

# **Indoor Air Pollution:** **National Burden of Disease Estimates**

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# Approach

## The burden of disease concept

The burden of disease quantifies mortality and morbidity due to a given disease or risk factor. The most commonly used measure is the Disability-Adjusted Life Year (DALY), which combines the years of life lost due to disability with the years of life lost due to death. This measure allows to compare diseases or risk factors in terms of their public health importance. The World Health Organization has been investigating the contribution of a range of risk factors, such as malnutrition, smoking and lack of access to water and sanitation, to the burden of disease.

## Assessing the burden of disease from indoor air pollution

Worldwide, more than three billion people depend on solid fuels, including biomass (wood, dung and crop residues) and coal, for cooking and heating. Exposure to indoor air pollution from solid fuels has been linked to many different diseases, including acute and chronic respiratory diseases, tuberculosis, asthma, cardiovascular disease and perinatal health outcomes. A recent review concluded that there is strong evidence for indoor air pollution as a cause of pneumonia and other acute lower respiratory infections (ALRI) among children under five years of age, and chronic obstructive pulmonary disease (COPD) and lung cancer (in relation to coal use) among adults. Only these three diseases were included in the assessment of the burden of disease from indoor air pollution.

Globally, reliance on solid fuels has emerged as one of the ten most important threats to public health. In 2000, indoor air pollution was responsible for more than 1.5 million deaths and 2.7% of the global burden of disease. In high-mortality developing countries, it accounted for 3.7% of the burden of disease, making it the most important risk factor after malnutrition, the HIV/AIDS epidemic and lack of safe water and adequate sanitation. Indoor air pollution disproportionately affects women and children who spend the most time near the domestic hearth.

The World Health Organization has assessed, for the first time, the burden of disease from indoor air pollution at the national level. The approach relies on three ingredients:

- ◆ percentage of population using biomass fuels and coal, by country;
- ◆ deaths and DALYs for ALRI, COPD and lung cancer, by age group and country; and
- ◆ relative risk of ALRI, COPD and lung cancer when exposed to indoor air pollution.

All data were obtained for 2002 or the latest available year. For industrialized countries, where less than 5% of the population use solid fuels, a national burden of

disease assessment was not undertaken as the method is not sensitive enough to provide reliable estimates.

## Using the burden of disease estimates

The number of deaths or DALYs attributable to a given risk factor provides a basis for rational policy-making. It can be used by the health, environment, energy and finance sectors to set priorities for preventive action and to assess performance of policies over time. In the context of limited resources, the burden of disease information should be complemented with knowledge on technological options and information on the costs and benefits of such options.

## Data sources

### *Proportion of population using solid fuels*

World Health Organization. Fuel for life: household energy and health. Geneva, WHO, 2006. Available at <http://www.who.int/indoorair/publications/fuelforlife/en/index.html>

World Health Organization, World Health Survey 2003. Available at <http://surveydata.who.int/index.html>

### *Population data*

United Nations estimates of the de-facto population (2002 revision). Available at <http://www.un.org/esa/population/unpop.htm>

### *Estimates of deaths and DALYs from ALRI, COPD and lung cancer*

World Health Organization, Death and DALY estimates for 2002 by cause for WHO Member States. Available at <http://www.who.int/healthinfo/bod/en/index.html>

## Methodology

Desai M, Mehta S, Smith KR. Indoor smoke from solid fuels: assessing the environmental burden of disease at national and local levels. Geneva, WHO, 2004. Environmental Burden of Disease Series No. 4. Available at <http://www.who.int/indoorair/publications/indoorsmoke/en/index.html>

Smith KR, Mehta S, Feuz M. Indoor air pollution from household solid fuel use. In: Ezzati M et al., eds. Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors. Geneva, WHO, 2004.

