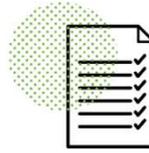
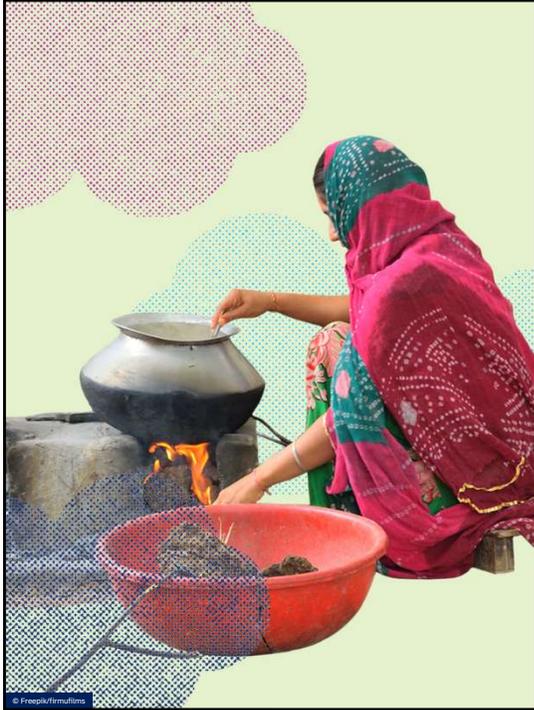


Notes

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- This module contains a large set of slides from which the presenter should select the most relevant ones to use for a specific presentation. These slides cover many facets of the problem. Present only those slides that apply most directly to the local or regional situation. Where relevant, you can adapt the information, statistics, and photos within each slide to the particular context in which this module is being presented.
- This module belongs to the Air Pollution and Health Training toolkit (APHT) targeting health workers. It has been developed in collaboration with more than 30 experts from government agencies, WHO collaborating centers, non-state actors, including medical and environmental health associations, as well as academic institutions. The methodology used for development included mapping existing air pollution and health training opportunities targeting health workers, which informed gaps and needs for a global set of materials. Experts identified through existing collaborations with WHO contributed to defining the outline and populating the training modules with content. Peer review and pilot tests coordinated by WHO ensured the collection of feedback and input for the finalization of the products. WHO made all possible efforts to ensure geographical and gender balance for developing this training toolkit, acknowledging limitations regarding expertise, experience, and overall feasibility. You can use and have access to other APHT modules where relevant. To see the full package, visit: <https://www.who.int/tools/air-pollution-and-health-training-toolkit-for-health-workers>
- For more information on WHO's work on air quality, energy, and health, please visit: <https://www.who.int/teams/environment-climate-change-and-health/air-quality-and-health>

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Learning objectives

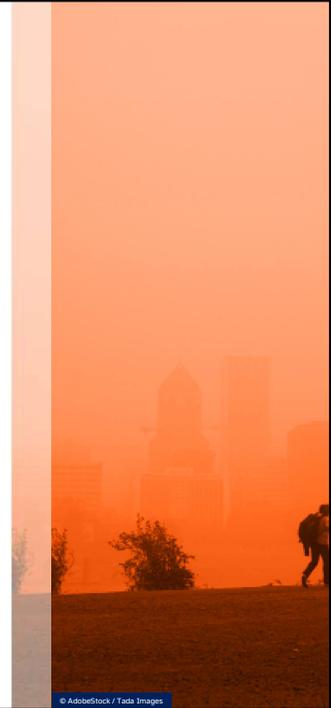
- Describe household air pollution and how it relates to indoor air pollution.
- List some of the main household air pollutants and their sources.
- Understand household air pollution health effects, including safety and social risks.
- Appraise the impacts of household air pollution on gender, climate, poverty and discuss risk perception.

Learning objectives:

1. Describe household air pollution and how it relates to indoor air pollution.
2. List some of the main household air pollutants and their sources.
3. Understand household air pollution health effects, including safety risks.
4. Appraise the impacts of household air pollution on gender, climate, poverty and discuss risk perception.

Acronyms

ALRI	acute low respiratory infections	LPG	liquified petroleum gas
CO	carbon monoxide	NCD	noncommunicable disease
CO ₂	carbon dioxide	PAH	polycyclic aromatic hydrocarbon
COHb	carboxyhaemoglobin	PM	particulate matter
COPD	chronic obstructive pulmonary disease	PM _{2.5}	particulate matter of diameter < 2.5 µm
DALY	disability-adjusted life years	SLCP	short-lived climate pollutant
GHG	greenhouse gas	VOC	volatile organic compound
HAP	household air pollution	WHO	World Health Organization
HICs	high-income countries	YLD	years of life lived with disability
IDH	ischaemic heart disease	YLL	years of life lost
LMICs	low- and middle-income countries		



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Module outline



1. What is household air pollution (HAP)?

- sources of HAP (carbon-based fuels);
- why not just call it indoor air pollution?



2. Main household air pollutants and health effects:

- main HAP pollutants;
- health effects from exposure to $PM_{2.5}$;
- burden of disease due to $PM_{2.5}$ household air pollution;
- health effects from exposure to CO.



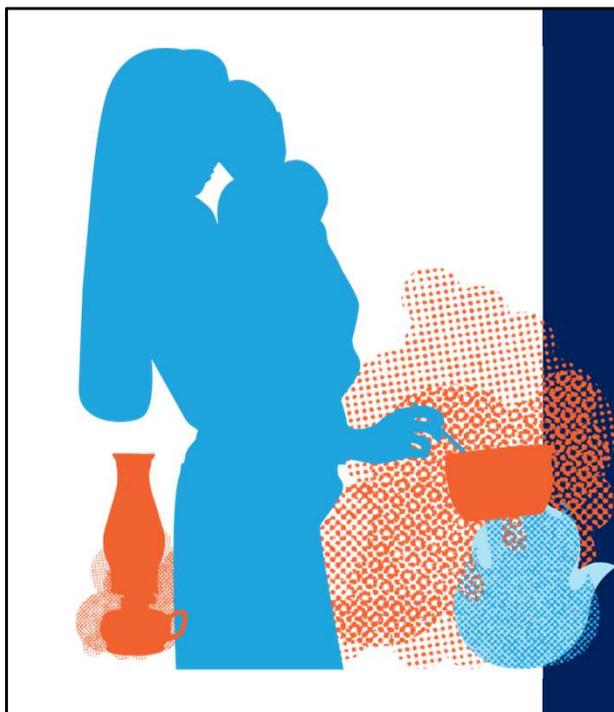
3. Safety and social impacts of household air pollution:

- safety risks in vulnerable populations;
- social risks in vulnerable populations.



