in many countries, focusing on the various diseases and illnesses caused by indoor pollution.

Finally, Dr. and Dra. Soriano of the Philippines have submitted an article reviewing their study on the correlation between indoor cooking smoke, cigarette smoking and tuberculosis and cataract. The study reveals a correlation between fuelwood use and tuberculosis and cataract prevalence.

Please enjoy your reading! We hope this issue provides readers with an overview of the various causes and impacts of indoor air pollution as released from inefficient biomass-burning cookstoves, and helps those working in ICS dissemination programs to develop sustainable and realistic approaches to stove development. g

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Front Cover : Stove with chimney hood in Vietnam (Le Van Thong, 2002)

GUEST EDITORS

Auke Koopmans
Auke Koopmans is a national of the Netherlands but lives in Thailand, which has been his "home on and off" for the last 27 years. He has a mechanical and ceramic background and has worked mainly in Asian countries (Bangladesh, Bhutan, Cambodia, Indonesia, Laos, Sri Lanka, Thailand and Vietnam) as well as in Africa and Central-America. His field of professional interest is biomass energy related with emphasis on biomass energy using small-scale industries as well as domestic and institutional cooking and heating stoves. Since the closure of the FAO-Regional Wood Energy Development Program, in which he worked initially as the Wood Energy Conservation Specialist and later as the Chief Technical Advisor, he works as an independent consultant in the field of biomass energy.

Preeti Malhotra
Preeti Malhotra is a social researcher having eight years of experience in rural energy development. She has a Masters degree in Social Work. She is presently working as a Research Fellow in the Regulatory Studies & Governance Division, TERI, New Delhi. She has worked in the following specific areas: i) Social impacts of energy/environment projects, ii) Gender and equity iss ues in rural energy and natural resource management, iii) Planning and implementing Renewable Energy Technology (RET) projects in rural areas, iv) Policy research and program evaluation, v) Market promotion of RETs, and vi) Technology and poverty alleviation (sustainable livelihoods, increasing choices/options, capacity building, etc.). She has co-authored four books and published and reviewed papers and articles in national and international journals.

EDITORIAL

Biomass Energy, Indoor Air Pollution and Health

Biomass energy (wood, charcoal, agricultural residues, dung, etc.) is widely used as a source of energy in developing countries. Rough estimates indicate that on a worldwide basis one third of the population or about 2 billion people depend on these sources of energy. Biomass energy is mainly used to cook food, using either traditional or improved stoves. However, cooking stoves may at the same time also serve as a source of heat (space heating), provide light, repel insects, preserve thatched roofs, dry crops and so on. In fact, the "simple cooking stove" is an integral part of the households, a feat which "modern" stoves may find difficult to emulate. This, as some people argue, may have been one of the reasons why it has been difficult to improve the situation through the introduction of better stoves or by changing the "cooking environment".

Improvements are needed, something no one will argue with, as evidence gathered over the last 2 decades, shows that the traditional multi-function wood and other biomass energy using stoves are not very efficient, often emit considerable amounts of smoke, soot, particulates as well as all kinds of harmful gaseous emissions from incomplete combustion (PIC). As a result, the cook - often the housewife - and small children she is taking care of while cooking - are exposed to high levels of indoor air pollution.

Results from studies carried out in developing countries indicate that particulate concentrations from traditional biomass using stoves are often 10 or more times higher than the standards set by the U.S. Environmental Protection Agency. Exposure to these high levels of pollution has been consistently associated with acute respiratory infections (ARI), the largest single-category cause of morbidity and mortality worldwide[1]. There is also evidence that links exposure to biomass fuel combustion with chronic obstructive lung disease, tuberculosis, cataracts, and adverse pregnancy outcomes. In fact, "indoor air pollution" is after "clean water and sanitation" the second largest environmental burden of disease when expressed in Disability Adjusted Life Years (DALYs)[2]. Besides being hazardous to the health of the users, PIC's are at the same time direct or indirect greenhouse gases (GHG) as well. This implies that reducing PIC levels will not only benefit health but also mitigate GHG at the same time.

Wood and other biomass will remain an important source of energy for many years to come and though these sources of energy are becoming less important in the overall energy situation in many countries, in absolute terms the amount consumed is still increasing. For that reason it is clear that action needs to be taken to improve the situation.

One of the easiest measures to reduce indoor air pollution - and widely used in some Asian countries - is the installation of a chimney or a fireplace-like hood over the stove. Admittedly, while this will reduce indoor air pollution, it does nothing for air pollution in general and would not help in reducing GHG. A switch to other less polluting fuels such as commercial sources of energy - LPG, kerosene, electricity, etc. - is another option. However, the cost of the stoves needed as well as the energy itself are generally considered to be barriers for a widespread adoption and use by a large part of the population in developing countries.

Considering that there is in principle nothing wrong with wood and biomass as a source of energy but that problems are being caused by the technology used, another option has been to improve the existing stoves. Initially this process was only technology driven but over time it became clear that something was lacking, as improved stoves were not widely adopted. Stoves, traditional as well as improved versions, need to be easy to use, cheap and durable, if possible be multi-functional, allow multi-fuel use, etc. In short, non-technical issues are equally, if not more, important. This is not to say that technology should not play a role but rather that an improved stove design should be a sensible combination of non-technical issues and technological issues like for instance heat transfer efficiency. It should be noted however that high heat transfer efficiency is not sufficient by itself because there can still be large PIC emissions. High combustion efficiency, i.e., low emissions of PICs is also needed, as this will reduce not only indoor air pollution but GHG's as well.

1 The World Health Organization (WHO) has estimated that as many as 2 million people in developing countries, with the majority under 5 years old, die prematurely every year from exposure to the combustion products of household solid fuels (Albalak et al, 2001).

2 The concept of DALYs combines life years lost due to premature death and fractions of years of healthy life lost as a result of illness or disability. A weighting function that incorporates discounting is used for years of life lost at each age to reflect the different social weights that are usually given to illness and premature mortality at different ages. The combination of discounting and age weights produces the pattern of DALY lost by a death at each age. For example, the death of a baby girl represents a loss of 32.5 DALYs, and a female death at age 60 represents 12 lost DALYs. Values are slightly lower for males (Worldbank 1999).

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Health Effects of Indoor Air Pollution

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Indoor air pollution in rural areas in developing countries where biomass is the principal fuel source has now been recognized as a serious and widespread health problem[1]. Evidence from a number of countries, including Nepal[2], India[3], Papua New Guinea[4,5] and Kenya[6] suggests that domestic fires for cooking and heating purposes can cause significant pollution with gaseous substances and suspended particulates in the home environment. This paper provides an overview of studies and research done on various health impacts from domestic cooking smoke.

It is estimated that about half the world's households cook daily with biomass fuels. Most of this cooking is done using unvented stoves, with women, infants and young children experiencing the highest exposures. Measured levels of air pollution in these houses in developing countries greatly exceed levels of indoor and outdoor pollution concentration levels found in developed countries. Pollutants found in biomass smoke include respirable suspended particles, carbon monoxide, nitrogen oxides, formaldehyde, and hundreds of other simple and complex organic compounds, including polyaromatic hydrocarbon etc[7]. In many parts of the world, for all or part of the year, these pollutants are released from stoves in fairly unventilated kitchens and homes. It is critical to understand the health impacts of such a significant problem affecting many parts of the developing world.

I. Domestic Smoke Pollution and Respiratory Diseases

Several studies have implicated domestic smoke pollution (DSP) as responsible for respiratory diseases including chronic obstructive pulmonary disease (COPD) in adults and acute respiratory infection (ARI) in children. There is further evidence of a correlation between DSP and tuberculosis and interstitial lung disease. There is also some suggestion that DSP may be related to asthma. This is an important area for further research.

1. Chronic bronchitis and chronic obstructive pulmonary disease (COPD) in adults

COPD is a leading cause of death and disability of human life around the world. In 1990, the World Bank and the World Health Organization (WHO) ranked COPD 12th as a disease of global burden, and it is estimated that COPD will be ranked 5th by 2020[8]. An early study done in Papua New Guinea[4] showed a possible relationship between DSP and chronic bronchitis. A definitive study was conducted in Nepal to determine the distribution and magnitude of these diseases in different geographical regions of the country and to identify responsible factors[9]. Four different sites were selected for this purpose: urban Kathmandu, the Sundarijal and Bhadrabas villages of Kathmandu district from the rural hill region, Parasauni of Bara district from the plain region, and Chandannath of Jumla district from the mountain region of the country. Analysis of data from different sites showed the crude prevalence rate of chronic bronchitis to be 11.3 percent in urban Kathmandu, 13.1 percent in Parasauni, 18.3 percent in Sundarijal and Bhadrabas and 30.9 percent in Chandannath.

