The urgent need for action and proven strategies to minimize adverse health effects of IndoorAir Pollution

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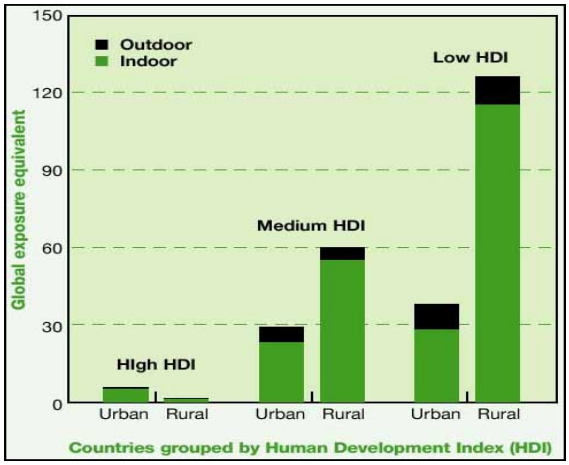


Air pollution is a much talked topic at present. In the recent past the focus was mainly on outdoor or urban air pollution and bulk of the research was carried out in the developed countries. However due to the persistence campaigning of WHO since 1990 issues related to indoor air pollution too have come to the limelight. Research indicates that the degree of air pollution is far worse in indoors than outdoors. A gram of pollution released indoors is likely to cause many hundreds of times more exposure than a gram released outdoors.**(K.R.Smith).** The chart1 indicates that indoor air pollution in rural house households of countries which has a low human development index is comparatively high compared to outdoor air pollution.

Source: UNDP

There are many sources of indoor air pollution in any home. These include combustion sources such as oil, gas, kerosene, coal, wood, and tobacco products; building materials and furnishings, wet or damp carpet, and cabinetry or furniture made of certain pressed wood products; products for household cleaning and maintenance such as paints, pesticides etc.

Indoor Air Pollution Sources by Major Pollutant Types

Particles	Combustion by-products (CO, NOx)	Volatile organics	Biologicals	Pesticides	Radon
Solid fuel and tobacco combustion, cleaning	Fuel and tobacco combustion	Furnishings, household products, solid fuel and tobacco combustion	Furnishings, ventilation ducts, moist areas	Household products, dust from outside	Ground under building, ventilation characteristics

However the focus of this presentation is on the issues of indoor air pollution caused by cooking with solid fuel(biomass) since it has wide spread implications covering a wide range of development issues affecting quality of life of majority of the rural and urban poor particularly women, children elderly in developing countries.

Nearly 90% of the energy for cooking is derived from biomass and over 90% of the rural and 25% of the urban population use biomass for cooking. This high degree of reliance on biomass and inefficient cooking methods expose the majority of our population to adverse health implications which have been satisfactorily proven by a number of research studies. .

Biomass Energy used for cooking:90% Total Energy for cooking

Biomass used for cooking as a % of total energy: 46%

Population using biomass for cooking: 90%

Average RSP outdoor < 300 µg/m3
Average RSP indoor : 500 - 10000 µg/m3

The average indoor pollution can be 5 to 10 times than outdoor air pollution
- USEPA

Source: ECF & Census Dept

According to these studies, although hundreds of chemicals can be found in biomass smoke, the major pollutants of biomass smoke which affects health conditions are:

Carbon Monoxide(CO)

Total Suspended Particles (TSP)
Hydrocarbons (HCs),
Formaldehyde (HCHO),
Nitrogen Oxides (NOx).

Of these pollutants, studies have proven that suspended particulates have adverse effects on health particularly on women , children and elderly.

The following chart gives a summary of measurements of particulate concentrations in several developing countries.

TABLE 5.2

Indoor Particulate Concentrations in Developing Countries, Summary of Selected Studies

Location	Conditions	Number of measurements	micrograms per cubic metre
Africa			
Kenya (1972)	Night: highlands	5	2,700-7,900
Kenya (1972)	Night: lowlands	3	300-1,500
Kenya (1987)	24 hour exposure	64	1,200-1,900
Kenya (1993)	Unvented hut: cooking	4	1,346-37,000
Nepal (1988)	24 hour exposure	18	400-2,400
Gambia (1988)	24 hour exposure	36	800-3,400
Zimbabwe (1990)	While cooking	20	100-4,900
Asia			
India (1983)		56	6,800
India (1988)		129	4,700
India (1988)		44	3,600
India (1988)		165	3,700
Nepal (1986)		49	2,000
Nepal (1988)	Traditional stoves	20	8,200
Nepal (1988)	Improved stoves	20	3,000
US 24-hour standard (not to be exceeded more than once/year)			250
US Annual Urban Levels			60

Note: These measurements of particulate concentrations, in micrograms per cubic metre, were obtained under a range of conditions — during cooking, as a daily average, etc. They are not directly comparable, but give a feel for the range of concentrations. The measured concentrations are consistently far above the U.S. one-time exposure standard and the annual average. Measurements are for particles having a diametre greater than 10 microns.

