



WORLD HEALTH ORGANIZATION

Indoor Air Pollution, Health and the Burden of Disease

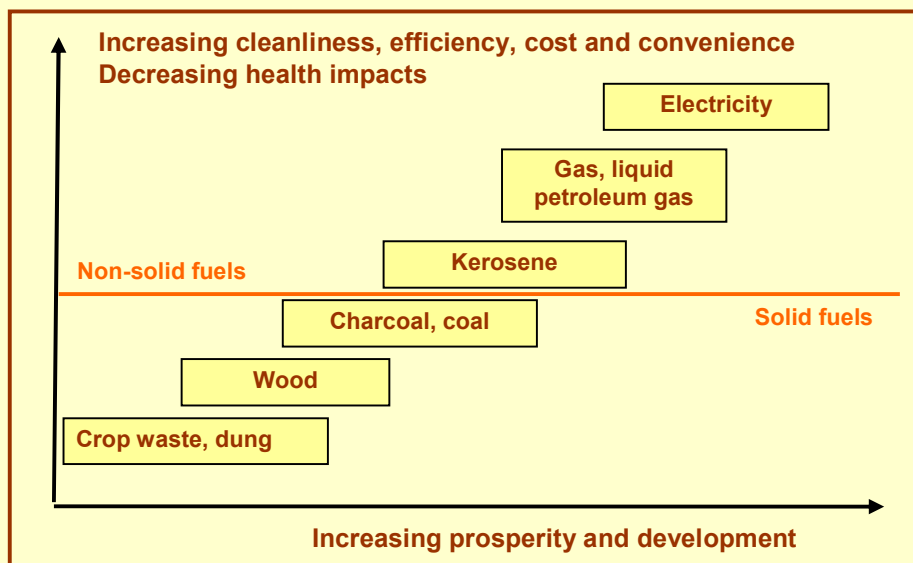
INDOOR AIR THEMATIC BRIEFING 2

Indoor air pollution from cooking and heating with solid fuels

In developing countries, the traditional use of household energy poses a serious threat to health: cooking and heating with biomass fuels (such as crop residues, dung, straw and wood) and coal produces high levels of indoor air pollution. This indoor smoke comprises a variety of health-damaging pollutants, such as particles (complex mixtures of chemicals in solid form and droplets), carbon monoxide, nitrous oxides, sulphur oxides (mainly from coal), formaldehyde and carcinogens, such as benzo[a]pyrene and benzene. Small particles with a diameter of 10 microns or less (PM_{10}) are able to penetrate deep into the lungs. The smallest particles with a diameter of 2.5 microns or less ($PM_{2.5}$) appear to have the greatest health-damaging potential.

A person's exposure to indoor air pollution is determined by the concentration of pollutants in the indoor environment and by the amount of time spent in this environment. With increasing prosperity households tend to move up the "energy ladder" (see diagram below) and use cleaner and more efficient, but also more costly, fuels. Stove features (e.g. the presence of a chimney or flue that routes the smoke to the outside), the location of the stove and kitchen, as well as ventilation practices have a major impact on indoor pollution levels.

The energy ladder



Studies from Asia, Africa and the Americas have shown that indoor air pollution levels in households reliant on biomass fuel or coal are extremely high: for example, typical 24-hour mean levels for PM_{10} in homes using biomass fuels are around $1000 \mu\text{g}/\text{m}^3$, compared to the current limit of $50 \mu\text{g}/\text{m}^3$ set by the European Union. Thus, typical concentrations of indoor air pollutants exceed many times the generally accepted guideline limits for outdoor air pollution. It is therefore of great concern that nearly half of the world's population continues to rely on polluting and inefficient solid fuels to meet its most basic daily energy needs.

Multiple health threats

Indoor air pollution has been associated with a wide range of health outcomes, and the evidence for these associations was classified as strong, moderate or tentative in a recent systematic review. There is consistent evidence that exposure to indoor air pollution increases the risk of pneumonia and other acute lower

respiratory infections (ALRI) among children under age five and chronic obstructive pulmonary disease (COPD) and lung cancer (in relation to coal use) among adults above age 30. The evidence for a link with lung cancer from exposure to biomass smoke, and for a link with asthma, cataracts and tuberculosis, was considered moderate. On the basis of the limited available studies, there is tentative evidence for an association between indoor air pollution and adverse pregnancy outcomes, in particular low birth weight, ischaemic heart disease and nasopharyngeal and laryngeal cancers.

While the precise mechanism of how exposure causes disease is still unclear, it is known that small particles and several of the other pollutants contained in indoor smoke cause inflammation of the airways and lungs and impair the immune response. Carbon monoxide also results in systemic effects by reducing the oxygen-carrying capacity of the blood.

