The health benefits of interventions to reduce indoor air pollution from solid fuel use: a cost-effectiveness analysis

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The air pollution-related health benefits of interventions to reduce indoor air pollution from cooking and heating with solid fuels are evaluated in South and South-east Asia, Africa, and the Americas using generalized cost-effectiveness methodology. Three scenarios are assessed: 1) providing access to cleaner fuels, (2) providing access to improved stoves, and (3) providing part of the population with access to cleaner fuels and part of the population with improved stoves. All intervention scenarios are compared with the current situation, i.e., the "business as usual" scenario where current exposures to indoor air pollution from solid fuel use would be sustained. Two major health outcomes associated with indoor air pollution are addressed, namely acute lower respiratory infections (ALRI) in young children under five years of age and chronic obstructive pulmonary disease in adults over twenty. While providing access to cleaner fuels has a larger health impact on the population than improved stoves, there are considerable health benefits associated with improved stove use. Improved stoves are also much more cost-effective than cleaner fuels. Of the cleaner fuels, kerosene, or paraffin, is more cost-effective than liquified petroleum gas (LPG), since kerosene is cheaper than LPG. Concerns about kerosene use, including poisoning, explosions, and possible carcinogenic effects, should be carefully considered before recommending its widespread use over LPG, however. This analysis offers further support for the argument that, from a public health point of view, there should be a continued emphasis on the promotion of improved stoves, as well as other locally appropriate means to reduce exposures within solid fuel-using households, until everyone can be given access to cleaner fuels.

1. Background

Cooking and heating with solid fuels, such as dung, wood, agricultural residues, charcoal, and coal, remains the most widespread traditional source of indoor air pollution (IAP) exposure on a global scale. People cook with solid fuels at least once a day in around half of the world's households [Smith et al., 2004]. In rural areas of developing countries, the prevalence of solid fuel use is even higher. For example, around 80 % of Indian households use solid fuels as their primary household cooking fuel [GoI, 1991; IIPS, 2002]. Combustion of solid fuels in inefficient stoves under poor ventilation conditions results in large exposure burdens, particularly for women and young children, who spend the greater part of their time at home.

At the intersection of household energy and public health, the reduction of exposures to indoor air pollution is a major concern. Practically speaking, before choosing an "ideal" intervention, efficacy, cost, and time taken to attain adequate intervention coverage need to be considered. Providing access to cleaner fuels certainly has a larger health impact on the population than improved stoves. As dramatic increases in access to cleaner fuels at the household level are unlikely to occur in large populations in the short term, however, the viability of ventilation options as interventions should also be addressed. It may be more practical in the short run to encourage people to improve ventilation until they have access to cleaner fuels. Moreover, if reduced exposures via improved ventilation significantly decrease morbidity and mortality, resulting in increased productivity, people may be able to shift up the energy ladder towards cleaner fuels sooner.

The impact of interventions on the reduction of two major health outcomes associated with indoor air pollution, namely lower respiratory infections (LRI) in young children under five years of age and chronic obstructive pulmonary disease (COPD) in adults over twenty, is evaluated here. These two health outcomes are responsible for nearly all of the 1.6 million deaths attributable to indoor air pollution each year [Smith et al., 2004]

2. Methods

Methods for conducting generalized cost-effectiveness analysis (CEA) have been developed by the World Health Organization to evaluate the efficiency of different interventions and/or intervention scenarios [WHOCC, 2003].

Table 1. Intervention scenarios for CEA of measures to reduce indoor air pollution

Cleaner fuel	Improved ventilation	Description	Result of intervention
X		Fuel shift to liquified petroleum gas (LPG)	No exposure
X		Fuel shift to kerosene/ paraffin	No exposure
	X	Improved stoves	Exposures reduced by 75 %
X	X	Combination: 50 % shift to LPG, 45 % receive improved stoves	50 % are unexposed, 45 % have exposures reduced by 75 %
X	X	Combination: 50 % shift to kerosene, 45 % receive improved stoves	50 % are unexposed, 45 % have exposures reduced by 75 %

In brief, this method involves:

1. defining the intervention scenarios;
2. determining intervention effectiveness for each scenario;
3. determining the cost of each intervention scenario; and
4. determining the cost-effectiveness of each intervention scenario, on the basis of 2 and 3 above.