Source: Data from P. Young and K. Wafula, "Smoked Maasai," ITDG/KENGO (London, 1993), mimeo; K.R. Smith et al., "Greenhouse Gases from Biomass and Fossil Fuel Stoves in Developing Countries: A Manila Pilot Study," *Chemosphere* 26 (1992), pp. 479-506, and K.R. Smith, "The Health Impact of Cookstove Smoke in Africa," in *African Development Perspectives Yearbook* 3 (Muenster: Lit Verlag, 1994).

In Sri Lanka measurements of particulates taken in 19 households in Waltrim Estate, Lindula indicated a 12 hr average of 1173 $\mu g/m^3$ as against 153 $\mu g/m^3$ taken near an outdoor security post in Kandy. (**Smoke Signals: Peter Young et al 1994**)

In the past air pollution both indoor and outdoor were supposed to be associated with industrialisation and urbanisation and thus with the cities and buildings of developed countries where most of the air quality measurements have been made. Recently, However UNEP/WHO global monitoring system (GEMS) has demonstrated that the worst air pollution concentrations and exposures reported are from the cities and households of developing countries. According to several studies carried out in developing countries, there is growing evidence that high indoor air pollution caused by cooking with biomass is a major hazard, which seriously affect the health of women, children and elderly.

Several epidemiological studies and animal toxicological studies in the developed and developing countries have suggested that domestic air pollution is responsible for several health hazards and deaths. However there is still some scepticism expressed about the nature of smoke as a contributory factor to respiratory ailments since wood has been used from time immemorial. Nevertheless there is a growing body of evidence linking various diseases to with prolonged exposure to smoke emissions. More recent studies have provided concrete evidence that biomass energy users are exposed to extremely high concentrations of respirable suspended particulate (RSP) inhaled from biomass smoke that are well above the standards recommended by the World Health Organisation(10 $\mu g/m^3$). In a pioneering research work carried out in 1987-Dr Kirk R. Smith and several researches carried out subsequently in Nepal, India, Papua New Guinea, Gautemala, Kenya and China provide statistically significant evidence for correlating biomass smoke with respiratory infection and debilitating lung diseases. In addition to over 100 studies in China 71 research studies have been recorded in developing countries most of which highlights the association of wood smoke to several diseases.

Number of Exposure – Response Studies

Region	Number of Studies	% Of Total
South Asia	23	32
Latin America	19	27
Africa	18	25
China	7	10
OtherAsia	2	3
Ocenia	2	3

This analysis does not include the 110+ china studies that were included in the WHO report
Indoor Air Pollution data base for China Smith K/R/ et al WHO 1998

The health effects of indoor air pollution can be categorised into four broad groups.

- **Infectious respiratory diseases : acute respiratory infections in children and tuberculosis.**
- **Chronic respiratory diseases: chronic obstructive pulmonary disease and Lung cancer.**
- **Adverse pregnancy effects: still birth, low birth weight, and**
- **Other suspected health effects for which less evidence exists: blindness, asthma and heart disease**