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# Burden of disease due to indoor air pollution from solid fuel use for the year 2002

Country	Percentage of population using solid fuels	ALRI deaths attributable to solid fuel use (<5 years)	COPD deaths attributable to solid fuel use (≥30 years)	Lung cancer deaths attributable to coal use (≥30 years)	Total deaths attributable to solid fuel use*	Total DALYs attributable to solid fuel use	Percentage of national burden of disease attributable to solid fuel use
Afghanistan	>95	22 700	1 200	-	23 900	832 300	4.9
Albania	50	40	<10	-	<100	1 500	0.3
Algeria	<5	270	180	-	400	10 500	0.2
Andorra	<5	-	-	-	-	-	-
Angola	>95	21 170	870	-	22 000	747 000	6.9
Antigua and Barbuda	46	-	-	-	-	100	0.7
Argentina	<5	-	-	-	-	-	-
Armenia	26	40	80	-	100	2 400	0.5
Australia	<5	-	-	-	-	-	-
Austria	<5	-	-	-	-	-	-
Azerbaijan	49	1 550	270	-	1 800	59 400	3.8
Bahamas	<5	-	-	-	-	-	-
Bahrain	<5	-	-	-	-	-	-
Bangladesh	89	32 330	13 620	-	46 000	1 316 400	3.6
Barbados	<5	-	-	-	-	-	-
Belarus	19	<10	150	-	200	2 100	0.1
Belgium	<5	-	-	-	-	-	-
Belize	43	-	-	-	-	400	0.9
Benin	95	5 790	480	-	6 300	206 000	6.8
Bhutan	no data	-	-	-	-	-	-
Bolivia	34	1 140	100	-	1 200	43 300	1.9
Bosnia and Herzegovina	50	<10	<10	<10	<100	300	0.1
Botswana	65	100	90	-	200	4 600	0.4
Brazil	13	1 360	2 640	80	4 100	110 100	0.3
Brunei Darussalam	no data	-	-	-	-	-	-
Bulgaria	17	<10	20	-	<100	500	0
Burkina Faso	>95	20 830	650	<10	21 500	738 300	8.5
Burundi	>95	5 930	640	-	6 600	212 600	5.2
Cambodia	>95	1 280	330	-	1 600	52 300	1.0
Cameroon	83	11 600	1 290	-	12 900	417 000	5.5
Canada	<5	-	-	-	-	-	-
Cape Verde	36	10	20	-	<100	600	0.7
Central African Republic	>95	2 420	460	-	2 900	88 200	3.7
Chad	>95	8 000	660	<10	8 700	285 900	5.6
Chile	<5	-	-	-	-	-	-
China	80	20 540	342 450	17720	380 700	3 204 900	1.6
Colombia	20	320	1 580	-	1 900	35 200	0.4
Comoros	77	100	40	-	100	3 700	1.8
Congo	85	470	240	<10	700	18 300	1.2
Cook Islands	no data	-	-	-	-	-	-
Costa Rica	23	<10	100	-	100	1 200	0.2
Côte d'Ivoire	74	8 010	1 260	10	9 300	290 000	3.4
Croatia	12	-	-	-	-	200	0
Cuba	21	10	140	-	100	2 900	0.2
Cyprus	<5	-	-	-	-	-	-
Czech Republic	<5	-	-	-	-	<100	0
Democratic People's Republic of Korea	no data	-	-	-	-	-	-
Democratic Republic of the Congo	>95	41 980	5 150	-	47 100	1 513 600	4.5