An interesting fact of this study is that there was a similar high rate of prevalence of chronic bronchitis in women as in men. This contrasts with the findings of most other studies which show a lower prevalence rate among women[10]. On the other hand, higher percentages of women as compared to men in all the four sites were either non-smokers or smoked lesser quantities. This can be explained in light of the fact that a significantly higher proportion of women as compared to men in all the four areas were exposed to DSP for longer hours. In Sundarijal and Bhadrabas the increasing trend of the prevalence of chronic bronchitis as the hours of exposure to DSP increased (even after elimination of the age effect and also among the non-smokers) further establishes the definite role of domestic smoke pollution in causing this disease[10].

Prevalence of chronic bronchitis according to time per day spent near fire place

Average time/day (H)	Women			
	N	Cases	Prevalence (%)	
			Crude	Age adjusted
Non smokers				
0 - 0.9	64	4	6.25	6.99
1 - 1.9	142	6	4.23	4.91
2 - 3.9	85	29	15.67	17.68
4+	134	27	20.14	19.87
Total	**525**	**66**	**12.57**	**13.76**

(X 2 = 19.96, DF=3, P < 0.001)

In the urban Kathmandu and Terai sites, a significant association between disease prevalence and hours of exposure to domestic smoke pollution was also found. A large number of people exposed to domestic smoke pollution for more than eight hours in the mountainous region of Chandannath provided an opportunity to see the effect of longer hours of exposure versus shorter hours of exposure. A significant correlation was seen even beyond eight hours of exposure in both the sexes, the longer the exposure, the higher the disease prevalence. Hence, there is a dose-response relationship between domestic smoke pollution and chronic bronchitis.

These studies tend to show that even non-smoking women who have cooked on biomass stoves for many years exhibit a higher prevalence of chronic bronchitis than might be expected in similar women who have had less exposure to biomass stoves. Indeed, in rural Nepal nearly 15% of non-smoking women (20 years and older) had chronic bronchitis, a high rate for non-smokers.

Domestic smoke pollution and respiratory function among women

Another study done in Nepal showed a statistically significant decline of lung function with increasing hours of exposure to DSP among smokers. In the non-smokers there was also a decline but this was not significant[11].

2. Acute Respiratory Infection (ARI)

ARI is the largest single disease category in the world contributing 8.5% of the total global burden of ill health[7]. More than five million children under five years of age die in the world each year from ARI and 80% of these deaths occur in developing countries[1]. Several studies have shown positive correlation of indoor air pollution with ARI morbidity and mortality. Passive inhalation of smoke may contribute to the respiratory infection in infants and children and the possible mechanisms are: cilial paralysis, the facilitation of attachment of respiratory bacteria to mucosa and the depression of immune responsiveness.

Studies done in developing countries

The most interesting studies on ARI and DSP now available were done in South Africa, Nepal, Zimbabwe, Gambia, Nigeria, India, Malaysia, Papua New Guinea and Brazil. A study in Nepal conducted in 1990 measured the pollutant levels and established a dose-response relationship between the exposure to DSP and the prevalence of ARI in children. An average length of time spent near the fireplace per day by children was taken as a measure of exposure to DSP. A positive correlation was found between all grades of ARI and hours of exposure to domestic smoke pollution among infants below 2 years of age.

There are many other studies indicating that indoor air pollution is a definite cause of ARI in children. In a study of 500 children in Gambia, girls under 5 years carried on their mother's back during cooking (in smoky cooking huts) were found to have a 6 times higher risk of ARI, a substantially higher risk factor than parental smoking. There was no significant risk observed, however, in young boys. The risk estimate was adjusted by using multivariate analysis to minimize the effect of some other factors like ethnic group, socioeconomic status, access to health care and nutrition[13]. Achmadi[14] from Indonesia observed during a three-month cohort study of acute respiratory infection (ARI) among children under five, that the episodes of acute respiratory tract infection were closely related to independent variables such as the degree of indoor air quality, number of people per square meter (population density), and socio-economic status. A South African hospital-based study of 132 infants with severe lower respiratory tract disease found that 70 percent had a history of heavy smoke exposure from cooking and/or heating fires[15].

However, a recent hospital-based study of children under five from Kerala, India failed to show a relationship between pneumonia and stove smoke after multivariate analysis[16]. There have also been reports from Malaysia and Papua New Guinea, which do not show any effects of domestic smoke on ARI. But these studies were done with school-age children who are at relatively low risk. Most of these studies provide extremely suggestive indication that exposure to wood smoke is an important risk factor of pneumonia.

K. Smith on his informal 'meta-analysis' of 10 studies in developing countries concludes that the exposed young children have 2-3 times more risk of serious ARI than unexposed children[17].

3. Tuberculosis

Although domestic smoke has been suggested to be a risk factor of tuberculosis, there has been no direct evidence of the same. Recently Mishra and Smith have shown on the basis of an analysis of 260,162 persons age 20 and over in India's 1992-93 National Family Health Survey, that persons living in households that primarily use biomass for cooking fuel have substantially higher prevalence of active tuberculosis than persons living in households that use cleaner fuels (odds ratio = 3.56, 95% confidence interval = 2.82-4.50)[18]. This effect is reduced somewhat when availability of a separate kitchen, house type, indoor crowding, age, gender, urban or rural residence, education, religion, caste or tribe, and geographic region are statistically controlled (OR = 2.58)[18]. This is an important study but has to be replicated in other parts of the world.

4. Asthma

The incidence of asthma is rapidly increasing in the developing world. In our recent study of 2,330 schoolchildren in Kathmandu, Nepal, the risk of asthma was higher in subjects exposed to passive smoking [OR 1.9, 95% Confidence Interval (1.0 to 3.9)] and indoor use of smoky fuels [OR 2.2, 95% Confidence Interval (1.0 to 4.5)][19].

ARI episodes according to time spent per day near the fireplace (February-June 1984) [12]

Average time per day (in h)	0-1 year				1-2 year			
	ARI episodes				ARI episodes			
	N	I	II	III/IV	N	I	II	III/IV
0-0.9	33	40 (1.21)	9 (0.27)	1 (0.03)	17	42 (2.47)	4 (0.24)	1 (0.06)
1-1.9	90	120 (1.33)	33 (0.37)	6 (0.07)	64	118 (1.84)	15 (0.23)	8 (0.13)
2-3.9	94	170 (1.81)	48 (0.15)	16 (0.17)	95	179 (1.88)	32 (0.34)	11 (0.12)
4+	16	30 (1.88)	13 (0.81)	9 (0.56)	40	81 (2.03)	31 (0.78)	11 (0.28)
Total	233	360 (1.55)	103 (0.44)	32 (0.14)	216	420 (1.94)	82 (0.38)	31 (0.14)

Grade I = Mid ARI, Grade II = Moderate ARI, Grade III/IV = Severe ARI

II. Other Health Effects of Domestic Smoke Pollution

1. Low birth weight

There are no recorded studies on the effects of indoor cooking smoke on birth weight. However, there is substantial evidence to suggest a significant impact. The major effect is thought to be the increased carbon monoxide content in the kitchen, which gets into the mother's bloodstream and affects the way the oxygen in the blood is delivered to the fetus. Given the well-documented effects of mothers' cigarette smoking on fetal growth, smoke-filled kitchens are likely to produce a low birth weight, or may lead to infant death before or at the time of birth. A second reason for low birth weight may be that the pregnant woman is more likely to suffer from lung infections that in turn reduce her appetite and food intake. At the same time, to fight the infection, her nutritional requirements increase, so less nutrition is delivered to the fetus, and there is reduced oxygen uptake in the bloodstream.

2. Cancer

There are many chemicals in biomass smoke which are known to cause cancer in laboratory animals and are found in mixtures known to cause cancer in humans[20]. In the 1970s, based on a small study in Kenya, it was thought that cancer in the nose and throat might be associated with biomass smoke[21], but newer studies in Malaysia[22] and Hong Kong[23] have failed to confirm this. A recent study from Osaka, Japan[24] found that women cooking with straw or wood fuel up to 30 years of age have an 80% increased chance of having lung cancer in later life. In contrast to biomass, there are many studies of the air pollution levels and health impacts of cooking with coal on open stoves, almost all done and published in China, where coal use for cooking is common[25]. A range of effects is found, including quite strong associations with lung cancer.

3. Eye problems

It is quite obvious to everybody that domestic smoke pollution causes minor irritations of the eyes and upper respiratory tract. It can cause conjunctivitis. It has been suggested that it may also be responsible for cataracts, but there has been no scientific evidence for the same. (Please see p.xx for more information on the correlation between indoor air pollution and cataracts)

Conclusion

Domestic smoke pollution is responsible for a relatively high percentage of morbidity and mortality mainly due to respiratory diseases in many parts of the developing world. Be it through the wide spread dissemination of fuel-efficient, smokeless stoves or through focusing on improving biomass fuel and fuel-processing technology, immediate attention to this issue is required to reduce the disease burden caused by indoor air pollution in these countries.

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Valuing the Invisible Health Benefits of Stoves

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While most research on the health effects of air pollution has focused on outdoor environments, Indoor Air Pollution (IAP), more specifically, cooking smoke emissions in developing countries, is increasingly being identified as a priority area for research and action. Research gaps have been identified at a global meeting convened by USAID-WHO (2000). This highlighted a need for research on the economic valuation of health impacts, particularly using Willingness To Pay (WTP) methods (ibid). The gap in economic values[1], once filled, will help to promote better policy-making and attention to environmental health problems.