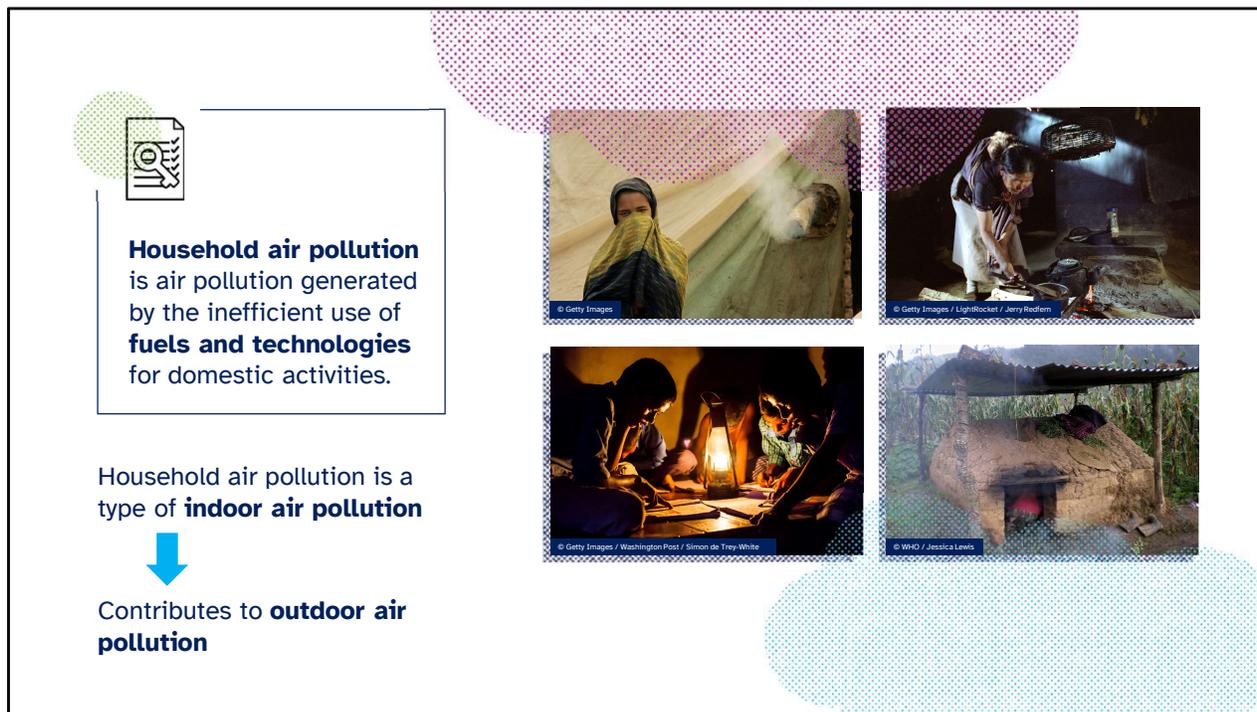
4. Other HAP impacts:

- global snapshot of clean energy access;
- gender implications in household air pollution;
- climate impacts of HAP;
- socioeconomic implications;
- a matter of risk perception and awareness.



UNIT 1

What is household air pollution?



Household air pollution (HAP) is air pollution generated by the **inefficient use of fuels and technologies** for domestic activities such as cooking, heating, and lighting.

Household air pollution is a type **of indoor air pollution** and contributes **to outdoor air pollution**.

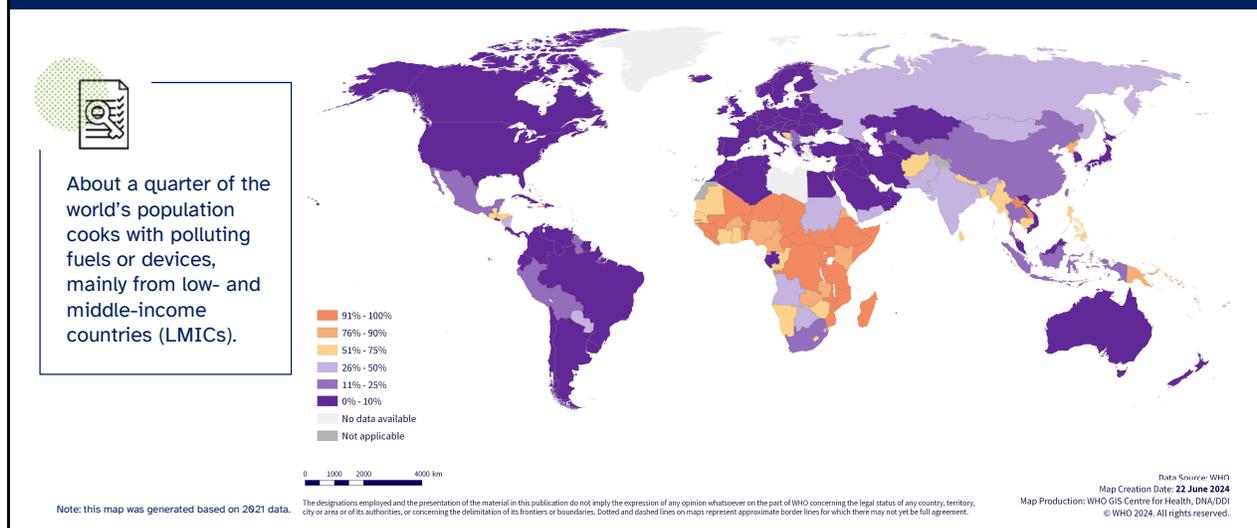
When we refer to HAP, we are considering the mixture of pollutants released as a result of the incomplete combustion (remember this!) of carbon-based fuels, not only indoors but in and around the home. These fuels are used for household activities such as cooking, heating, and lighting.