Results are presented for epidemiological sub-regions within Africa, the Americas, South and South-east Asia, and the Western Pacific Region, which includes China. For a list of countries included in each sub-region, see Appendix A. Regions with low prevalence of exposure to indoor air pollution from solid-fuel use, i.e., those regions where nearly all households have switched to cleaner fuels or cleaner cooking technologies, have been excluded from the analysis.

3. Intervention scenarios

Interventions fall into two broad categories: access to cleaner fuel and access to improved ventilation. Two categories of increased access to cleaner fuel are addressed here: a fuel shift to propane, or liquified petroleum gas (LPG); and a fuel shift to paraffin, or kerosene. While LPG and kerosene are assumed to have the same impact on indoor air pollution levels, cooking with kerosene does result in slightly more indoor air pollution than cooking with LPG [Smith, 1987; ESMAP, SAR, 2002].

Access to ventilation can refer to a number of different interventions. Behavioral interventions to reduce exposures to indoor air pollution do exist. For example, an ongoing study to identify behavioral intervention opportunities in South Africa has identified four major intervention strategies: improve stove maintenance practices, move children away from the stove during cooking, increase ventilation for a longer duration of time during cooking, reduce the duration of burning [Barnes, 2002]. All four options are low-cost and user-initiated. The impact of these strategies on exposures remains unclear, however, and they have not been included at this time.

Owing to the wide variability in type of intervention and related cost, only improved stoves, mostly with chimneys, and mostly those which vent to the outside, are addressed here. The evidence on the efficiency of improved stoves is limited. Improved stoves have clearly reduced exposures in China, but have shown fairly disappointing results in India [ESMAP, SAR, 2002]. Shifting from three-stone fires to improved charcoal stoves indoors in Kenya has been associated with decreased incidence of acute lower respiratory infections (ALRI) of up to 65 % with lower changes in incidence observed when shifting to improved ceramic woodstoves [Ezzati and Kammen, 2001]. Conclusive epidemiological evidence demonstrating decreased risk in households using improved stoves is in progress in Guatemala, but unavailable at present. It is assumed here that well-designed, carefully installed, and routinely maintained improved stoves could result in a 75 % reduction in exposures. This is consistent with assumptions used to estimate exposures in households using improved stoves when estimating the burden of disease from household solid fuel use [Smith et al., 2004].

Since widespread access to cleaner fuels cannot occur until regions have adequate fuel supplies and reliable distribution systems, mixed intervention scenarios have been created to simulate a situation that is feasible in the near future, where 50 % of the population would gain access to cleaner fuels, and the remainder of the population would receive improved stoves. Thus, three scenarios are assessed: (1) providing access to cleaner fuels, (2) providing access to improved stoves, and (3) providing part of the population with access to cleaner fuels and part of the population with improved stoves. (See Table 1.) All intervention scenarios are assessed assuming that 95 % coverage of the population would be attained, and are compared with the current situation, i.e., the "business as usual" scenario where current exposures to indoor air pollution from solid-fuel use would be sustained.

4. Intervention effectiveness

The efficacy of the different intervention scenarios varies from region to region, as it is dependent on current levels of exposure, as well as region-specific levels of morbidity and mortality. It is assumed that household equivalents of exposures applied at the regional level translate into exposures, as well as associated health effects, at the individual level. In addition, exposed and unexposed household equivalents correspond to equal population proportions in each age group. For example, the average number of children per household is the same in households irrespective of household fuel use and ventilation characteristics. This is likely to be a conservative estimate, as households using solid fuels are likely to be rural and/or have lower socio-economic status, and may consequently have higher fertility rates.