Valuation is key for stove projects and other household energy initiatives, to better and more effectively represent the benefits of such initiatives given the competing demands on economic and donor resources. Fuller valuation implies improved cost-benefit analysis-based decision-making. Further, it allows a fuller assessment of resource scarcity, environmental protection and solutions-led responses to pollution by policy-makers who can weigh costs vs. benefits of specific policies in different sectors.

A range of approaches have been used to estimate the health impacts of air pollution – from epidemiological to mortality and morbidity valuation. Economic valuation uses either Physical or Behavioral methods, but often lacks comparability as each method measures different welfare costs. Table 1 summarizes these approaches as used in studies valuing air pollution.

Valuing health impacts is often controversial and misunderstood, particularly in valuing mortality, or life. Much work has been done already on valuing the health effects of outdoor air pollution such as studies by Alberini et al. (2000), Cropper et al. (1997), Ostro et al. (1998), and Krupnick et al. (2000, 1999, 1996). Valuation of IAP is a new research priority, with research by Larson et al. (2002) and Saksena et al. (1997) using a Benefit Transfer (BT) approach, and Parikh et al. (2002) using a Cost of Illness[4] (COI) method.

Valuation of the benefits and costs of using Improved Cook Stoves (ICS) to address environmental health problems is limited. There have been several limited micro-studies on these issues from an epidemiological and public health perspective. Most ICS project documentation and evaluations and general development initiatives on household energy issues report on user perceptions of stove performance and satisfaction. For example, the Department for International Development (DFID, 2000) presents user perceptions of improved stoves adopted, poverty impacts, etc., as reported numbers or percentages perceiving a particular benefit. Ramakrishna et al. (1989) notes that in particular smoke reduction is the main reason (and fuel efficiency the secondary benefit) for improved stove adoption by users in multi-country surveys. There has however, been little analysis of the priorities attached to these benefits and their values in terms of welfare impacts. The result is a lack of a common metric useful for economic decision-making.

The Health Impacts of IAP – where do we go from here?

Reducing the health impacts of IAP is little understood from a household

Table 1: Summary of Valuation approaches – Air Pollution and health impact

Physical linkage approach	**Behavioral linkage approach**
Technical relationship between environmental change & damage – Dose-Response or damage function. Physical relationship applicable to most environmental problems, particularly when people are unaware of pollution effects.	Value of damage based on individual's willingness to pay (WTP) for reduced or avoiding damage (mortality and morbidity)
Methods to value opportunity costs: 1. Cost of productivity 2. Cost of Illness (COI) – morbidity effects 3. Human Capital (HK) – mortality effects 4. Replacement costs **Steps:** a) relate exposure associated with environmental quality to human morbidity / mortality (Dose Response or D-R coefficient) b) calculate physical damage size using D-R coefficients c) evaluate monetary costs of measured damages using any of four above methods	**Methods**: 1. Revealed Preference (RP) Method[2] or use of a surrogate market 1.1 Property value differentials (Hedonic Price method) 1.2 Wage differentials 1.3 Defensive expenditure or averting behavior 2. Stated Preference (SP) Method[3] – hypothetical survey techniques to elicit WTP responses 2.1 Contingent Valuation Method (CVM) 2.2 Stated Choice Method (SCM)

perspective. A better understanding of household preferences regarding improving indoor air quality and what people are willing to pay for this improvement will lead to effective abatement strategies. This is well-addressed by Larson et al. (2002). Given that indoor air quality is a non-market good, understanding household demand for this requires an innovative approach.

Existing research on health impacts consists of mainly epidemiological studies for specific groups of persons in specific countries. The problems in transferring such estimates are apparent given the differences in population characteristics and other factors between sites. Research also tends to fall short of indicating where health risks are felt most in relation to specific household conditions, i.e. stove types used, behavior of cooks, cooking practices, etc. This is addressed to some extent in Ezzati et al. (2002) and Balakrishnan (2002). However, the link between health benefits and IAP abatement strategies needs greater attention. Questions that remain to be addressed in further research include: What makes people buy cleaner stoves? Do users value reduced smoke emissions from their new stove? Do they perceive the reduced health risks from reduced smoke emissions as a benefit? Is the lack of understanding about health benefits from cleaner stoves responsible for a relatively low demand of stoves even in countries where they are commercially available and relatively inexpensive? In what ways can the link between health and household energy use be effectively conveyed to households?

Using Environmental Valuation methods to value IAP related health Impacts – the use of Stated Choice

Valuation studies of IAP-related health impacts are scarce. Valuation would help in solving the puzzle of why, for example, ICS's are not more widely adopted given the evidence of relatively high demand (expressed as household WTP) as seen from a benefit-transfer study by Larson et al. (2002) or, alternatively in the Cost of Illness (COI) study showing relatively high expenditures on respiratory illnesses by Parikh et al. (2002). Research using Stated Preference (SP) techniques in undertaking primary Willingness to Pay studies in developing countries is still an emerging area. Potentially, the Stated Choice Method (SCM), a relatively new SP tool, presents a way whereby health benefits from reducing IAP can be measured in terms of a monetary value, or marginal WTP. In addition to deriving the WTP for health risk reductions from reduced IAP, it can also be used to value distinct stove attributes, including varying smoke levels among other attributes.

Any good or service can be described by its characteristics (or attributes). Therefore, a person's value placed on a good or service will depend on the levels/presence of these attributes in a specific good. SCM analyzes people's choices, or trade-offs over a good's (or, environmental service's) specific attributes and their different levels to get a value for each of these characteristics. A monetary attribute such as the cost of reducing IAP via various abatement options at the household level is usually included. Respondents are given a realistic but hypothetical context with possibly some background on the good they will be asked to consider. They are then asked to choose their preferred alternative from among several alternatives (for instance Options A, B or C, which is a no choice option) in a choice set or, experiment. Each alternative (A or B) is described by a number of attributes (see Figure 1). Repeated choice experiments provide choice data in a specific context drawn up for respondents. Carlsson et al. (2002) notes the usefulness of "warm up" choices in conducting experiments. It is a hypothetical survey method that elicits household preferences in a specific context. Interestingly, a study comparing hypothetical versus actual choice experiment by Carlsson (ibid) found no differences in preferences based on Marginal WTP. Good research design with careful pre-testing of all survey components is key to getting accurate and meaningful values in this method.

Benefits

SCM is a relatively new method with roots in market research and has been used in transport and health care issues. It has also been used for valuing environmental and non-market goods like recreational and hunting services. The method has many advantages. First, it is attractive to economists given that it is a utility-based method yielding valid welfare measures. Second, it gives total welfare values unlike other methods such as the Cost of Illness (COI) method, which addresses medical expenses and days lost to illness but ignores indirect costs like pain and suffering, defensive expenditure, lost leisure time and altruistic benefits. Third, SCM is suited to valuing multi-attribute goods such as ICS where respondents may not be aware of all attributes. Fourth, SCM is able to separately value a good's attributes given certain assumptions. Fifth, repeated choice experiments including substitutes, different attribute levels and options enable preference construction in a real market-like decision context. It therefore allows for testing of internal validity and consistency in responses. Finally, in keeping with this realism, proposed payment vehicles are flexible and context responsive. They may be price or non-monetary attributes. Non-monetary payment vehicles may include property taxes, work days, or voluntary donations to avoid protest votes associated with compulsory payment mechanisms like taxes.

SCM can be used to assess reductions in the risk of morbidity and mortality from IAP. The use of SCM for valuing risk reduction directly as an attribute has already been applied in some studies such as Hjalte et al. (2000) for risk values for fatal and non-fatal road accidents, and Telser et al. (2002) for risks of femur fracture in the elderly.

Methodology

A vital factor is how risk reductions are linked with IAP abatement strategies (such as increased ventilation,

Figure 1: Illustrative example of a choice experiment card on stove characteristics

Your Stove will have the following characteristics	Alternatives to Choose From		
	Option A	Option B	Option C
Fuel wood consumption	Same	Less	Do not Choose Either A or B - Prefer to use my current stove
Smoke Emissions	Less	More	
Cooking Time	Same	Less	
Ease of use	Less	Less	
Soot levels on pots	Same	More	
Price of Stove (in Sri Lanka Rupees)	Rs. 60	Rs.100	
Tick Preference			

switch to cleaner stoves, stove position etc) and then conveyed to respondents. This will have to be done using visual and other methods of conveying risk information and changes in IAP levels associated with various household characteristics. Any valuation elicitation exercise needs to set up background and contextual information for respondents to think about the issue before expressing their values. This judgment context helps focus the task, reduce cognitive effort while making respondents think and learn, and makes the task relevant and meaningful. There is a growing area of evidence on effective risk communication tools to use in valuation studies. For example, Satterfield et al. (2000) finds an advantage in using narrative (everyday, storyteller, first-person language) over utilitarian (passive, abstract, technical sounding) text for the judgment context read by respondents. Others, like Corso et al. (2001) have tested different visual methods of communicating mortality risk reductions to respondents as a prelude to value elicitation exercises.