For the sake of completeness, we should call it “household air pollution from the use of inefficient fuel and technologies”, where the expression “fuel and technologies” encompasses different types of both fuels (solid and liquid) and polluting devices (stoves, lamps, etc.) used for cooking, heating, and lighting.

Bibliography

- Smith KR, Bruce N, Balakrishnan K, Adair-Rohani H, Balmes J, Chafe Z et al. Millions dead: how do we know and what does it mean? Methods used in the comparative risk assessment of household air pollution. Annual Rev Public Health. 2014;35:185–206. doi:10.1146/annurev-publhealth-032013-182356.
- Burning opportunity: clean household energy for health, sustainable development, and wellbeing of women and children. Geneva: World Health Organization; 2016 (<https://apps.who.int/iris/handle/10665/204717>, accessed 9 December 2024).
- WHO guidelines for indoor air quality: household fuel combustion: executive summary. Geneva: World Health Organization; 2014 (<https://apps.who.int/iris/handle/10665/144309>, accessed 9 December 2024).

Proportion of population with primary reliance on polluting fuels and technologies for cooking (%)



About a quarter of the world's population, 2.1 billion people in 2022, mainly from LMICs, cooks with fuels or devices that emit a substantial amount of toxic air pollutants.

This poses a great risk to human health.

In the map you can see the proportion of the population with primary reliance on polluting fuels and technologies for cooking. Countries in sub-Saharan Africa and South-East Asia have the highest proportions of population that rely on such fuels.

Clean fuels and technologies are defined in accordance with WHO guidelines for indoor air quality: household fuel combustion. This includes households primarily relying on electricity, biogas, natural gas, liquified petroleum gas (LPG), solar or alcohol fuels for cooking.

Bibliography

- Air pollution data portal. Global health observatory [online database]. Geneva: World Health Organization; (<https://www.who.int/data/gho/data/themes/air-pollution>, accessed 9 December 2024).
- IEA, IRENA, UNSD, World Bank, WHO. 2024. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. © World Bank. License: Creative Commons Attribution - NonCommercial 3.0 IGO (CC BY-NC 3.0 IGO)



Household air pollution is responsible for 3.2 million deaths in 2019

This number:

- Only accounts for the health impacts from polluting cooking
- Is likely an underestimate of the total burden of disease attributable to household air pollution
- Only includes health outcomes with the strongest evidence

According to WHO estimates for 2019, globally household air pollution from cooking is responsible for 3.2 million deaths.

This number:

- Only accounts for the health impacts from the main fuel and technology used for cooking.
- Is likely to be an underestimate of the total burden of disease attributable to household air pollution. This is largely due because this figure does not account for the health impacts associated with polluting lighting and heating practices as well as additional cooking fuels and devices used in parallel.
- it also only includes the number of attributable deaths for health outcomes with the strongest evidence.

Bibliography

- Air pollution data portal. Global health observatory [online database]. Geneva: World Health Organization; (<https://www.who.int/data/gho/data/themes/air-pollution>, accessed 9 December 2024).

Solid and non-solid fuels

Solid fuels



Biomass



Non-solid fuels



Fuels that generate household air pollution (through incomplete combustion) can be divided into solid and non-solid fuels.

Solid fuels are solid materials burned as fuels.

Some common solid fuels include **raw or unprocessed coal and biomass fuels**.

Biomass fuels are derived from plant matter and used directly as fuel or processed into other forms before combustion, like pellets.

Biomass fuels used in and around the home include:

- wood
- crop waste
- animal dung
- and charcoal (a form of carbon produced by the destructive distillation of wood (i.e. , the heating of wood out of contact with air).

In some cases, plastic bottles, tyres, and other solid materials are used as fuels.

A **non-solid** fuel that is a source of HAP is **kerosene** – a transparent liquid that is used in oil lamps, stoves, and heaters.

Bibliography

- Lam NL, Smith KR, Gauthier A, Bates MN. Kerosene: a review of household uses and their hazards in low- and middle-income countries. *J Toxicol Environ Health B*. 2012; 15(6):396–432. doi:10.1080/10937404.2012.710134.
- Glossary of statistical terms: solid biomass. Paris: Organisation for Economic Co-operation and Development; 2002 (<https://stats.oecd.org/glossary/detail.asp?ID=4603>, accessed 9 December 2024).
- WHO. Glossary on air pollution. World Health Organization. Regional Office for Europe; 1980 (<https://apps.who.int/iris/handle/10665/272866>, accessed 9 December 2024).