Current estimates of exposure (Table 2) are used in combination with current estimates of the disease burden to estimate the region-specific disease burdens for exposed and unexposed populations. Incidences for each of

Table 2. Regional exposures to indoor air pollution from solid fuel use, 2000

	Africa		The Americas		Eastern Mediterranean		Europe	South and South-east Asia		Western Pacific
	AFRO D	AFRO E	AMRO B	AMRO D	EMRO B	EMRO D	EURO B	SEARO B	SEARO D	WPRO B
Population (million)	294	346	431	71	139	343	218	294	1242	1533
Average household size	7.5	4.9	5.3	4.6	5.9	4.4	2.8	4.4	6.0	3.4
Number of households (million)	39	71	81	15	23	78	78	66	206	448
Population currently exposed										
%	73 %	86 %	25 %	53 %	6 %	55 %	26 %	66 %	83 %	28 %
Number of households (million)	29	61	20	8	1	43	20	44	171	126

Source: Smith, et al., 2004

the intervention scenarios are then calculated on the basis of expected changes in exposure. Regional patterns of disease for the year 2000, including incidence, mortality, remission, duration, and case fatality rate, as well as age-specific disability weights, were obtained from the Burden of Disease unit at the World Health Organization.

4.1. Choice of implementation time

The implementation time chosen for CEA has key implications for the meaningfulness and interpretability of the results. Interventions are often evaluated over a one-year period, since policy-makers may be more concerned with the CEA of an intervention over a relatively short time-period. While this may make sense for clinical interventions, it does bias against interventions which take several years to implement, those with high start-up costs, and preventive interventions whose benefits occur in the more distant future. Generalized cost-effectiveness analysis assumes a 10-year implementation period. Effects are evaluated over one hundred years (to approximate the benefits experienced by an entire population cohort).

For interventions involving long-term structural changes, however, such as changes in household energy, it may make sense to evaluate over a longer implementation period. This is especially true when assessing the impact of an intervention on the reduction of chronic health effects that result from cumulative, or time-weighted, exposures. If exposures are decreased over a short time-period, the burden of exposure experienced by the population is essentially deferred for ten years, resulting in essentially the same population incidence occurring ten years down the line. Thus the only substantive effects would be in any reduced disability resulting in decreased exposures of prevalent cases.

If effectiveness were modeled over a longer implementation period, averted cases of illness could also be assessed. For example, if people quit smoking and then start smoking with the same intensity ten years afterwards, it is likely that they would experience a similar burden of illness ten years down the line. In contrast, if people quit smoking entirely, the health benefits would be far more substantial, as smoking-related illness could be avoided entirely.

4.2. Effectiveness for LRI

A number of studies have been done in the developing world that give quantitative estimates of the relative risk of severe LRI for children living in biomass-burning households. As part of the comparative risk assessment for solid-fuel use, a systematic review of the literature, specifically a meta-analysis, was conducted to synthesize the results of these studies [Smith et al., 2004]. On the basis of this review of 15 studies, the estimate of the average risk of LRI in young children under five years of age exposed to indoor air pollution from solid-fuel use was estimated to be 2.3 (CI 95 %: 1.9, 2.7). In other words, children exposed to indoor air pollution from household solid-fuel use have around 2.3 times higher risk of having lower respiratory infections.

4.3. Effectiveness for COPD

Globally, the most important risk factor for COPD is thought to be tobacco-smoking [NHLBI et al., 2001]. Smoking is an important potential confounding variable for COPD, particularly so if men are included in the analysis, given the higher prevalence of smoking in men than in women in developing countries [Jha, 1999]. At present, information on the joint effects of smoking and solid-fuel use is rare. To avoid possible overestimation of the burden of disease from solid-fuel use, therefore, attributable fractions for lung cancer and COPD from solid-fuel use were applied to disease burdens remaining after removal of smoking-attributable burdens [Ezzati and Lopez, 2004]. This is conservative in that some of the ill-health attributable to smoking could also be attributed to solid-fuel use.

A number of studies examining various symptoms of chronic respiratory ill-health in women who cook with open biomass stoves [Smith et al., 2004] have quantified the association between indoor air pollution and COPD. A meta-analysis has estimated the overall risk of COPD in women exposed to indoor air pollution from solid-fuel use to be 3.2, 95 % CI 2.3–4.8 [Smith et al., 2004]. There is much less evidence available about the impact on men, but the risk seems to be lower, 1.8, 95 % CI 1.0–3.2[2], presumably because of less exposure [Smith et al., 2004].