Another more conventional market research use of SCM is to disaggregate users' preferences and values for different stove characteristics. For example, how much do households value wood savings as compared with smoke reductions or time savings and convenience? Valuing each characteristic gives stove programs and policy makers an idea of what users' priorities are, why people don't currently buy cleaner stoves, the extent of users' demands for a stove with certain characteristics, and in general a better understanding of the barriers to stove purchase.

Elicitation of choices can be done with cards, in words or illustrated, or talked through with a respondent. An example is illustrated in Figure 1.

Conclusion

Past work on IAP and health issues has focused on the size and extent of the problem, links between fuel use, emissions and health, user perceptions and benefits and some analysis of impacts of interventions. A key gap lies in understanding household demand for IAP abatement. Pushing the research frontier to find efficient abatement strategies[5] implies analyzing household preferences and demand for clean stoves and cleaner indoor air quality by using non-market economic valuation techniques at the household level. SCM, when applied to ICSPs, can assist in closing this information gap by focusing on user preferences and values of health risks and stove attributes (rather than user perceptions of ICS benefits which provides little quantitative data). This can provide ICSPs with the necessary information to develop program direction and focus on ICS attributes most appropriate to user preferences. It also provides fuller information for improved decision-making and policy-making on IAP abatement, household energy and environmental health issues.

1 A value is a monetary amount (cost or benefit) placed on a good or service that is consumed directly, indirectly or simply appreciated by its very existence, e.g. the existence of rain forests in a distant region one is unlikely to ever visit. Values for economic and environmental goods and services can be held either by individuals or public groups, or assigned to specific ecological functions or services, e.g. a watershed area.

2 Revealed Preference methods infer the value of non-market goods by analyzing actual (revealed) market behavior on a closely linked market. For example, the value of drinking water may be gathered from looking at expenditure on water filters, bottled water, etc.

3 Stated Preference methods derive the value of non-market goods by asking people to state their preferences or WTP in a hypothetical setting. Survey design is developed to alleviate various biases associated with such a survey approach.

4 Cost of Illness approach values morbidity cost as the sum of medical expenditures and lost work wages during a period of illness. It is viewed as a relatively low estimate of the total economic value of morbidity.

5 An efficient abatement strategy does not usually imply no smoke emissions. There will be some level of emission where the marginal cost of abating stove smoke equals the benefits of this level of reduced smoke emissions.

Fuel Usage and Indoor Air Pollution In Low-income Urban Areas Of Delhi

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In recent times there has been an increasing awareness about the potential health hazards associated with the combustion of traditional biofuels for the purpose of cooking or space heating. In rural areas, women and children are exposed only to pollutants from such combustion, but their counterparts in urban slums are further exposed to pollution from industrial sources and vehicles, as slums are commonly located near factories and highways.

A number of studies have attempted to estimate the exposure from biomass combustion in rural areas of India, Nepal, and a few countries in Africa. However, availability of information related to the urban situation is sparse. This paper will attempt to shed light on this subject.

It has been postulated that switching from lower to higher quality fuels, i.e., moving up the energy ladder, generally leads to substantially lower emissions of health-damaging pollutants. The extent to which exposure is reduced in urban areas is particularly difficult to assess, due to the presence of both indoor and outdoor air pollution sources.

Even at the household level, the impacts involved in shifting to better energy systems are significant. Considering the large populations of developing countries, the implications at national and international levels are indeed likely to be astronomical. Coupled with the difficulties in obtaining suitable alternative fuels, the policy issues are of serious concern to decision-makers and planners. Before embarking on new national policy or technical initiatives, there is a need to gather extensive scientific evidence. Some questions of interest here are:

- How clean are clean-fuel stoves?
- Are clean-fuel stoves the sole guarantee to a better energy-environment situation?
- What are the energy-environment implications of urban growth and rural-urban migration to both the communities involved and at the national level?

Delhi case study

The study is of special interest because of the current lack of information regarding the urban slum situation, including possible complex interactions between indoor and outdoor air quality and housing conditions.

The objective of the study was to estimate the daily exposure of infants in winter to fine particulate matter (also called respirable suspended particulates, RSP) and carbon monoxide. The secondary objective of the study included estimating the daily exposure of mothers with infants to RSP, studying the fuel usage patterns in the selected slums, and gathering data on basic household information and baseline health status. The study involved identifying the environments in which the target groups spend most of their time, and measuring both the concentration levels of pollutants and the time spent in each of them. RSP was measured using portable personal samplers (small and light enough to be strapped on to a study subject) that draw air through a cyclone (for separating the finer particles from the bigger ones) and then through a filter on which the particles are finally deposited. CO was measured using a small digital dosimeter (a device for measuring doses of radiations). For measuring cooking time exposures both instruments were placed a metre away from the stove at the height of the breathing zone. In other environments, they were placed in the centre of a room or other convenient locations.

We conducted the survey in two slums - one a highly polluted area and the other a relatively less polluted area. In each slum, our sample consisted of equal numbers of households that predominantly used wood or kerosene. The survey was conducted in winter – November 1994 to February 1995 by the Tata Energy Research Institute.

According to a survey conducted by the Delhi Administration in 1991, there are more than 1000 slum clusters in Delhi. These are called Jhuggi-Jhopri (JJ) clusters. While slum-like conditions exist in about 50% of Delhi's population, the JJ clusters account for 10% of the total population. The decade between 1971-1981 saw a 200% increase in the supply of fuelwood in Delhi. However, after 1981 there has been a steady decline. Ration cards enabling the purchase of kerosene were issued in 1991 to most slum dwellers, and after that fuelwood consumption decreased drastically. Those who have ration cards may still have found the price too high, and there is the additional issue of kerosene earmarked for domestic consumption being illegally diverted for other uses. Right now, Delhi has the highest per capita consumption of kerosene among the cities of India. Both rural and urban poor households in South Asia and perhaps in Southeast Asia as well do not use much coal, as compared to African or Chinese households.

Results

The results of measurements relating to cooking energy are shown in Table 1. It was observed of wood users that there were statistically significant differences in fuel consumption between the two slums. The per capita consumption of wood seems lower than that reported by previous studies, which report a typical fuelwood use of 1 kg/capita/day. The possible reasons for this are:

- the data reported here is based on actual measurements, whereas earlier surveys relying largely on recall methods tend to overestimate consumption
- communities with lower purchasing power tend to cook a fewer number of meals, and have less access to food and fuel.
- A tendency has also been observed in slums towards buying partly or fully cooked food.

Table 1 Cooking energy consumption patterns in the two slums

Fuel Category	Slum location (outdoor air pollution levels)	No. of meals cooked in a day	Time spent in cooking (h)	Burn rate (kg/h)	Fuel use (kg/cap/day)	Useful energy consumption (kCal/cap/day)
Wood	High	1.4	1.70	1.42	0.40	222
	Low	2.0	2.20	1.33	0.60	336
Kerosene	High	1.9	2.20	0.16	0.06	263
	Low	2.4	2.10	0.16	0.08	321

(n = 20, each group; Coefficient of Variation = 30-50%)

The per capita useful energy consumption was found to be higher in houses that use kerosene. This may be explained by the fact that a shift towards kerosene also reflects increased purchasing power; which in turn may also lead to cooking more food, more meals, or more types of food that require longer cooking times.

Table 2 Location of cooking with respect to fuel type

Season	% Houses cooking indoors	
	Wood	Kerosene
Winter	65.5	93.4
Summer	32.5	69.1
Moonsoon	91.6	97.7

We observed that about 55% of wood users also own a kerosene stove, and 44% of kerosene users also own wood-burning stoves. This shows the high degree of use of multiple fuels making exposure classification a complex task. Furthermore, while 72% of wood-using houses are electrified, this is true of 80% of kerosene-using houses. Again, this gives some support to the hypothesis that as household income increases there is a shift towards better amenities – stoves and electricity.

The dependency of the cooking location on the type of fuel used is shown in Table 2. This aspect strongly influences the exposure patterns as does the time-activity patterns of women and infants. We observed that the actual fraction of time spent near the fire by infants is 62% for wood users, and 81% in case of kerosene users. It is speculated that since kerosene users largely cook indoors, that is where they will keep the child and feel secure. Wood users who cook outdoors could keep the child near them or even inside the house where the child will be safe. There could be other complex cultural factors that influence such activity patterns.