Major energy uses in the home



Cooking



Heating



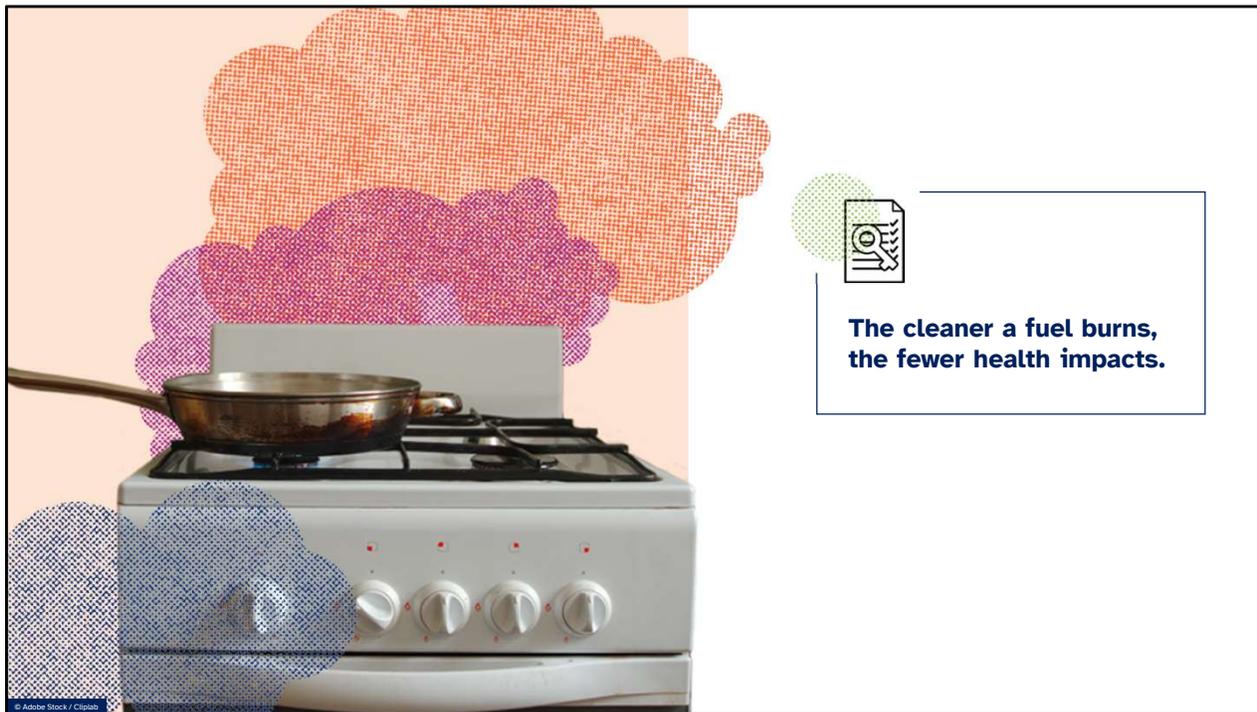
Lighting



These polluting fuels are used for several household-related activities, such as:

- cooking
- heating
- lighting.

This module will focus on these three categories, but other sources of household air pollution include the burning of candles, mosquito coils and incense, which can also pose health risks.



To understand the level of health risk from household air pollution, we need to know how efficiently or how well the stove or device burns the fuel. The rule is the cleaner it burns, the less health impacts.

Some fuels, like gaseous fuels, can be burnt very efficiently, largely independent of the device.

Whereas for other fuels, like solid fuels and kerosene, the level of pollutants emitted is largely dependent upon the performance of the stove or device in which the fuel is burned.

Clean fuels and technologies



WHO Guidelines for indoor air quality: Household fuel combustion define which fuels and technologies can be used safely in the home and can be considered clean for health at the point of use.



Clean fuels and technologies are defined in accordance with WHO guidelines for indoor air quality household fuel combustion. These guidelines define which fuels and technologies can be used safely in the home and can be considered clean for health at the point of use.

Bibliography

- WHO guidelines for indoor air quality: household fuel combustion: executive summary. Geneva: World Health Organization; 2014 (<https://apps.who.int/iris/handle/10665/144309>, accessed 9 December 2024).

Clean fuels and technologies

Clean fuels and technologies for health at the point of use include:

- electricity
- biogas
- natural gas
- liquified petroleum gas (LPG)
- solar or alcohol fuels



Defining clean fuels and technologies (WHO Clean Household Energy Solutions Toolkit):
<https://www.who.int/tools/clean-household-energy-solutions-toolkit/module-7-defining-clean>



The most common clean household fuels and technologies include:

- electricity
- biogas
- natural gas
- liquified petroleum gas (or LPG)
- solar or alcohol fuels for cooking.

You can get more information on clean fuels and technologies in the WHO Clean Household Energy Solutions Toolkit.

Bibliography

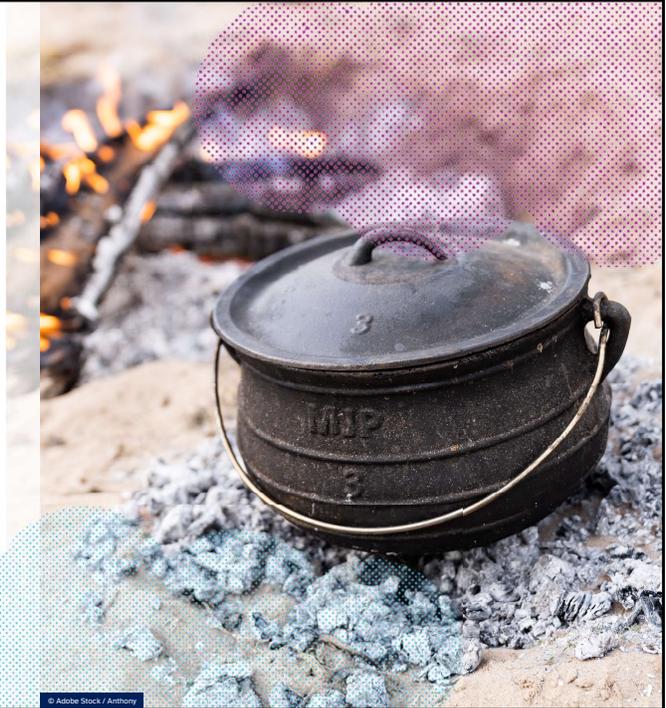
- WHO guidelines for indoor air quality: household fuel combustion: executive summary. Geneva: World Health Organization; 2014 (<https://apps.who.int/iris/handle/10665/144309>, accessed 9 December 2024).
- WHO Clean Household Energy Solutions Toolkit (CHEST). Geneva: World Health Organization; 2023 (<https://www.who.int/tools/clean-household-energy-solutions-toolkit>, accessed 9 December 2024).

Fuel and technologies for cooking, heating and lighting



**fuel + device =
main source of emissions**

Fuel and technologies for cooking,
heating and lighting



The main sources of household air pollution emissions come from the fuel and devices used for burning; we refer to such sources as “fuel and technologies for cooking, heating, and lighting.”



Why not just call it indoor air pollution?



Why not just call it indoor air pollution?



Household air pollution

Includes only combustion-related emissions



Indoor air pollution

Also refers to other sources, e.g, radon, dust, mould, chemicals from textiles and furniture

The first difference between household and indoor pollution is that:

- household air pollution includes **only combustion-related emissions**; while
- “indoor air pollution” also refers to **other indoor sources**, such as **radon, dust, mould**, and chemicals from textiles and furniture among others.



Why not just call it indoor air pollution?