Health Effects of Exposure to Smoke: Plausible Ranges of Relative Risk

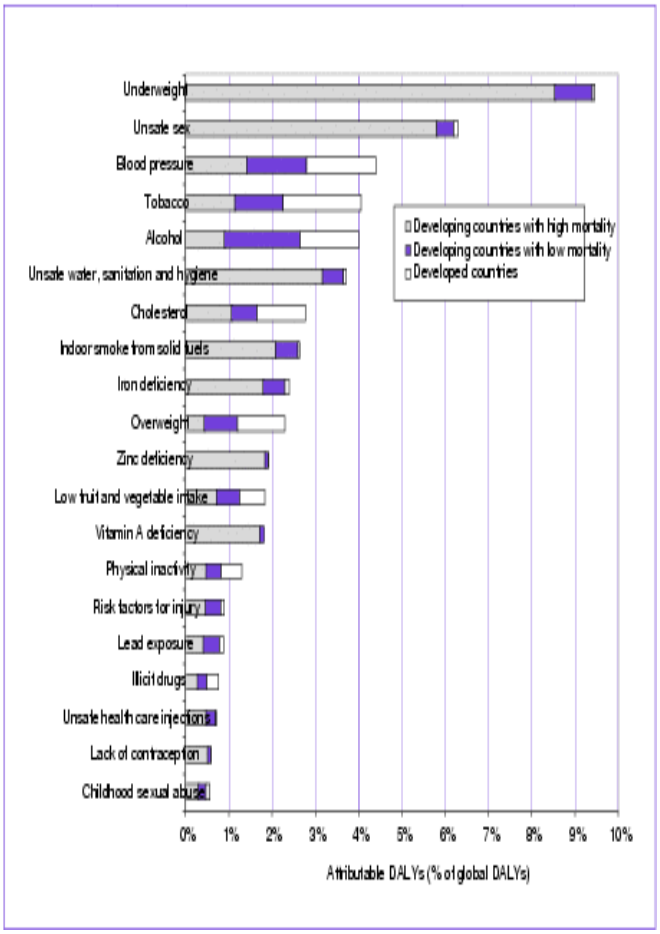
In Solid Fuel Using Households

Health Outcome	Population Affected	Relative Risk Low High	Evidence
Acute Lower Respiratory Infection (ALRI)	< 5 years	2.0 3.0	Strong
Asthma	≥ 15 Females	1.4 2,5	Moderate
Blindness(Cataracts)	≥ 15 Females	1.3 1.6	Moderate
Chronic Obstructive Pulmonary Disease(COPD)	≥ 15 Females	2.0 4.0	Strong
Lung Cancer(Coal only)	≥ 15 Females	3.0 5.0	Strong
Tuberculosis	≥ 15 Females	1.5 3.0	Moderate

Adapted from Smith 2000

These studies have shown reasonably consistent and strong relationships between the indoor use of solid fuel and a number of diseases. **WHO** estimates that indoor smoke from solid fuels causes about 35.7% of lower respiratory infections, 22.0% of chronic obstructive pulmonary disease and 1.5% of trachea, bronchus and lung cancer. In total, 2.7% of disability adjusted life years lost (DALYs) worldwide are attributable to indoor smoke, 2.5% in males and 2.8% in females. The report also mentions that indoor air pollution is the 8th highest risk factor globally and 4th highest in the developing countries. Acute respiratory infections in children under five years of age are the largest single category of deaths (64%) and DALYs (81%) from indoor air pollution, apparently being responsible globally for about 1.2 million premature deaths annually in the early 1990s. The annual burden of disease attribulatable to solid fuel use in developing countries estimated by the WHO indicates 1.8 million deaths and 53 million DALYs.

Figure 4.9 Global distribution of burden of disease attributable to 20 leading selected risk factors



Estimated annual health effects of indoor air pollution in India

Disease	Deaths, thousands	YLL, millions	DALYs, millions	Sickday severity
I. Strong evidence				
ARI* (880,000)	270–400	9.2–14	9.6–14	0.28
COPD† (60,000)	20–35	0.19–0.34	0.39–0.68	0.43
Lung cancer† (6,000)	0.42–0.79	0.0046–0.0086	0.0048–0.0090	0.15
II. Moderate evidence				
Blindness† (~0)	≈0	≈0	0.064–0.13	0.5
TB† (250,000)	53–130	0.97–2.4	1.1–2.6	0.15
APO (560,000)	?	?	?	
Asthma (20,000)	3.6–9.0	0.046–0.12	0.27–0.68	0.15
III. Suggestive evidence				
IHD† (1,100,000)	54–200	0.49–1.8	0.55–2.1	0.32
Possible total (2,300,000)	400–780	11–18	12–20	
Range used‡:	400–550	11–16	12–17	

Source: WHO
Source: Smith and Mehta USAID/WHO

Until now there was lack of adequate scientific data and there by lack of official recognition of the magnitude and gravity of the problem for effective action. There is now convincing evidence of the seriousness of the problem and to accept that indoor air pollution is a major contributory factor in mortality and morbidity which warrants urgent action from the relevant authorities.

The possible interventions to mitigate the adverse effects of indoor air pollution.

Several interventions have been tried out internationally some of which have been proven scientifically effective, These technologies and strategies fall under three categories namely source of smoke, cooking environment and user behaviour.