The study confirmed that indoor levels of RSP and CO during cooking times are high in comparison to ambient standards and that concentration levels in kerosene-using houses are usually less than that in wood-using houses (see Table 3). The Indian ambient standard for RSP is 100 micrograms/m^3. RSP levels, for example, in wood-using houses during cooking were found to be 7-17 times this limit. However, the daily exposure to RSP due to cooking smoke is not statistically significantly different between kerosene and woodfuel user groups (see Figure 1), even though the concentration of exposure due to kerosene appears to be slightly less than that due to wood. This is because, perhaps due to socio-economic reasons, kerosene-using women were found to cook more meals, for longer durations, cook inside more often, and that infants in such houses stayed in the kitchen for longer durations. In the more highly-polluted slum the difference between the two fuel groups was very significant. This is perhaps because of the tendency of certain ethnic groups residing there to keep

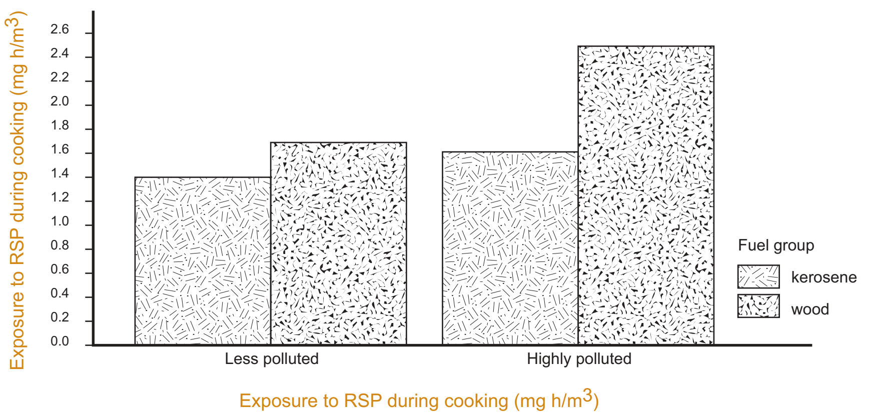
Table 3. Concentration (geometric mean) of RSP and CO during cooking sessions

Fuel	Location of cooking	Slum	n	RSP (µg m^{-3}) Personal Sampling (mother)	RSP (µg m^{-3}) Area Sampling (infant)	CO (ppm)
Wood	In	High	15	1630 (2.0)	1680 (2.3)	16 (2.0)
		Low	10	987 (1.5)	1210 (1.7)	9 (1.7)
	Out	High	5	820 (1.7)	690 (2.0)	6 (1.6)
		Low	10	650 (1.7)	830 (1.6)	8 (2.2)
Kerosene	In	High	19	730 (1.5)	650 (1.5)	4 (1.7)
		Low	19	590 (1.7)	610 (1.5)	1 (3.4)
	Out	High	1	1650 (na)	1280 (na)	9 (na)
		Low	1	450 (na)	830 (na)	0 (na)

The value in parenthesis is the geometric standard deviation.

n = Number of households
na = Not applicable

Figure 1 Comparison of daily exposure of infants to RSP during cooking



fires going for a very long time. In the less-polluted slum we observed that both fuel groups are exposed to similar levels of RSP pollution. Thus, at least for infants, it is very likely that there is considerable overlap of exposure levels between the two fuel groups.

Thus while the energy ladder concept does predict some degree of overlap between fuels, this study indicates that in some places and for some groups the overlap may be total. As asked in the introduction to this article, 'is a supposedly cleaner fuel the sole guarantee to cleaner air?' While the upward shift toward a cleaner fuel (kerosene) may reduce the concentration of emissions, this effect is perhaps being countered by the harmful effects of shifting to a less ventilated environment and increased duration of cooking.

Conclusions

This study has shown that apart from fuel type there are at least three other factors that strongly influence exposure:

- Ventilation - housing type, and location of cooking
- Behaviourial patterns induced by a change in purchasing power/ affluence.
- Cultural practices

The daily exposure of infants and women living in slums exceeds that of people living in rural areas by approximately 25%. Also, the study showed that in urban slums, the share of outdoor sources of pollution is also significant when compared with indoor sources.

The study suggests that in the context of urban environments there is a need to further understand emissions from kerosene stoves and the relationship between indoor and outdoor air quality before launching major interventions such as mass scale provision of kerosene or introducing improved stoves, as is being done by the Delhi Energy Development Agency. The fuel supply and demand situation in slums needs to be examined in greater detail, through scientifically designed surveys, keeping in mind economic, social, and environmental considerations. From the viewpoint of testing the relationship between exposure and health impacts, it is becoming increasingly clear that it is essential to use intervention type studies, which examine the exposures and health status before and after the intervention.

This study has shown that exposure during cooking and the daily integrated exposure in kerosene-using houses is not always less than that in biomass using houses. It is hoped that the results of this study will cause decision-makers to pause and think about the net benefits of kerosene, which may then have an impact at the policy level.

Indoor Air Pollution and Tuberculosis: A Retrospective Study

BY: IMELDA D. SORIANO, MD, MCH; RODOLFO J. SORIANO JR. MD, MPH

Despite rapid development in the Philippines, fuelwood is still used by close to seven out of 10 households, mostly in rural areas (WB, 1988, in RWEDP 1996). It is estimated that the use of fuelwood will increase in the coming years as more people in rural and urban areas continue to use fuelwood because it is cheap and readily available within ones surroundings. This type of energy is used mainly for cooking in the Philippines, and not for heating because of the hot tropical climate in the area. Most households in rural areas have not been reached by electrification so kerosene is used for illumination at night.

The ill effects of fuelwood to one's health are rather well-documented, including causing increased prevalence of chronic obstructive lung diseases (COLD), acute respiratory illnesses (ARI) and cor pulmonale. It is also said to contribute to low birth weight, eye infections and certain cancers (RWEDP 1996).

Tuberculosis is one of the leading health problems in the Philippines today. This infectious disease is among the leading causes of mortality, where an estimated 67 Filipinos succumb to the disease everyday (Medical Observer, 1999). The effect of biomass fuels on the onset and severity of tuberculosis, as well as its possible negative influence on treatment, is something that has yet to be investigated. Factors affecting TB such as cigarette smoking, poor nutritional status, overcrowding, and environmental health are well-documented, but the issue of the possible role of indoor air pollution in compounding the TB problem is also yet to be known.

Research objectives

This study, therefore, aims to investigate the effects of biomass fuel on the severity and cure of tuberculosis. The research was done in two municipalities of North Cotabato, namely: Aleosan and Midsayap. Specifically, the study aims to:

1. Describe the socio-demographic profile of tuberculosis patients coming from these two municipalities.
2. Determine exposure of these patients to biomass fuels, in terms of: type of cookstove, length of exposure to smoke from wood combustion and ventilation of cooking area.
3. Establish a relationship between exposure to biomass fuels and the onset, severity and cure of TB.

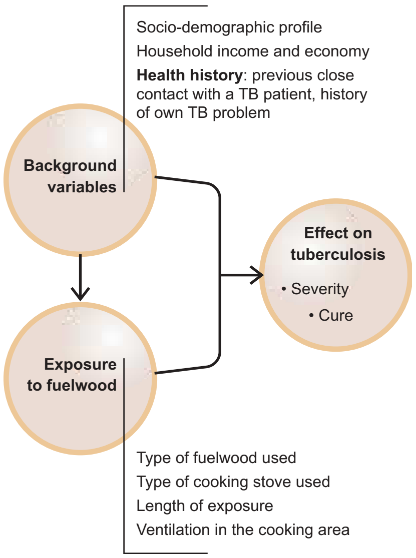
Study design

Cases were defined as patients positively identified as suffering from TB and who were not cured after six months of chemotherapy. A control group, also composed of TB patients identified in the past year, was also interviewed for comparison. Those who belong to the control group are TB positives who were cured after six months of treatment.

Conceptual framework

It is considered that the effect of fuelwood on TB is a function of the type of fuelwood used, the type of cookstove, length of exposure to fuelwood, and ventilation in the cooking area.

Aside from exposure to fuelwood combustion, socio-demographic factors, including gender, will be examined to see any variation in the effect of fuelwood on TB when these factors are considered. Previous health history will also be examined. The following graph illustrates this framework:



Study site

The study was conducted in the municipalities of Midsayap and Aleosan, in North Cotabato, where a total of 400 combined cases of TB were identified last year. They have a total of 200 patients currently undergoing treatment. Only TB patients who have underwent treatment in the year 2000 were included in the study.

Data gathering tools

This research utilized face-to-face interviews using an interview protocol. A list of qualified respondents (TB patients undergoing treatment in year 2000) was obtained from the Municipal Health Office (MHO) or the main Rural Health Unit (RHU). These patients were then visited in their respective homes for an interview. Interviews were conducted in the respondent's home in order to validate his/her claims about their cooking facility.

The protocol contains questions about the cookstove being used at home, type of fuel used, type of kitchen, respondent's role in the kitchen work (whether cooking is his/her main responsibility or not), and the number of years exposed to the type of cooking facility.

Data processing

Completed protocols were checked and reviewed while still in the field. Data cleaning (checking for consistency in answers and for completeness) was done in the office. The data was processed using SPSS. Descriptive statistics were used to group the data together. To determine a relationship between exposure to biomass fuels and TB Pearson's correlation and linear regression analysis were utilized.

Tuberculosis Findings

The following summarizes the findings from the survey.

Profile of respondents

A majority of both response groups were male and married. The control group (those cured from TB after 6 months of treatment), with a median age of 53.5, was slightly younger than the case group (those not cured after 6 months of treatment), with a median age of 55. Over half of the study respondents reported a household size of 6 or more.