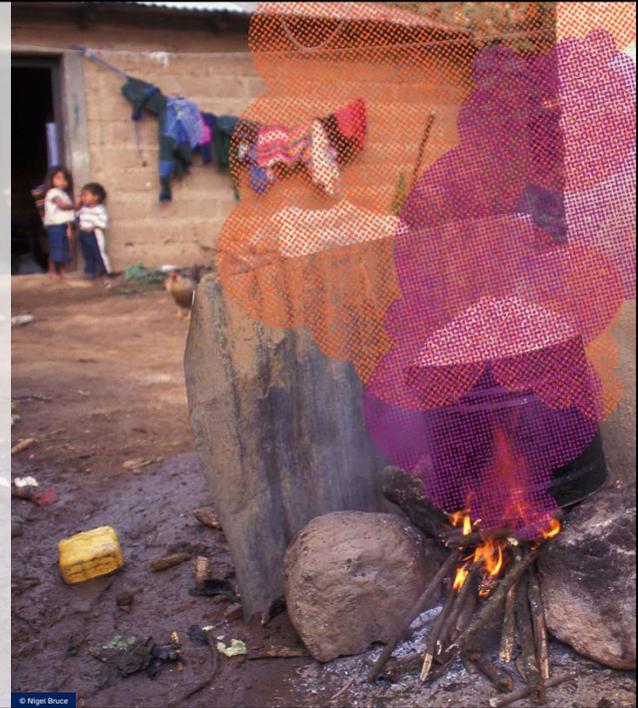
Household air pollution



Household air pollution is in AND around the home

Some domestic activities take place in the open air, polluting the nearby environment:

- Outdoor cooking
- Animal food preparation



Another defining difference is that household air pollution refers to pollution that occurs in and around the home as some domestic activities that take place in the open air, polluting the nearby environment. Examples include outdoor cooking and animal food preparation.

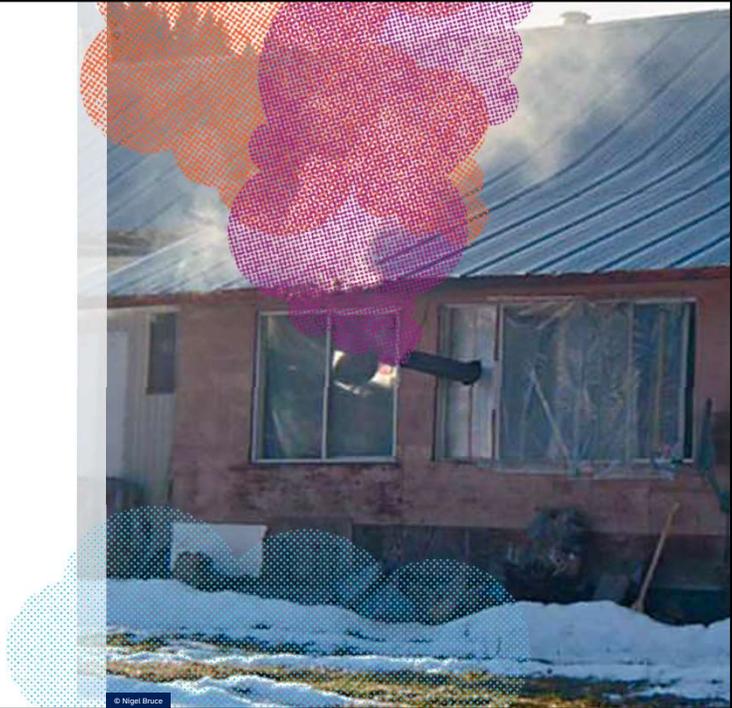


Why not just call it indoor air pollution?

Household air pollution

Smoke can leak out from open windows, chimneys and doors, and spread throughout the outdoor environment.

Open windows or poor housing conditions/construction allow smoke vented by a chimney to recirculate back indoors.



The term “indoor” implies that an effective chimney or other venting would solve the problem entirely, which is not the case. The neighbourhood pollution resulting from the indoor smoke circulated outdoors, exposes household members as well as neighbours to health-damaging pollutants.

Smoke is not trapped inside the home. We should consider the smoke leakages from open windows, chimneys and doors. In addition, open windows or poor housing conditions/construction allow smoke vented by a chimney to recirculate back indoors.

Such leakages ultimately increase outdoor air pollution levels and cause ill health in the neighbourhood and beyond.

What are some existing myths around home air pollution and its reach?



2018 video series at WHO First Global Conference on Air Pollution and Health

Kalpana Balakrishnan,
Faculty of Public Health,
India

(1 min 58 sec)



Source:
<https://www.who.int/teams/environment-climate-change-and-health/air-quality-and-health/videos/mosaic/air-quality-management/household-energy>

<1 min and 58 sec video>

Note: You can use other videos and embed them in the presentation using the WHO video mosaic series on air pollution and health: <https://www.who.int/teams/environment-climate-change-and-health/air-quality-and-health/videos/mosaic>

Bibliography

- Is household air pollution a global problem? In: WHO video mosaic [website]. Geneva: World Health Organization; 2018. (<https://www.who.int/teams/environment-climate-change-and-health/air-quality-and-health/videos/mosaic/air-quality-management/household-energy>, accessed 9 December 2024)



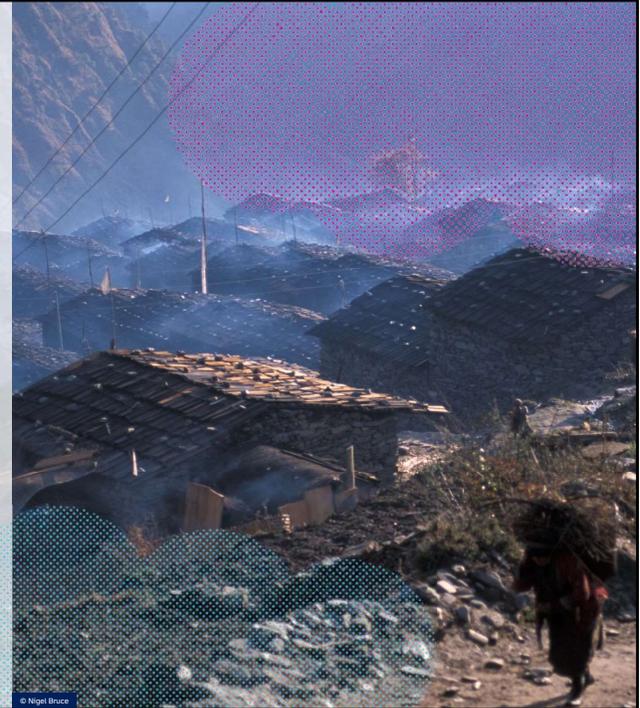
Why not just call it indoor air pollution?