While the impact of smoking on COPD is thought to occur after the age of thirty [Ezzati and Kammen, 2004], exposure to indoor air pollution from solid-fuel use begins at much younger ages. Indeed, exposed women have been diagnosed with COPD in their late teens and early

Table 3. Average annual healthy years gained (discounted 3 %, age-weighted)

	Africa		The Americas		Eastern Mediterranean		Europe	South and South-east Asia		Western Pacific
	AfrD	**AfrE**	**AmrB**	**AmrD**	**EmrB**	**EmrB**	**EurB**	**SearB**	**SearD**	**WprB**
Cleaner fuels	310,000	564,000	61,000	60,000	1,000	255,000	52,000	184,000	2,186,000	6,284,000
Improved stoves	201,000	395,000	-	30,000	-	133,000	-	113,000	1,516,000	132,000
Combined intervention	281,000	519,000	43,000	52,000	-	223,000	37,000	166,000	2,013,000	4,655,000

twenties [Norboo et al., 1991]. Relative risk estimates for exposures are thus applied to all adults over twenty.

Under the ten year-implementation scenario, incident cases are deferred by ten years to reflect the reduced burden of exposure during the implementation period. Since COPD disease progression is never fully reversible, there is no remission from COPD. Decreased exposures can reduce disability in prevalent cases, however, and it is assumed that decreased exposures result in a milder form of COPD.

5. Costing

The costs for cooking systems, including stove and fuel costs, were estimated at the household level. For propane/LPG, cooking system costs also include the price of a gas cylinder. Cooking system costs were derived using best available estimates from the literature on household energy and indoor air pollution [Westhoff and Germann, 1995; von Schirnding et al., 2001]. It should be noted, however, that regional estimates of stove costs are highly uncertain, given the lack of information and variability in cooking practices among regions. In the absence of information on the average household size in every country, the number of households per region (Table 2) was estimated using information on average household size in a representative country for each region (Table 1) from the United Nations Human Settlements Program [UNHSP, 2002].

Program costs were estimated for cleaner fuel and improved stove programs separately, using an ingredient approach, and a costing template developed by WHO [WHOCC, 2003]. To get regional cost estimates, costs for all traded goods were converted into "international dollars" (this term is explained below), using official exchange rates and purchasing power parity. All costs were annualized assuming a 3 % discount rate [WHOCC, 2003]. Costs for tradable goods are scaled using region-specific standardized price multipliers [Johns et al., 2003] to reflect the increasing costs of expanding coverage owing to mark-ups from increased transportation costs to more remote areas. Price multipliers were not applied to improved stoves, as the stoves are manufactured locally from local materials. (See Table 1.)

All costs are calculated and presented in year-2000 international dollars ($I). $I have the same purchasing power as a US dollar (US$) in the United States, and are calculated at a national level using purchasing power parity (PPP) exchange rates. As PPP varies widely by countries within a region, however, regional costs cannot be directly translated into US$. To facilitate the interpretation of results for readers unfamiliar with $I, 1000 $I in India, if converted into US$ assuming 2000 estimates of PPP (14.56) and exchange rate (45 rupees/US$) would be the equivalent of around $324 US.

6. Results

6.1 Effectiveness of interventions

The avoidable burden of disease in each intervention scenario is given in Table 3. While providing access to cleaner fuels has a larger impact on the health of the population than improved stoves, there are considerable health benefits associated with improved stove use. In many cases, the gain in healthy years in the combined intervention scenarios is only slightly lower than the gain in the cleaner fuel scenarios. Where scenarios show no effect, countries are already either at or above the level of coverage, i.e., present coverage in the region already exceeds coverage in the intervention scenario.

6.2. Costs of interventions

The cost of cooking systems per household ranges from $I 40 to 90 for propane/LPG, $I 10 to 20 for paraffin/kerosene, and $I 3 to 24 for improved stoves. (See Table 4.) The recurrent cost of fuel is the most significant cost driver for the cleaner fuel interventions.

Program costs make up a very small proportion of the costs. When existing information on program costs from Nepal [Shresta, 2002] was used to benchmark cost estimates, actual annual improved stove program costs fell within estimates for attaining between 80 and 95 % coverage.