Table 1. Respondents' demographic characteristics cross-classified by case and control

Category	Case (N=40)	Control (N=40)	Total (N=80)
Sex			
Male	27 (67.5%)	26 (65.0%)	53 (66.3%)
Female	13 (32.5%)	14 (35.0%)	27 (33.8%)
Age			
15-35	2 (5.0%)	5 (12.5%)	7 (8.75%)
36-55	18 (45.0%)	17 (42.5%)	35 (43.75%)
56-86	20 (50.0%)	18 (45.0%)	38 (47.5%)
Mean age	55.20	50.70	52.95
Median age	55.0	53.50	54.0
Range	30-86	15-73	15-86
Civil status			
Married	26 (65.0%)	33 (82.5%)	59 (73.8%)
S/W/W	14 (35.0%)	7 (17.5%)	21 (26.52%)
Separated	-	-	-
Household size			
1-5 members	23 (57.5%)	16 (57.5)	39 (49.4%)
6-10 members	17 (42.5%)	23 (59.0%)	40 (58.6%)
No response	-	1	1

Table 2. Respondents' occupation status and type of occupation crossclassified by case and control

Category	Case (N=40)	Control (N=40)	Total (N=80)
Occupational status			
Employed	29 (72.5%)	29 (72.5%)	58 (72.5%)
Not employed	11 (27.5%)	11 (27.5%)	22 (27.5%)
Occupation	(n=29)	(n=29)	(n=58)
Farming	12	20	32
Own bussines	0	2	2
Transportation	2	0	2
Blue collar	15	7	22

Exposure to cooking and woodsmoke

A large majority of the respondents (91.3%) revealed that they have ever cooked. Over four-fifths of the total respondents (81.3%) said their kitchens were located inside their houses, and a slightly higher percentage of the case group reported having indoor kitchens. Having a cookstove using fuelwood inside the house increases the person's exposure to smoke and ashes from fuelwood combustion. Almost all respondents (74 of 80) said that they used fuelwood for cooking. All cases have been using fuelwood.

Over half of the total respondents reported having cooked for more than 20 years, and almost half said they were exposed to smoke and ashes from cooking. A third reported that they cooked three times a day, while another third reported seldom cooking.

Table 3. Respondents' exposure to wood smoke cross classified by case and control

Category	Case (N=40)	Control (N=40)	Total (N=80)
Ever Cooked			
Yes	39 (97.5%)	34 (85.0%)	73 (91.3%)
No	1 (2.5%)		1 (1.3%)
No response		6 (15.0%)	6 (7.5%)
Kitchen type			
Inside the house	34 (85.0%)	31 (77.5%)	65 (81.3%)
Outside the house	6 (15.0%)	8 (20.0%)	14 (17.5%)
No response		1 (2.5%)	1 (1.3%)
Type of cooking facility			
Firewood stoves	40 (100.0%)	34 (85.0%)	74 (92.5%)
LPG/kerosene gas		6 (15.0%)	6 (7.5%)
	(n=39)	(n=34)	(n=37)
Duration exposed to cooking			
> 20 years	25 (64.1%)	21 (61.8%)	46 (63.0%)
10-19 years	8 (20.5%)	4 (11.8%)	12 (16.4%)
< 10 years	4 (10.3%)	2 (5.9%)	6 (8.2%)
No responses	2 (5.1%)	7 (20.6%)	9 (12.3%)
No. of times cooking in a day			
Once	10	8	18
Twice	3	4	7
Thrice	13	11	24
Seldom	14	11	24
No response		6	6
Responsible for cleaning the stove			
Yes	14	8	22
Exposure to smoke/ashes			
Yes	23	12	35

Exposure to cigarette smoke

The respondents were also asked about their exposure to cigarette smoke. Over half of the respondents (57.5%) admitted having ever smoked, but only one-fourth (20 of 80) are currently smoking. More than half (67.5%) of those who ever smoked were from the case group. Cigarette type use was not specified. Please refer to Table 4 for more information.

Table 4. Respondents' exposure to cigarette smoking cross-classified by case and control groups

Category	Case (N=40)	Control (N=40)	Total (N=80)
Ever smoked			
Yes	27 (67.5%)	19 (47.5%)	46 (57.5%)
No	12 (30.0%)	18 (45.0%)	30 (37.5%)
No response	1 (2.5%)	3 (7.5%)	4 (5.0%)
Currently smoking	(n=27)	(n=19)	(n=46)
Yes	10	10	20
HH members currently smoking			
Yes	35 (87.5%)	15 (37.5%)	50 (62.5%)

Respondents history of TB

Most of the respondents had their TB ailment diagnosed last year. However, there were also several who were diagnosed with TB more than 2 years ago. Slightly more respondents from the case group have been diagnosed for TB and/or have complained of coughing for more than three years.

Only two respondents reported that another member of their family was diagnosed with TB, and these came from the case group. It was further revealed that these two household members were also exposed to the same cooking facility (cookstove using fuelwood). There were ten respondents in the case group who said that another member of their household complains of coughing.

Table 5. Respondents' occupation status and type of occupation crossclassified by case and control

Category	Case (N=40)	Control (N=40)	Total (N=80)
When diagnosed with TB			
Two years ago (1999-2001)	30 (75.0%)	40 (100.0%)	70 (87.5%)
Three years ago or longer (1999-2001)	10 (25.0%)		10 (12.5%)
When started coughing			
Two years ago (1999-2001)	16 (40.0%)	33 (82.5%)	49 (61.3%)
Three years ago or longer (1999-2001)	14 (35.0%)	4 (10.0%)	18 (22.5%)
No response	10 (25.0%)	3 (7.5%)	13 (16.2%)
With other household member diagnosed with TB	2	0	2
HH member with TB also exposed to cooking	2	0	2
Other household member complained of coughing	10	0	10

Data analysis

Data analysis has shown that cases (i.e., TB patients who remained TB positive after 6 months of chemotherapy) were correlated with the characteristics of cooking facility like type of fuel used, type of cookstove, whether the respondent has ever cooked, and exposure to smoke/ashes from the fuelwood. Cases were also found to be correlated with smoking by other household members, but not with smoking by the respondent themselves (whether ever smoked or currently smoking). The year when TB was diagnosed was also correlated. It can be noted that a number of cases (n=10) had their diseases diagnosed more than 3 years ago. However, the study did not reveal whether these 10 cases were already previously treated for TB.

Cases were also found to be correlated with other members of the household who complainsed of coughing.

The above-mentioned correlations were derived using Pearson's test[1] for two-tailed correlation. Table 6 summarizes this analysis.

Table 6. Summary of Pearson's correlation results for variables that are correlated with Cases

Variables	Value	Significance Level
Ever cooked	.009	99%
Type of fuel	.021	95%
Type of cookstove	.010	95%
Responsible for cleaning the stove	.026	95%
Exposure to smoke/ashes	.003	99%
Member of HH who smokes	.002	99%
Year diagnosed with TB	.016	99%
How long ago diagnosed with TB (≤ 2 years or ≥ 3 years)	.014	95%
Other household member who complains of cough	.002	99%

Regression analysis[2] was also done to test which of the above-mentioned variables are strongly related with the development of TB that is not cured after 6 months of treatment. Regression analysis showed that only exposure to cooking, exposure to ashes, household members smoking and household members complaining of coughing are the only variables that were found to be related to Cases.

Table 7. Summary of regression results

Variables	R Value	Coefficient
Model 1:	.452	
Type of fuel		.469
Cleaning of stove		.791
Ever cooked		.030*
Exposure to ashes		.056*
Type of cookstove		.992
Model 2	.347	
HH member who smokes		.002*
Model 3	.273	
Year diagnosed with TB		.925
How long ago diagnosed with TB		.688
Model 4	.356	
Other HH member who complains of cough		.002*

[1] Pearson's Correlation: A Statistic measuring the linear relationship between two variables in a sample and used as an estimate of the correlation in the whole population. Source: wordreference.com

[2] See cataract article.

It should be noted that cooking-related and fuelwood related variables did not come out strongly in the regression. What appears to be strongly related with the development of hard-to-cure TB was cigarette smoking in the household and complaints of coughing among household members.

Conclusions and recommendations

This pilot study has demonstrated that the development of more severe cases of TB, herein defined as one which is not cured after 6 months of routine chemotherapy, have been correlated with the use of fuelwood in cooking, as well as with other variables such as cigarette smoking within the household.