Household air pollution

Smoke is not trapped inside the home.



Increasing ambient air pollution levels and causing ill health far from the source.

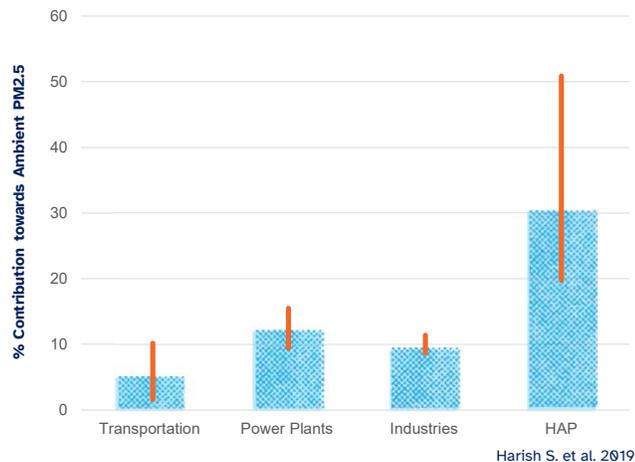


Smoke is not trapped inside the home. Polluting smoke can leak from windows, doors, and chimneys and then spread throughout the outdoor environment, increasing ambient air pollution levels and causing ill health far from the source.

Case example: HAP is a major contributor to ambient air pollution in India

In India, about 30% of ambient air pollution (PM_{2.5}) is due to household air pollution.

Other sources such as transport, power plants and industries contribute less than household air pollution.



We illustrate these last points using data from India.

Scientists estimate that household air pollution causes at least 22% and as much as 52% of ambient particulate matter of diameter < 2.5 μm (PM_{2.5}) levels in India. The median estimate is about 30%; this means that one third of ambient air pollution in India is the result of household air pollution. In this chart, the height of the bars represents the median contribution towards ambient PM_{2.5} levels according to a selection of studies based in India. The range, represented by the red line, indicates the lowest and highest estimate for each considered source.

Transportation, power plants, and industries are some of the other sources of air pollution in the country, but it is clear from the graph that they are estimated to contribute less to ambient air pollution than HAP. HAP is therefore the greatest source of ambient air pollution in India. It is clear that venting polluted air outside is not a solution; cleaner household energy use is needed.

Bibliography

- Harish S, Smith KR, Chowdhury S, Chafe ZA, Pillarisetti A, Lelieveld J et al. The contribution of household fuels to ambient air pollution in India - a comparison of recent estimates. Collaborative Clear Air Policy Centre; 2019 (<https://ccapc.org.in/policy-briefs/2019/5/30/the-contribution-of-household-fuels-to-ambient-air-pollution-in-india-a-comparison-of-recent-estimates>; accessed 9 December 2024).
- Rao ND, Kiesewetter G, Min J, Pachauri S, Wagner F. Household contributions to and impacts from air pollution in India. *Nat Sustain.* 2021;4:859–67. doi:10.1038/s41893-021-00744-0.
- Smith KR, Bruce N, Balakrishnan K, Adair-Rohani H, Balmes J, Chafe Z et al. Millions dead: how do we know and what does it mean? Methods used in the comparative risk assessment of household air pollution. *Annu Rev Public Health.* 2014;35:185–206. doi:10.1146/annurev-publhealth-032013-182356.

Why not just call it indoor air pollution?



1. “Indoor air pollution” refers to **sources of other types** (radon, dust and mould); HAP includes only combustion-related emissions.



2. Some of the sources of HAP may be **outside the house**.



3. The term “indoor” implies that an effective chimney or other venting would solve the problem entirely, but the basic problem is **dirty combustion**.



4. Indoor to outdoor: **ill health far** from the **source**.

To recap: we use the term “household air pollution” for the following reasons:

1. “Indoor air pollution” can be used to refer to indoor pollution from sources of other types (e.g., radon, dust and mould).
2. Much of the health-relevant air pollution exposure from HAP occurs in the household near the home, not just indoors. Some of the sources of pollution may be outside, for example, where households have their main cookstove just outside the house or in a courtyard.
3. The term “indoor” implies that an effective chimney or other venting would solve the problem entirely, when actually the problem is dirty combustion.
4. The use of polluting fuel contributes significantly to ambient (outdoor) air pollution levels, causing ill health far from the source.

Is household air pollution a problem?



2018 video series at WHO First Global Conference on Air Pollution and Health

In memory of Prof
Kirk Smith, University
of Berkley, USA

(1 min 42 sec)



Source:
<https://www.who.int/teams/environment-climate-change-and-health/air-quality-and-health/videos/mosaic/household-and-indoor-air-pollution/wood-burning-and-solid-fuel-use#>

<1 min and 42 sec video>

Note: You can use other videos and embed them in the presentation using the WHO video mosaic series on air pollution and health: <https://www.who.int/teams/environment-climate-change-and-health/air-quality-and-health/videos/mosaic>

Bibliography

- Is household air pollution a global problem? In: WHO video mosaic [website]. Geneva: World Health Organization; 2018. (<https://www.who.int/teams/environment-climate-change-and-health/air-quality-and-health/videos/mosaic/household-and-indoor-air-pollution/wood-burning-and-solid-fuel-use>, accessed 9 December 2024)



UNIT 2

Main household air pollutants: health effects and impacts



Wood smoke is natural – why is it harmful?

Wood is mainly carbon, hydrogen and oxygen – chemical elements commonly present in nature.

The **INCOMPLETE COMBUSTION** of wood generates a mixture of harmful toxic substances.

Biomass smoke is natural. Why is it harmful?

The inefficient burning of solid fuels on an open fire or traditional stove indoors creates a dangerous cocktail of hundreds of pollutants, including particulate matter, carbon monoxide, nitrogen oxides, benzene, butadiene, formaldehyde, polyaromatic hydrocarbons (PAHs), and many other chemicals damaging to health.

The combustion of fuels containing carbon and hydrogen is complete when these two elements have been completely oxidized to carbon dioxide and water. Incomplete combustion may lead to appreciable amounts of carbon remaining in the ash, emission of some of the carbon as carbon monoxide, and the reaction of the fuel molecules to emit a range of products of greater complexity than that of the fuel molecules themselves (if these products escape combustion, they are emitted as smoke).