A major global killer

The World Health Organization (WHO) assessed the contribution of a range of risk factors to the burden of disease and revealed indoor air pollution as responsible for 2.7% of the global burden of disease. Globally, indoor air pollution from solid fuel use accounts for more than 1.6 million deaths and 39 million DALYs (Disability-Adjusted Life Years, a measure combining years of life lost due to disability and death) every year. Included in this assessment were only those health outcomes for which the evidence for indoor air pollution as a cause was classified as strong.

Pneumonia and other acute lower respiratory infections (ALRI)

Globally, pneumonia represents the single most important cause of death in children under age five. Exposure to indoor air pollution more than doubles the risk of this disease and is responsible for more than 900 000 of the 2 million annual deaths from pneumonia and other ALRI.

Chronic obstructive pulmonary disease (COPD)

Women exposed to indoor smoke are three times as likely to suffer from COPD, such as chronic bronchitis, than women who cook and heat with electricity, gas and other cleaner fuels. Among men, exposure to this neglected risk factor nearly doubles the risk of chronic respiratory disease. Consequently, indoor air pollution is responsible for approximately 700 000 out of the 2.7 million global deaths due to COPD (independent of the effects of smoking).

Lung cancer

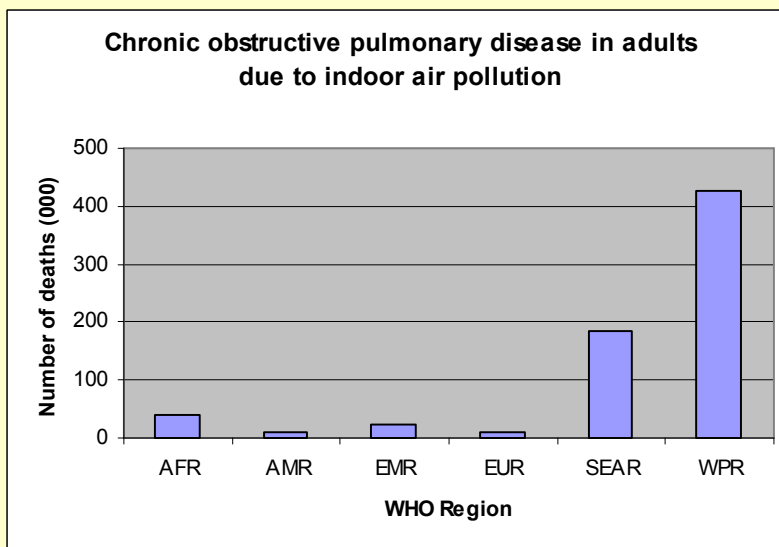
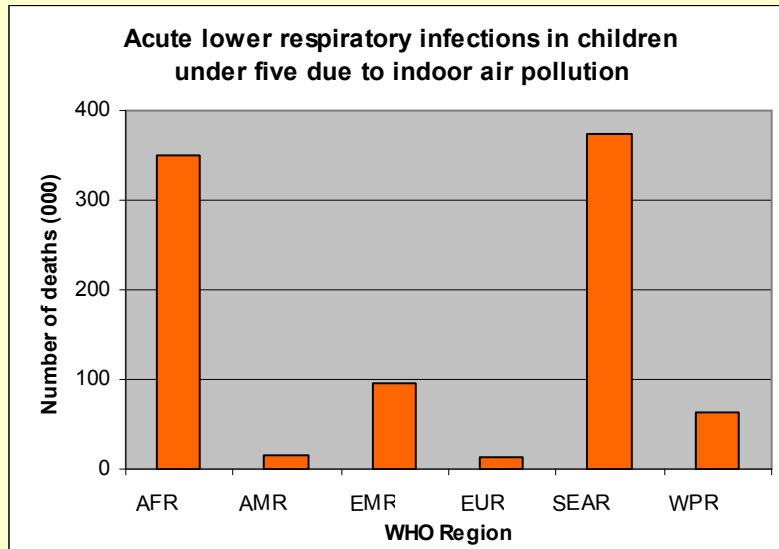
Coal use is widespread in China and cooking on open fires or simple stoves can cause lung cancer in women. Exposure to smoke from coal fires doubles the risk of lung cancer, in particular among women, who tend to smoke less than men in most developing countries. Every year, more than one million people die from lung cancer globally, and indoor air pollution is responsible for approximately 1.5% of these deaths.

Disproportionate impacts on children and women

In most societies, women are in charge of cooking and - depending on demands of the local cuisine - they spend between 3 and 7 hours per day near the stove, preparing food. Thus indoor air pollution disproportionately impacts on females. Young children are often carried on their mother's back or kept close to the warm hearth. Consequently, children spend many hours breathing indoor smoke during their first year of life when their developing airways make them particularly vulnerable to hazardous pollutants. As a result, 56% of all indoor air pollution-attributable deaths occur in children under five years of age.