Country	Percentage of population using solid fuels	ALRI deaths attributable to solid fuel use (<5 years)	COPD deaths attributable to solid fuel use (≥30 years)	Lung cancer deaths attributable to coal use (≥30 years)	Total deaths attributable to solid fuel use*	Total DALYs attributable to solid fuel use	Percentage of national burden of disease attributable to solid fuel use
Denmark	<5	-	-	-	-	-	-
Djibouti	5	60	<10	-	<100	2 000	0.7
Dominica	21	-	-	-	-	100	0.9
Dominican Republic	15	50	40	<10	<100	2 900	0.2
Ecuador	<5	70	40	<10	100	2 700	0.1
Egypt	<5	360	320	-	700	16 500	0.1
El Salvador	33	220	160	-	400	13 600	1.0
Equatorial Guinea	no data	-	-	-	-	-	-
Eritrea	80	2 600	240	<10	2 800	92 700	6.3
Estonia	16	-	-	-	-	<100	0
Ethiopia	>95	50 320	6 410	-	56 700	1 790 800	4.9
Fiji	40	20	20	-	<100	1 200	0.8
Finland	<5	-	-	-	-	-	-
France	<5	-	-	-	-	-	-
Gabon	28	100	60	-	200	4 000	0.9
Gambia	>95	530	100	-	600	19 200	3.7
Georgia	43	70	30	-	100	2 900	0.3
Germany	<5	-	-	-	-	-	-
Ghana	87	3 960	1 640	<10	5 600	153 500	2.2
Greece	<5	-	-	-	-	-	-
Grenada	48	-	-	-	-	200	0.9
Guatemala	62	1 570	1 690	-	3 300	88 800	3.1
Guinea	>95	240	580	-	800	14 200	0.4
Guinea-Bissau	95	1 100	120	-	1 200	39 100	4.4
Guyana	59	20	20	-	<100	1 200	0.6
Haiti	>95	2 790	70	-	2 900	105 100	3.0
Honduras	57	390	140	-	500	19 800	1.4
Hungary	<5	-	-	-	-	-	-
Iceland	<5	-	-	-	-	-	-
India	82	251 560	155 250	340	407 100	10 646 500	3.5
Indonesia	72	3 130	12 160	-	15 300	320 800	0.7
Iran, Islamic Republic of	<5	50	110	-	200	3 700	0
Iraq	<5	530	40	-	600	19 500	0.2
Ireland	<5	-	-	-	-	-	-
Israel	<5	-	-	-	-	-	-
Italy	<5	-	-	-	-	-	-
Jamaica	45	30	50	-	<100	2 600	0.7
Japan	<5	-	-	-	-	-	-
Jordan	<5	-	-	-	-	-	-
Kazakhstan	<5	20	30	<10	<100	1 500	0
Kenya	63	10 430	2 550	-	13 000	383 800	2.9
Kiribati	no data	-	-	-	-	-	-
Kuwait	<5	-	-	-	-	-	-
Kyrgyzstan	76	750	820	-	1 600	38 200	3.3
Lao People's Democratic Republic	>95	1 900	530	-	2 400	77 100	3.5
Latvia	10	-	-	-	-	<100	0
Lebanon	<5	-	-	-	-	-	-
Lesotho	83	260	180	-	400	10 500	0.8
Liberia	no data	-	-	-	-	-	-

# Burden of disease due to indoor air pollution from solid fuel use for the year 2002

Country	Percentage of population using solid fuels	ALRI deaths attributable to solid fuel use (<5 years)	COPD deaths attributable to solid fuel use (≥30 years)	Lung cancer deaths attributable to coal use (≥30 years)	Total deaths attributable to solid fuel use*	Total DALYs attributable to solid fuel use	Percentage of national burden of disease attributable to solid fuel use
Libyan Arab Jamahiriya	<5	20	20	-	<100	1 100	0.1
Lithuania	<5	-	-	-	-	-	-
Luxembourg	<5	-	-	-	-	-	-
Madagascar	>95	10 270	1 420	-	11 700	372 400	5.3
Malawi	>95	12 240	1 060	-	13 300	431 300	5.2
Malaysia	<5	<10	20	-	<100	300	0
Maldives	no data	-	-	-	-	-	-
Mali	>95	16 120	780	<10	16 900	568 000	6.6
Malta	<5	-	-	-	-	-	-
Marshall Islands	no data	-	-	-	-	-	-
Mauritania	56	2 100	200	<10	2 300	74 900	5.5
Mauritius	<5	-	-	-	-	<100	0.0
Mexico	14	900	1 510	<10	2 400	58 900	0.4
Micronesia, Federated States of	no data	-	-	-	-	-	-
Monaco	<5	-	-	-	-	-	-
Mongolia	51	240	30	-	300	9 200	1.6
Montenegro	no data	-	-	-	-	-	-
Morocco	5	390	210	-	600	16 500	0.3
Mozambique	80	8 450	1 230	-	9 700	300 200	2.4
Myanmar	>95	11 590	3 070	-	14 700	469 200	3.2
Namibia	65	80	150	-	200	4 000	0.5
Nauru	no data	-	-	-	-	-	-
Nepal	81	4 820	2 680	-	7 500	204 400	2.7
Netherlands	<5	-	-	-	-	-	-
New Zealand	<5	-	-	-	-	-	-
Nicaragua	64	570	160	-	700	22 100	2.3
Niger	>95	13 070	520	-	13 600	463 100	5.2
Nigeria	67	70 390	8 570	-	79 000	2 591 500	3.8
Niue	no data	-	-	-	-	-	-
Norway	<5	-	-	-	-	-	-
Oman	<5	-	-	-	-	-	-
Pakistan	81	51 760	18 980	<10	70 700	2 057 400	4.6
Palau	no data	-	-	-	-	-	-
Panama	33	30	70	-	<100	2 000	0.4
Papua New Guinea	90	990	560	-	1 600	51 200	3.2
Paraguay	53	240	30	-	300	11 100	1.1
Peru	33	1 230	320	-	1 500	47 900	0.9
Philippines	45	5 520	1 400	20	6 900	238 100	1.6
Poland	<5	-	-	-	-	-	-
Portugal	<5	-	-	-	-	-	-
Qatar	<5	-	-	-	-	-	-
Republic of Korea	<5	-	-	-	-	-	-
Republic of Moldova	63	30	130	-	200	3 000	0.3
Romania	23	90	170	-	300	4 600	0.1
Russian Federation	9	30	320	10	400	5 900	0
Rwanda	>95	7 350	760	-	8 100	262 300	5.8
Saint Kitts and Nevis	<5	-	-	-	-	-	-
Saint Lucia	63	-	-	-	-	300	1.4
Saint Vincent and the Grenadines	31	-	-	-	-	200	1.0