6.3. Cost-effectiveness of interventions

Improved stoves offer the most cost-effective way of improving health per unit of investment. (See Table 5.) In Africa and South and South-east Asia, the regions with the greatest number of people exposed, improved stoves could reduce the burden of disease associated with exposures to indoor air pollution for an average yearly cost of I$ 500-600 per healthy year gained. In contrast, as cleaner fuels require a shift in cooking technology, as well as the additional cost of purchasing more expensive fuels, cost-effectiveness ratios (CERs) for cleaner fuels are substantially higher. This suggests that providing households with improved stoves until they have access to cleaner fuels could be justified in many places as a primary health intervention, i.e., worth large-scale societal subsidy. Of the combined interventions, combining kerosene and improved stoves is more cost-effective than combining stoves with LPG, since kerosene is cheaper than LPG.

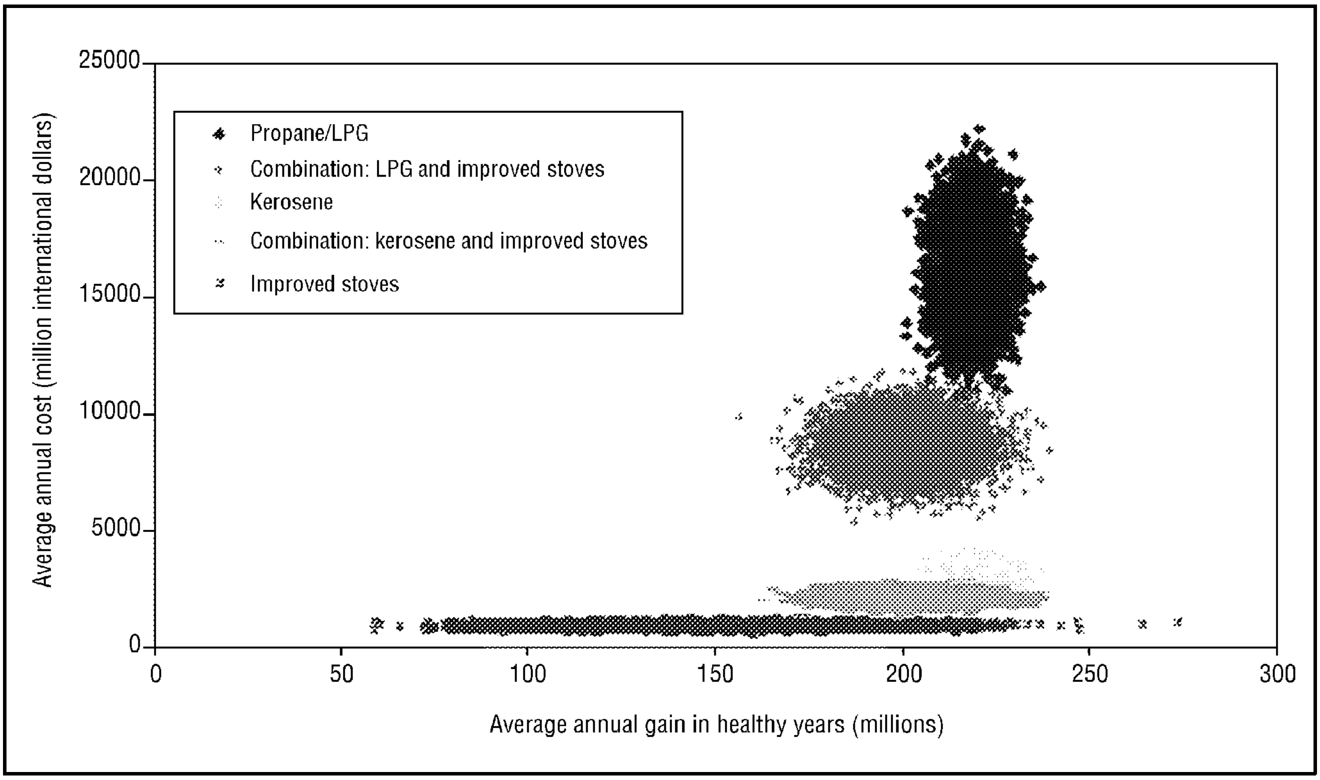

Figure 1. Cost effectiveness uncertainty analysis for South-east Asia region

Table 4. Average annual cost of interventions to reduce exposures to indoor air pollution from solid fuel use ('000 international dollars)