Source of Smoke	Cooking	User Behaviour

	environment	
Improved cooking devices Chimneyless improved biomass stoves Improved stoves with chimneys Alternative fuel–cooker combinations Briquettes and pellets Charcoal Kerosene LPG Biogas Producer gas Solar cookers (thermal) Other low smoke fuels Electricity **Reduced need for fire** Efficient housing Solar water heating	Improved ventilation Hoods/fireplaces Windows/ventilation holes Kitchen design and placement of stove Shelters/cooking huts Stove at waist height	Reduced exposure through operation of source Fuel drying Use of pot lids Good maintenance Sound operation Reductions by avoiding smoke Keeping children out of smoke

The obvious solution suggested is to promote the use of cleaner fuels to replace the use of biomass. However in reality due to high price of cleaner fuels, large scale fuel switching to modern fuels will be unlikely in the foreseeable future. Moreover due to economic

and environmental reasons and energy security concerns, continuous use of biomass which is a local and renewable energy resource will be more prudent provided modern technologies could be introduced for efficient use of biomass.

Evidence of successful interventions

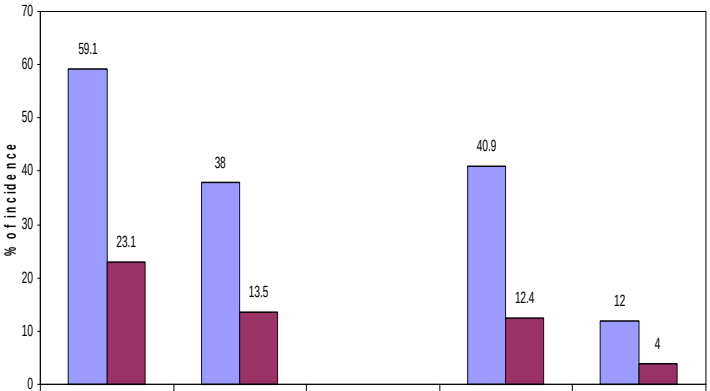
Research conducted in other countries and in a survey in Sri Lanka it is revealed that emissions are reduced by the use of Improved wood stoves.

In the Sri Lankan study in Waltrim Estate it is seen that particulates are reduced by 33% and *CO* by 8% by the use of "Anagi" improved stove.
(Smoke Signals : Peter Young et al ITDG/IDEA study in 1994).

"Dr. Pandey et all conducted a longitudinal study by monitoring the personal exposure level of RSPs in 20 households in a rural community in Nepal. The results provided convincing evidence of cause- effect relationship between the introduction and use of smokeless stoves and the reduction of indoor air pollution. The smokeless stoves emitted less smoke than the traditional stoves and 75% of the cooks preferred the smoke less stove to the traditional stove" (**Health Impacts of Woodfuel Emission and How to Improve Them-RWEDP/ FAO publication 2000-Dr M.R.Pandey**)

Relationshiop of stove type used & the % of incidence of ARI and Conjuctivitis: Study in Kenya by GTZ

OF=open fire ICS=improved stove



	Child ARI	Mother ARI		Child Conj	Mother Conj
OF	59.1	38		40.9	12
ICS	23.1	13.5		12.4	4

Comparison of Improved Stoves and Traditional Stoves

	Traditional Stove	Anagi Stove	% Reduction
Firewood	1.65 Kg	0.82 Kg	50
Methane(CH_4)	12.54 g/Kg	7.12	42
Total Suspended Particles(TSP)	12.54 g/Kg	7.21 .36	42.5 50
Sulphur Dioxides(SO_x)	.726 g/Kg	1.02	52.6 52.4
Oxides of Nitrogen (NO_x)	2.13 g/Kg	905.28	20.4
Carbon Dioxides	1901.37 g/Kg	61.36.	

Carbon Monoxide(CO)	**76.95 g/Kg**		

Source: University of Moratuwa and AIT, Bangkok

The following summary is from a research report titled Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: published in the Lancet, 5th Aug 2001. It gives % reduction of ARI and ALRI as a result of using improved stoves and cooking outside as compared to cooking on an open fire

AGE - years	ARI		ALRI		ARI		ALRI		ARI		ALRI		ARI		ARLI	
	ICS				OF - OUTSIDE				ICS - OUTSIDE				CHARCOAL			
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
0 - 4	24 %	24 %	21 %	21 %	35 %	35 %	27 %	28 %	42 %	49 %	36 %	35 %	64	64	44	44
5 - 14	12	7	9	15	17	32	26	30	38	63	44	45	71	64	61	46
15 -	14	2	15	10	15	50	17	38	37	58	43	42	6	6	6	4

49													8	2	5	5

ICS : Improved Cook Stove OF: Open Fire **Source: M. Ezzati and D.M.Kammen**