Burning fuels such as dung, wood and coal in inefficient stoves or open hearths produces a variety of health-damaging pollutants, including particulate matter, black carbon, methane, carbon monoxide, polycyclic aromatic hydrocarbon (PAHs) and volatile organic compounds (VOCs).

The main health-damaging pollutants in the context of household air pollution are fine particulate matter and carbon monoxide.

Let's now look at household air pollution **main health effects**.

Note: Particulate matter (PM) is a mixture of solid particles and liquid droplets found in the air. The major components of PM include sulphates, nitrates, ammonia, black carbon and water. Some particles are large or dark enough to be visible with the naked eye. Others can only be detected using an electron microscope. Because PM can cover a wide range of sizes, it is classified according to its diameter. Fine particles ($PM_{2.5}$) have the most serious health effects. The smaller the particles, the greater the likelihood of them reaching the furthest parts of the respiratory tree and entering the bloodstream, where they cause greater harm to the body. You can learn more about PM by checking Module 1.

Bibliography

- WHO global air quality guidelines: particulate matter (PM_{2.5} and PM₁₀), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. Geneva: World Health Organization; 2021 (<https://apps.who.int/iris/handle/10665/345329>, accessed 9 December 2024).
- WHO guidelines for indoor air quality: household fuel combustion: executive summary. Geneva: World Health Organization; 2014 (<https://apps.who.int/iris/handle/10665/144309>, accessed 9 December 2024).

Main health effects of PM_{2.5}

- ischaemic heart disease (IHD)
- stroke
- chronic obstructive pulmonary disease (COPD)
- lung cancer
- acute low respiratory tract infections (ALRI)
- cataracts



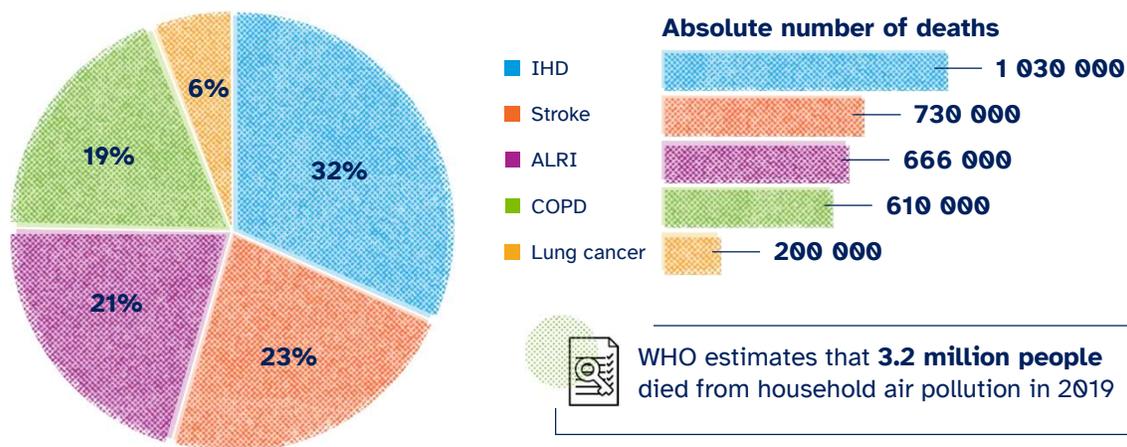
The health impacts of exposure to fine particulate matter in household air pollution, for which the strongest evidence exists, include:

- ischaemic heart disease and stroke;
- chronic obstructive pulmonary disease;
- lung cancer;
- acute lower respiratory infections which is more frequent in children; and
- cataracts, which is the main cause of blindness in low- and middle-income countries.

Bibliography

- Air pollution data portal. Global health observatory [online database]. Geneva: World Health Organization; (<https://www.who.int/data/gho/data/themes/air-pollution>, accessed 9 December 2024).
- Burden of disease from household air pollution for 2016. Geneva: World Health Organization; 2018 (https://cdn.who.int/media/docs/default-source/air-quality-database/aqd-2018/hap_bod_methods_may2018.pdf?sfvrsn=d277d739_3, accessed 9 December 2024).
- WHO guidelines for indoor air quality: household fuel combustion: executive summary. Geneva: World Health Organization; 2014 (<https://apps.who.int/iris/handle/10665/144309>, accessed 9 December 2024).

Deaths attributable to household air pollution PM_{2.5} by disease outcome (2019)



* Any variation beyond 100% may be due to rounding process

ALRI: acute low respiratory tract infections; COPD: chronic obstructive pulmonary disease; IHD: ischaemic heart disease

WHO estimates that, globally, household air pollution from the use of polluting fuels and devices for cooking was responsible for 3.2 million deaths in 2019.

Here, you can see the percentage of deaths attributable to HAP from exposure to PM_{2.5}.

Of the deaths resulting from exposure to household air pollution in 2019 – around 3.2 million – the greatest proportion was due to ischaemic heart disease (32%), followed by stroke (23%), acute low respiratory tract infections (21%), chronic obstructive pulmonary diseases (19%) and lung cancer (6%). It is also noteworthy that the majority of these deaths were from noncommunicable diseases (NCDs).

Note: ALRI: acute low respiratory infections; COPD: chronic obstructive pulmonary disease; IHD: ischaemic heart disease.

Bibliography

- Air pollution data portal. Global health observatory [online database]. Geneva: World Health Organization; (<https://www.who.int/data/gho/data/themes/air-pollution>, accessed 9 December 2024).
- Burden of disease from household air pollution for 2016. Geneva: World Health Organization; 2018 (https://cdn.who.int/media/docs/default-source/air-quality-database/aqd-2018/hap_bod_methods_may2018.pdf?sfvrsn=d277d739_3, accessed 9 December 2024).