	Africa		The Americas		Eastern Mediterranean		Europe	South and South-east Asia		Western Pacific
	AfrD	**AfrE**	**AmrB**	**AmrD**	**EmrB**	**EmrD**	**EurB**	**SearB**	**SearD**	**WprB**
Propane/LPG										
Cooking system	1,932,000	6,217,000	830,000	446,000	9,000	2,796,000	909,000	2,772,000	16,031,000	8,833,000
Program costs	12,600	14,100	26,900	3,800	15,200	14,200	13,300	10,300	27,600	58,400
Total	1,944,600	6,231,100	856,900	449,800	24,200	2,810,200	922,300	2,782,300	16,058,600	8,891,400
Cost per household	70	100	40	60	20	70	50	60	90	70
Paraffin/kerosene										
Cooking system	297,000	1,113,000	120,000	67,000	1,000	444,000	143,000	441,000	2,988,000	1,558,000
Program costs	12,600	14,100	26,900	3,800	15,200	14,200	13,300	10,300	27,600	58,400
Total	309,600	1,127,100	146,900	70,800	16,200	458,200	156,300	451,300	3,015,600	1,616,400
Cost per household	10	20	10	10	10	10	10	10	20	10
Improved stoves										
Cooking system	61,000	246,000	327,000	165,000	2,000	999,000	400,000	104,000	852,000	4,093,000
Program costs	38,800	41,300	77,900	11,500	44,400	38,900	42,600	29,000	80,200	163,300
Total	99,800	287,300	404,900	176,500	46,400	1,037,900	442,600	133,000	932,200	4,256,300
Cost per household	3	5	20	22	33	24	22	3	5	4

Note

"Cooking system" includes stove, cylinder (for propane/LPG), fuel

7. Characterizing uncertainty

There is undoubtedly a great deal of uncertainty surrounding estimates of costs and effects.

A multivariate sensitivity analysis was conducted to assess the magnitude of uncertainty surrounding cost and effectiveness information. Costs were assumed to vary with a standard deviation of 5 %. Effectiveness was varied by the confidence interval surrounding the relative risk estimate for each health end-point. (See Figure 1.) The "clouds" or uncertainty regions illustrate the range of possible point estimates emerging from the uncertainty analysis for LPG, kerosene, and improved stove intervention coverage. Results, shown here for the South and South-east Asian Region D, suggest that despite uncertainty, the

Table 5. Cost effectiveness ratios (CERs) for interventions to reduce indoor air pollution from solid fuels[1]

	Africa		The Americas		Eastern Mediterranean		Europe	South and South-east Asia		Western Pacific
	AfrD	AfrE	AmrB	AmrD	EmrB	EmrD	EurB	SearB	SearD	WprB
Cost-effectiveness ratio (CER) (I$/healthy year gained)										
LPG	6,270	11,050	14,050	7,500	24,200	11,020	17,740	15,120	7,350	1,410
Kerosene	1,000	2,000	2,410	1,180	16,200	1,800	3,010	2,450	1,380	260
Improved stoves	500	730	-	5,880	-	7,800	-	1,180	610	32,240
Combination: LPG and improved stoves	3,750	6,440	16,330	6,770	-	9,780	19,870	8,970	4,280	1,570
Combination: kerosene and improved stoves	840	1,530	8,080	3,120	-	4,500	9,510	1,950	1,040	780

Note

1. Missing values indicate that health benefits from current regional coverage exceed those of the intervention scenario.

trend in the ordering of the interventions to be chosen on the basis of this analysis remains the same.

8. Limitations

This analysis only addresses gains in healthy years from averted illness. Incorporating treatment costs would further strengthen the cost-effectiveness of interventions. On the other hand, as the vast majority of these cases are likely to go untreated [Goldman et al., 2002], the inclusion of treatment costs could result in inflated CERs.

The use of CEA for environmental health risk factors has its limitations. Since future benefits are discounted when evaluating the effectiveness of interventions, the proper treatment of issues such as sustainability becomes somewhat problematic [Hutton, 2001].