Country	Percentage of population using solid fuels	ALRI deaths attributable to solid fuel use (<5 years)	COPD deaths attributable to solid fuel use (≥30 years)	Lung cancer deaths attributable to coal use (≥30 years)	Total deaths attributable to solid fuel use*	Total DALYs attributable to solid fuel use	Percentage of national burden of disease attributable to solid fuel use
Samoa	70	-	-	-	-	400	1.3
San Marino	<5	-	-	-	-	-	-
Sao Tome and Principe	95	30	<10	-	<100	1 000	2.3
Saudi Arabia	<5	-	-	-	-	-	-
Senegal	53	5 010	420	<10	5 400	181 100	4.8
Serbia	no data	-	-	-	-	-	-
Seychelles	<5	-	-	-	-	-	-
Sierra Leone	92	7 170	410	-	7 600	258 200	5.7
Singapore	<5	-	-	-	-	-	-
Slovakia	<5	-	-	-	-	<100	0
Slovenia	8	-	-	-	-	<100	0
Solomon Islands	95	40	30	-	<100	2 000	1.9
Somalia	no data	-	-	-	-	-	-
South Africa	18	450	560	20	1 000	20 800	0.1
Spain	<5	-	-	-	-	-	-
Sri Lanka	67	100	3 030	-	3 100	44 500	1.3
Sudan	>95	1 460	2 930	-	4 400	79 900	0.7
Suriname	no data	-	-	-	-	-	-
Swaziland	64	320	60	-	400	11 300	1.4
Sweden	<5	-	-	-	-	-	-
Switzerland	<5	-	-	-	-	-	-
Syrian Arab Republic	32	180	220	-	400	10 800	0.4
Tajikistan	75	1 150	410	-	1 600	48 700	3.5
Thailand	72	1 850	2 710	-	4 600	95 900	0.8
The former Yugoslav Republic of Macedonia	30	-	-	-	-	200	0
Timor-Leste	no data	-	-	-	-	-	-
Togo	87	3 700	380	-	4 100	134 900	6.4
Tonga	56	-	-	-	-	200	1.0
Trinidad and Tobago	8	-	-	-	-	200	0.1
Tunisia	<5	60	70	<10	100	3 200	0.2
Turkey	11	820	1 720	-	2 500	62 100	0.5
Turkmenistan	<5	-	-	-	-	300	0
Tuvalu	no data	-	-	-	-	-	-
Uganda	>95	18 250	1 650	30	19 900	654 000	4.9
Ukraine	6	<10	230	<10	200	3 500	0
United Arab Emirates	<5	-	-	-	-	<100	0
United Kingdom	<5	-	-	-	-	-	-
United Republic of Tanzania	>95	25 050	2 410	-	27 500	885 600	4.4
United States of America	<5	-	-	-	-	-	-
Uruguay	<5	-	-	-	-	<100	0
Uzbekistan	72	3 860	1 390	-	5 300	157 600	3.7
Vanuatu	79	-	-	-	-	300	0.8
Venezuela, Bolivarian Republic of	5	40	70	-	100	3 000	0.1
Viet Nam	70	2 620	7 810	150	10 600	157 100	1.2
Yemen	42	6 590	460	-	7 000	242 000	3.5
Zambia	87	8 160	470	-	8 600	285 400	3.8
Zimbabwe	72	1 380	510	-	1 900	50 900	0.6

\* The total deaths attributable to solid fuel use were rounded and may not be equal to the sum of ALRI, COPD and lung cancer deaths.