These findings, however, should be taken with caution. Some aspects in the research appear weak, i.e., non-randomization of respondents. The use of purposive, non-randomized sampling was done due to financial and administrative considerations. There is also a need to further refine the indicators and measurements used in the study, including:

Cook-stove and wood smoke related indicators:

- Exposure to woodsmoke in terms of no. of hours/minutes per day
- More specified type of fuelwood used (e.g., what kind of wood)
- Description of kitchen ventilation (size of kitchen, presence/absence of windows/exhaust, wind direction, etc.)
- More specific measurement of the number of years exposed to fuelwood

TB-related indicators:

- TB history
- Medicine-taking behavior
- History and development of other respiratory disease conditions

Prospective cross-sectional studies can also be done to further validate the findings of this research. Prospective studies are considered to yield better conclusive findings. g

Indoor Pollution and Cataract: A Retrospective Study

EDWARD J. SORIANO MD , IMELDA D. SORIANO MD MCH

*This retrospective study aimed to investigate the effects of biomass smoke exposure on the development of cataract and other eye problems. The research was done in the municipalities of Midsayap and Aleosan in North Cotabato, Philippines, where 179 patients were selected from a total of 500 patients that were seen in the ophthalmologist's clinic in Midsayap in the year 2000. **

Utilizing face-to-face interviews and an interview protocol, a list of qualified respondents from the clinic were interviewed in their respective homes. Patients were considered as having a cataract if they had been diagnosed by the ophthalmologist as having this condition. Another group of patients with other eye problems (not cataract) was also interviewed for comparison.

* This study used the same study design and methodology as was used in the previous article "Indoor Air Pollution and Tuberculosis." Findings are represented below.

Findings

Table 1. Socio-demographic profile of all respondents

Category	With Cataract (n = 133)	Without Cataract (n = 46)	Total (n = 179)
Sex			
Female	63.9	69.6	65.4
Male	36.1	30.4	34.6
Civil status*			
Single	6.0	19.6	9.5
Married	60.2	71.7	63.1
Widow/widower	30.8	6.5	24.6
Address*			
Aleosan	15.6	8.4	24.0
Midsayap	55.9	16.8	72.7
Religion			
Christian (RC)	70.7	65.2	69.3
Christian (non-RC)	24.8	32.6	26.8
Islam/non-Christian	3.8	2.1	3.4
Occupational status*			
Employed	34.6	39.1	35.8
Not employed	51.8	52.2	52.0
Retired	9.8	4.3	8.4
Family type*			
Nuclear	57.9	78.3	63.1
Extended	39.1	21.7	34.6

*Figures do not total to 100% because of missing cases or not applicable

Exposure to cooking and woodsmoke

The data on exposure to woodsmoke from cooking showed that those who developed a cataract had cooked for, on average, 5% more years than those who did not develop a cataract. A larger percentage of the cataract group (70.7%) also reported to cooking three times a day compared to the non-cataract group (45.7%). Furthermore, those using woodfuel in the "cataract" group were about twice as many compared to those who did not have cataract. Both groups reported that their kitchens were located inside their homes.

Table 2. Percentage distribution of patients' exposure to cooking and woodsmoke cross-classified with or without cataract

Category	With Cataract (n = 133)	Without Cataract (n = 46)	Total (n = 179)
Ever cooked			
Yes	91.0	89.1	90.5
No	7.5	8.7	7.8
No response	1.5	2.2	1.7
No. of years cooking	(n = 113)	(n = 39)	(n = 152)
1-15 years	4.4	15.4	7.2
16-30 years	11.5	20.5	13.8
31 years or more	84.1	64.1	78.9
Range	1-70	1-82	1-82
Mean years cooking	51.2 years	48.5 years	46.99 years
No. of times in a day spent for cooking*			
Once/seldom	13.6	26.1	16.8
Twice	6.8	19.6	10.1
Thrice	70.7	45.7	64.2
4 of more	.8	0.0	.6
Type of cooking facility			
Used firewood	53.4	28.3	46.9
Non-firewood	46.6	71.7	53.1
Location of cooking facility			
Inside the house	74.2	84.8	76.9
Outside the house	25.8	15.2	23.1
Responsible for cleaning			
Yes	85.8	70.5	81.9
No	14.2	29.5	18.1
Exposure to smoke*			
Yes	25.6	26.1	25.7
No	71.4	71.7	71.6

*Figures do not total to 100% because of missing cases or not applicable

Respondents history of cataract

Most cataract patients said that their condition was diagnosed about ten years ago or less. Furthermore, close to three out of 10 said other members of their household also had cataract or eye problems.

Table 3. History of Cataract Diagnosis

Category	With Cataract (n = 133)
How long has the cataract been diagnosed?	
. 5-10 years	91.7
11-20 years	4.5
21-31 years	3.8
Mean	3.5 years
Mode	1 year
Range	.5 to 31 years

Table 4. Respondents with other members of household reporting cataract/eye problems

Category	With Cataract (n = 133)	Without Cataract (n = 46)	Total (n = 179)
Do any other household members have eye problems?			
Yes	28.6%	30.4%	29.1%
No	71.4%	69.6%	70.9%
How many have such problems?	n = 38	n = 14	n = 52
1	28	11	39
2	4	3	7
3	6	0	6

Data analysis

A correlation analysis was done to identify which variables are correlated to cataract development. The following variables were found to be correlated:

Table 5. Variables correlated with cataract development

Category	With Cataract (n = 133)
Civil status	.001 **
Number of years cooking	..001 **
Responsible for cleaning stove	.023*
Presence of other eye problems	.000 **

** Correlation is significant at the .01 level (2-tailed)
* Correlation is significant at .05 level (2-tailed)

The above variables as well as other selected variables were used in a linear regression analysis to determine further whether exposure to woodsmoke leads to the development of cataract. The analysis has shown that only the variables "responsible for cleaning stove" and "kitchen is inside the house" were found to be significantly related with the development of cataract.

Table 6. Regression analysis

Category	With Cataract (n = 133)
Number of years cooking	.870
Responsible for cleaning stove	.031*
Use of wood for cooking	.685
Kitchen is inside the house	..007**
Exposure to smoke/ashes	.986

Millions Choke While Stoves Burn

MARILYN BEACH

In China's Guizhou Province, locals live for delicious hot sauce made with native red chilies. Hot chili sauce is added to virtually all dishes, and I see hundreds of chilies drying over open coal fires on my visit to this southern province. I also see people who have no idea that they are slowly poisoning themselves.

Each day, millions of Chinese are using tainted coal to cook their food and as a result are inhaling and contaminating their food with arsenic, fluorine, lead, and mercury. Peppers dried over coal fires, for instance, can have up to 500 parts per million of arsenic. At least 3000 cases of chronic arsenic poisoning have been confirmed, according to a study by the US National Academy of Sciences.

In 14 other Chinese provinces, at least 10 million people have fluorine poisoning as a direct result of coal burning. Farmers who use coal with a high fluorine content to dry corn develop fluorosis, with effects ranging from discoloured teeth to deformed bones.

The Chinese Academy of Preventive Medicine reported in May, 1999, that air quality in many Beijing households had fallen "far below national standards, often leading to headaches, allergic reactions, and depression." In fact, some Chinese medical experts claim that indoor air pollution, especially from coal-burning stoves, is a more serious threat than outdoor air pollution. A central problem is that the vast majority of China's coal is not cleaned before it is used, and it is burned in unvented stoves. Smoke fills the home and especially affects the women and children who spend more time cooking and staying indoors. An estimated 800 million of China's 1.25 billion people use coal in their homes, and about 22% of rural homes depend on coal for domestic fuel.

Coal is cheap, a socio-economic tradition dating back decades when fuel was first subsidised, and the low cost encourages its use. Also, the growing number of small coal mines keeps the price low due to increasing regional competition. For many peasants, coal is simply dug out of the hillsides, and is free for the taking. I frequently see villagers haul heavy loads of soft coal on their backs as they make their way back home.

Respiratory infections from coal use, as well as from automobile and industrial emissions, are common throughout China. A recent study supported by the WHO and other groups found that nine of the world's ten most polluted cities are in China. Chinese researchers blame pollution for most of the country's 1.4 million deaths from chronic obstructive pulmonary diseases such as emphysema and chronic bronchitis.

Devra Lee Davis, an epidemiologist who led the WHO study, argues that most children living in large cities in the developing world, including China, "breath air that is the equivalent of smoking two packs of cigarettes a day." Chinese parents are increasingly worried about their children, as links between pollution and public health are made more clear. Automobile exhaust from leaded gasoline is one of the biggest culprits, causing lead poisoning in children.

Yuan Guotai, a doctor of traditional Chinese medicine, has a special perspective on public health and air pollution because her husband is an environmental engineer with experience in controlling industrial emissions. Yuan confirmed that on days with the worst air quality, hospitals see more emergency patients with respiratory problems. Asthma rates are high in cities such as Beijing according to specialists at Beijing Children's Hospital. It is not uncommon for health-care workers to treat 60 wheezing, coughing children in a single day. Yuan and her husband told me that they feed their young daughter foods known to strengthen the lungs, according to traditional Chinese medical practice, against the ill effects of polluted air.

I often ask my Chinese friends and colleagues why there is not more done to limit pollution. The same response is nearly always given: "we cannot afford to slow down the pace of economic development. China is a poor country. When we have achieved a higher level of industrial development, then we can tackle the pollution problem."

In fact, China cannot afford to wait. Air and water pollution may cause US$54 billion a year in economic losses accounting for nearly 7% of the gross domestic product, according to a recent World Bank study. Each year some 7.4 million work-years are lost to health damages related to air pollution. Moreover, acid rain in the high-sulphur coal regions of southern and southwest China threatens to damage 10% of the land area, and may already have reduced crop and forestry productivity by 3%.