For risk factors that are addressed using a multi-sectoral approach, especially those requiring substantial investments in infrastructure, interventions may not appear to be cost-effective if health benefits are the only benefits quantified. Non-health benefits, including social and environmental benefits, are often significant for development-related environmental risk factors. While past improved stove programs have not necessarily resulted in decreased exposures or increased fuel efficiency [ESMAP, SAR, 2002], their ability to promote women's participation in community-building activities is unequivocal [Cecelski, 1995]. Having access to cleaner fuels could result in significant time-saving for women. As a result, where women have access to income-generating activities, there could be additional economic and social benefits that are not captured within this CEA framework.

9. Discussion

Of the two cleaner fuels assessed here, kerosene is consistently more cost-effective than liquefied petroleum gas (LPG). It should be noted, however, that concerns about kerosene use, including poisoning [Reed and Conradie, 1997; Abu-Ekteish, 2002], burns [Mabrouk et al., 2000], and possible carcinogenic effects [Kim Oanh et al., 2002], should be carefully considered before recommending it over LPG purely on the basis of cost-effectiveness.

The cost-effectiveness of these interventions should be interpreted within the right context. Improved stoves and cleaner fuels are not clinical interventions. Health-care providers could promote improved stoves, as they are relatively low-cost and can be manufactured from local materials. It is a bit harder to envision the promotion of cleaner fuels by the public health sector, since access to cleaner fuels is embedded within energy policies. At the very minimum, sustainable access to cleaner fuels would require an investment in energy infrastructure, increased supply of cleaner fuels to rural areas, and subsidy schemes for gas cylinders and stoves.

This offers further support for the argument that, from a public health point of view, there should be a continued emphasis on the promotion of improved stoves, as well as other locally appropriate means to reduce exposures within solid fuel-using households. In other words, health benefits associated with reducing exposures to indoor air pollution can be attained in the near future, without having to wait until everyone can be given access to cleaner fuels. ■

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Notes

1. The authors are affiliated to WHO-CHOICE, Evidence and Information for Policy, World Health Organization.
2. For men, it did not seem appropriate to use the unadjusted risk estimate, particularly when the adjusted estimates for both sexes were lower than either the unadjusted male alone or the adjusted female risks. The risk chosen for men, 1.8, is the risk that would, when used with the adjusted female risk, 3.2, result in the combined mean risk of 2.5 observed when analyses included both men and women, by simple averaging. The low end of the confidence interval was set at 1.0 (no effect) and the high end only at the unadjusted male risk, 3.2.

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Appendix A. Countries included in World Health Organization epidemiologic sub-regions

Region[1]	Mortality stratum[2]	Countries
AFR	D	Algeria, Angola, **Benin,** Burkina Faso, Cameroon, Cape Verde, Chad, Comoros, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Mali, Mauritania, Mauritius, Niger, Nigeria, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Togo
AFR	E	Botswana, Burundi, Central African Republic, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Eritrea, Ethiopia, **Kenya,** Lesotho, Malawi, Mozambique, Namibia, Rwanda, South Africa, Swaziland, Uganda, United Republic of Tanzania, Zambia, Zimbabwe
AMR	B	Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, **Mexico,** Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela
AMR	D	Bolivia, **Ecuador,** Guatemala, Haiti, Nicaragua, Peru
EMR	B	Bahrain, Cyprus, Iran (Islamic Republic of), Jordan, Kuwait, **Lebanon,** Libyan Arab Jamahiriya, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates
EMR	D	Afghanistan, Djibouti, **Egypt,** Iraq, Morocco, Pakistan, Somalia, Sudan, Yemen
EUR	B	Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Georgia, Kyrgyzstan, **Poland,** Romania, Slovakia, Tajikistan, the Former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Uzbekistan, Yugoslavia
SEAR	B	Indonesia, Sri Lanka, **Thailand**
SEAR	D	Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Maldives, Myanmar, **Nepal**
WPR	B	Cambodia, **China,** Lao People's Democratic Republic, Malaysia, Mongolia, Philippines, Republic of Korea, Viet Nam, Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu

Notes

1. AFR = Africa Region; AMR = Region of the Americas; EMR = Eastern Mediterranean Region; EUR = European Region; SEAR = South-east Asian Region; WPR = Western Pacific Region
2. B = low adult, low child mortality; C = high adult, low child mortality; D = high adult, high child mortality; E = very high adult, high child mortality
3. Representative country for each region indicated in bold type.