Stark regional differences

Household energy practices vary widely around the world, as does the resultant death toll due to indoor smoke. The figures on the following page depict deaths due to ALRI and COPD attributable to indoor smoke for the six WHO Regions (see explanatory note on the back of this briefing). While children in Africa and South East Asia are most affected by indoor smoke, more than 50% of the COPD deaths due to solid fuel use occur in the Western Pacific region. In high-mortality developing countries, indoor smoke is responsible for 3.7% of the overall disease burden, making it the most important risk factor after malnutrition, unsafe sex and lack of safe water and adequate sanitation. In low-mortality developing countries, indoor smoke occupies the 8th rank and accounts for 1.9% of the disease burden. In contrast, in industrialized countries the impact of cooking and heating with solid fuels becomes negligible in relation to risk factors, such as tobacco, high blood pressure and alcohol consumption.



African Region (AFR)

- More than half a billion people, representing 78% of the African population, continue to cook with solid fuels.
- In 2000, indoor air pollution accounted for approximately 41 000 deaths due to COPD and 350 000 deaths due to ALRI.
- More than one third of all child deaths caused by indoor air pollution occur on the African continent.

Region of the Americas (AMR)

- 20% of the population in North America, Latin America and the Caribbean - more than 170 million people - rely on wood, dung and other solid fuels.
- Up to 11 000 COPD deaths and 15 000 ALRI deaths were attributed to indoor smoke in 2000.
- Noteworthy are stark differences in household energy practices between urban and rural, often indigenous populations.

Eastern-Mediterranean Region (EMR)

- More than 200 million people, constituting 42% of the population, cook with solid fuels.
- In 2000, indoor smoke was to blame for 118 000 deaths, 22 000 due to COPD and 95 000 due to ALRI.
- This burden almost exclusively falls on the poorest countries in the region, including Afghanistan, Djibouti, Iraq, Morocco, Pakistan, Somalia, Sudan and Yemen while the oil-rich Gulf states and most other Eastern-Mediterranean countries tend to use gas or electricity for cooking.

European Region (EUR)

- Solid combustibles constitute the cooking fuel of 160 million people in this region, representing 19% of the European and Central Asian population. While gas and electricity use is predominant in most European countries, many of the newly independent states in Central Asia still heavily rely on wood and coal.
- At least 21 000 annual deaths could be avoided by switching to cleaner fuels.
- Compared to other regions, the burden of disease from solid fuel use is relatively low, which in part is due to the widespread use of stoves with good ventilation.

South-East Asian Region (SEAR)

- 78% of the South-East Asian population, that is 1.2 billion people, rely on solid fuels for cooking.
- In this region, indoor air pollution was estimated to be the cause of 374 000 deaths in children under five and 185 000 deaths in adults in 2000.
- Given its size, India is the main victim and indoor air pollution is estimated to be responsible for between 4% and 6% of the national burden of disease.

Western Pacific Region (WPR)

- 1.2 billion people, representing 71% of the population of this region, use solid fuels for cooking.
- 426 000 COPD deaths and 15 000 lung cancer deaths were attributed to indoor air pollution in 2000. The lives of 62 000 children could be saved by providing their homes with access to cleaner energy sources.
- Most of this health burden falls on China where nearly 80% of the population cook with solid combustibles and 84% of rural households use crop wastes and wood for cooking.

African Region (AFR): 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, 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

Region of the Americas (AMR): Canada, Cuba, United States of America, 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, Bolivia, Ecuador, Guatemala, Haiti, Nicaragua, Peru

Eastern-Mediterranean Region (EMR): Bahrain, Cyprus, Iran (Islamic Republic of), Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates, Afghanistan, Djibouti, Egypt, Iraq, Morocco, Pakistan, Somalia, Sudan, Yemen

European Region (EUR): Andorra, Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, United Kingdom, Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Georgia, Kyrgyzstan, Poland, Romania, Slovakia, Tajikistan, The former Yugoslav Republic of Macedonia, Serbia and Montenegro, Turkey, Turkmenistan, Uzbekistan, Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine

South-East Asian Region (SEAR): Indonesia, Sri Lanka, Thailand, Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Maldives, Myanmar, Nepal, Timor-Leste

Western Pacific Region (WPR): Australia, Brunei Darussalam, Japan, New Zealand, Singapore, Cambodia, China, Cook Islands, Fiji, Kiribati, Lao People's Democratic Republic, Malaysia, Marshall Islands, Micronesia (Federated States of), Mongolia, Nauru, Niue, Palau, Papua New Guinea, Philippines, Republic of Korea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, Viet Nam

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