Automobile use is on the rise, and the average Chinese car emits 10 to 15 times the exhaust of its US counterpart. There are more than 1.3 million cars registered in Beijing alone today compared with 200,000 in 1988.

The Chinese leadership is aware that something needs to be done about air pollution. Newspapers abound with stories about more stringent laws and regulations designed to limit automobile exhaust fumes, curb industrial emissions, or produce cleaner coal. These steps are important, but enforcement is often ineffective due to priorities placed on economic development, insufficient financing, poor monitoring practices, and corruption. Incentives and disincentives designed to promote the development and use of cleaner alternative fuels are gravely needed.

In the past few years, local governments have begun to disclose pollution data to a public long accustomed to secrecy about such facts. And in Beijing, for instance, the media regularly reveals the latest pollution data. Environmental awareness is growing in China, especially in the cities. Such consciousness may be the only hope for truly effective action to occur in both urban and rural areas, especially when that action might come from parents seeking to safeguard their only children against ill health from polluted air.

Source: The Lancet Volume 354, Number 9173 10 July 1999

In Praise of Petroleum?

KIRK SMITH, SCIENCE, VOL. 298

Among other difficulties, the 2002 World Summit on Sustainable Development (Rio+10) struggled with defining "sustainability." Typical of efforts to make concrete this slippery concept was a preparatory paper addressing one of the most pressing issues in human development: how to bring modern energy services to the one-third of humanity whose development and survival requirements suffer from the lack of them.1 These 2 billion people have little access to electricity and depend for cooking and heating on local biomass in the form of wood, crop residues, and dung. In common with other such analyses, the premise of this paper was that, for the poor as for everyone else, only renewable energy sources qualify as sustainable.

After all, fossil fuels are in principle limited, and the fossil carbon they contain is a threat when released. Nevertheless, there are questionable assumptions behind the premise that fossil fuels are unsustainable for the rural poor:

1) That the major alternative - local use of biomass fuel - is, by comparison, sustainable. In many cases, however, it contributes to local depletion of biomass resources, including forests; produces serious health impacts in the local population because of its high emissions of pollutants; and even when renewably harvested, is not greenhouse-neutral because the poor combustion in simple stoves releases non-CO2 greenhouse pollutants such as methane and dark particles.

2) That provision of household fuel to the world's poor would appreciably add to the environmental burden of fossil fuels. Even if all 2 billion people shifted to liquefied petroleum gas (LPG) for household fuel, it would add less than 2% to global greenhouse gas (GHG) emissions from fossil fuels. In terms of human health, a shift to LPG would actually result in a net reduction of human exposures to air pollution that would be substantially larger than today's total exposure from all fossil fuel emissions.

3) That, being nonrenewable, petroleum cannot be relied on to serve household needs in the future. Petroleum resources, however, are more than sufficient to supply all conceivable household needs far into the future. It is demand from other sectors that depletes supplies, stresses the balance of payments, and threatens international security.

4) That available means to supply high-quality renewable energy services for cooking and heating will be affordable, reliable, and suitable for the rural poor. True sustainability needs to consider these factors as well. Unfortunately, few of the available renewable technologies to replace household fuels with high-quality substitutes meet these requirements today.

Does it make sense to ask the poor to take on novel devices and fuels that have never been tried elsewhere, because otherwise we may add a bit to GHG emissions or shorten the petroleum era by a few weeks? Shouldn't it be those that produce the most GHG and have the resources and technology to do something about it who shoulder the burden of testing and using new low-GHG high efficiency technologies? To illustrate, efficiency increases in the world automobile fleet of just 0.5% per year (5.1% over 10 years, which is not much more than 1 mile per gallon) would free up annually sufficient fuel energy for the cooking needs of all 2 billion people well before the year of the next Earth Summit (Rio+20). If continued, by Rio+30, a 10-year household fuel reserve could also be put aside for these people. Put another way, no matter how the rural poor do their cooking, the GHG production and petroleum demand battles that count will be fought in Detroit, Yokohama, and Stuttgart (as well as Shanghai, São Paulo, and Mumbai).

What possible better use for high-efficiency clean-burning fossil fuels such as LPG than providing high-quality energy services for poor households? There remain serious cost constraints and implications for local employment, of course, but there are no realistic resource or greenhouse constraints to keep us from targeting the needs of the poorest with LPG in places where renewable technologies are not yet appropriate or sustainable. In addition, there are clear health benefits of doing so. The World Health Organization (WHO), for example, has recently estimated that some 1.6 million premature deaths each year come from the use of solid fuels (biomass and coal) in poor households.2 Rather than excluding petroleum, some of this one-time gift from nature ought actually to be reserved to help fulfill our obligation to bring the health and welfare of all people to a reasonable level: an essential goal of sustainable development, no matter how defined.

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Source: www.sciencemag.org SCIENCE VOL 298 6 DECEMBER 2002, p1847.

[1] Greenpeace/The Body Shop, Power to Tackle Poverty: Getting Renewable Energy to the World's Poor (IT Power, London, 2001).

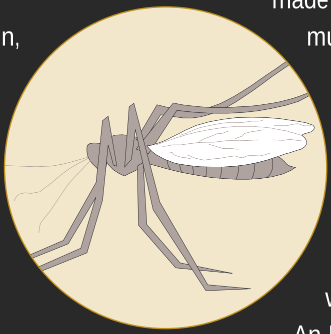
[2] WHO, World Health Report: Reducing Risks, Promoting Healthy Life (WHO, Geneva, Switzerland, 2002).

A LITTLE-KNOWN SOURCE OF INDOOR AIR POLLUTION

Indoor air pollution is not only caused by incomplete fuel combustion in inefficient cookstoves. Recently researchers have begun to pay attention to other causes of indoor air pollution, including the burning of anti-mosquito coils and the use of electrical mats that can release mosquito-repelling chemicals for up to 12 hours. Health impacts from the use of these products are just beginning to be known, mostly in developing countries throughout the world.

Mosquito coils are made of 98% sawdust or coconut shell powder and .2% active ingredients. It's unhealthy to expose oneself to smoke, be it from burning sawdust, coconut shells, or cigarettes.

A mosquito mat contains 1 -1.2 % allethrin, a chemical produced for outdoor purposes only. Short-term dermal exposure to allethrin may cause itching, burning, tingling, numbness, or a feeling of warmth. Exposure to large doses by any route may lead to nausea, vomiting, diarrhea, hyperexcitability, incoordination, tremors, convulsive twitching, convulsions, bloody tears, incontinence, muscular paralysis, prostration and coma. Almost all types of mosquito repellents --coils, mats, lotions and vaporizers--contain allethrin.



These repellents are known to contribute to indoor air pollution that largely aggravates the afflictions of a weaker immune system, especially those of children living indoors. Research done in western countries has established that the prolonged use of mats is harmful to humans. It can lead to corneal damage, shortness of breath, asthma and even liver damage in the long run. Furthermore, certain chemicals used in the mats and coils can adversely affect male and female fertility. The blotting paper used in the preparation of the mats contains dioxin, a proven carcinogen, which is then released during the heating process.

Repellents are not meant to kill, but to ward off the offending insects. So the insects live another day and in what can be perceived as a vicious circle, the coils are lit again the following night. Furthermore, mosquitoes develop immunity to coils and other repellents in the event of constant use. Hence, users are forced to continually change brands.

Use of these anti-mosquito repellents also puts a financial burden on families, and does not contribute to a long-term solution. In Sri Lanka alone, Rs. 1 billion (US 20 million) is spent annually on mosquito coils, a figure comparable to the national health budget. Out of annual incomes of $300-$400 in some regions, Africans have been estimated to spend up to $65 -- a fifth of their annual income -- on items to combat mosquito bites and on mosquito coils to keep insects out of their homes.

A cost-effective and safe alternative is "neem cream" made up of 5 parts neem oil and 95 parts coconut or mustard oil. Mosquito nets however remain the best and safest alternative to repellents.

Unfortunately, this problem is not easily solvable due to the very real need for mosquito repellant in countries with high malaria incidence. Lack of proper warning labels complicates the problem further, as often labels are written in a language that is foreign to the buyer.

An NGO in Malaysia found in their own research that most users do not understand the labels, in some cases because the language is too complicated, in others because the Chinese and Indian populations do not always find instructions in their respective languages. This also occurs in Peru, where many imported products are labeled only in English or Chinese. Although the average literacy rate is approximately 85% in both countries, the percentage of literate women in rural areas could be much lower. Due to a lack of information, awareness of potential health risks related to indoor use of pesticides is low.

Some community health experts argue that a large-scale mosquito eradication program could significantly reduce the amount spent by families on mosquito repellent, while reducing disease prevalence and therefore government expenditures on health programs. Whether this is viable or not remains to be seen, but the problem of indoor air pollution from anti-mosquito devices has yet to be tackled.

Source: Compiled from internet sources.