Other emerging health effects of PM_{2.5}

Chronic diseases

- asthma
- diabetes
- cognitive development and impairment

Infectious diseases

- ear and upper respiratory infections
- tuberculosis

Cancers

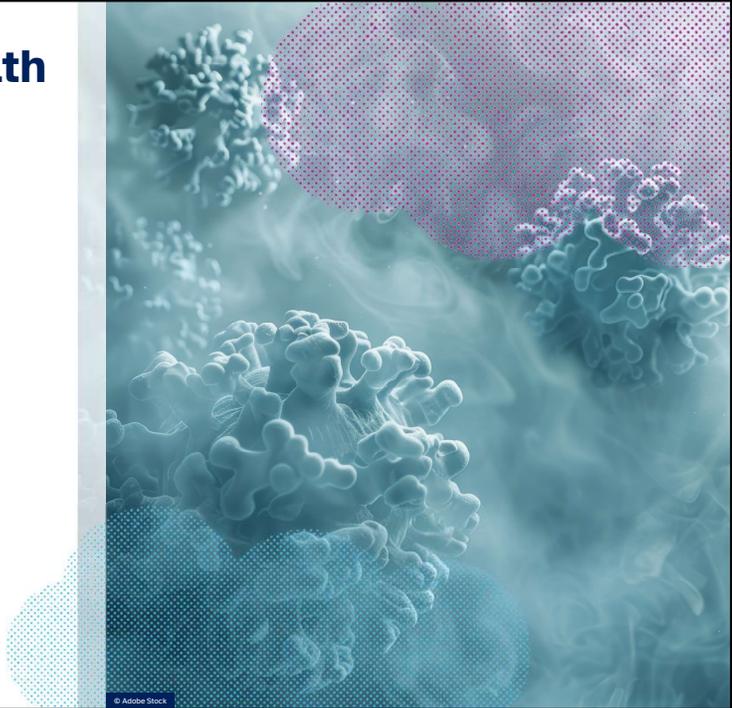
- nasopharyngeal and laryngeal cancers
- cervical cancer

Birth outcomes

- low birth weight
- stillbirth

Other

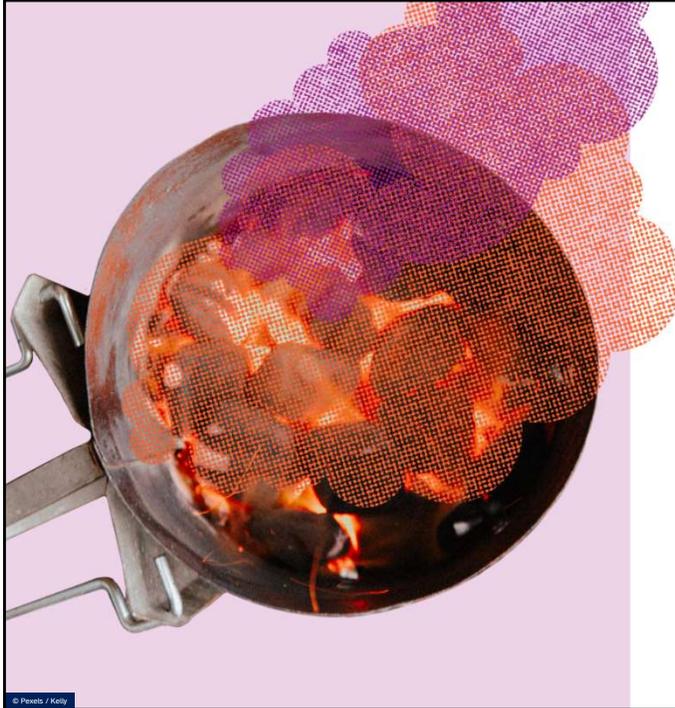
- kidney diseases
- cataract



There is emerging evidence that fine particulate matter also increases the risk of other important health problems, such as asthma, ear and upper respiratory infections, tuberculosis, nasopharyngeal and laryngeal cancers, cervical cancer, low birth weight and stillbirths, as well as impacting cognitive development.

Bibliography

- Balti, E. V., Echouffo-Tcheugui, J. B., Yako, Y. Y., & Kengne, A. P. (2014). Air pollution and risk of type 2 diabetes mellitus: a systematic review and meta-analysis. *Diabetes research and clinical practice*, 106(2), 161-172.
- Burden of disease from household air pollution for 2016. Geneva: World Health Organization; 2018 (https://cdn.who.int/media/docs/default-source/air-quality-database/aqd-2018/hap_bod_methods_may2018.pdf?sfvrsn=d277d739_3, accessed 9 December 2024).
- The global health observatory. Geneva: World Health Organization; 2022 (<https://www.who.int/data/gho>, accessed 9 December 2024).
- Xu, X., Nie, S., Ding, H., & Hou, F. F. (2018). Environmental pollution and kidney diseases. *Nature Reviews Nephrology*, 14(5), 313-324.



Carbon monoxide (CO):

- one of the most relevant household air pollutants;
- a colourless, odourless toxic product of the incomplete combustion of carbon-containing materials; and
- its binding affinity with haemoglobin interferes with the ability of the blood (red cells) to carry oxygen to the body tissues and organs.

Burning charcoal:

- produces more CO than burning fuels such as wood; and
- is a leading cause of CO poisoning.

Carbon monoxide is one of the most relevant household air pollutants. Carbon monoxide is a colourless, odourless toxic product of the incomplete combustion of carbon-containing materials. Its adverse health effects are not related to lung injury, but rather to its binding affinity with haemoglobin to form carboxyhaemoglobin that interferes with the ability of the blood (red cells) to carry oxygen to the body tissues and organs.

Carbon monoxide is closely related to household air pollution as a result of the use of unclean fuel and technologies for cooking, heating and lighting. It is released by inefficient stoves, such as charcoal stoves.

Burning charcoal tends to produce more carbon monoxide than burning fuels such as wood and is a leading cause of carbon monoxide poisoning, especially when used in an enclosed space.

Bibliography

- WHO guidelines for indoor air quality: selected pollutants. World Health Organization Regional Office for Europe; 2010 (<https://apps.who.int/iris/handle/10665/260127>, accessed 9 December 2024).

Health effects of carbon monoxide

Short term exposure (less than 24 hours) = acute toxicity:

- drowsiness
- headache
- unconsciousness
- convulsions and death

Long-term exposure (more than 24 hours) = increased risk of chronic diseases and low birth weight



We can classify the health effects as either short-term (less than 24 hours) or long-term (more than 24 hours).

Short-term exposure (less than 24 hours) to high levels of carbon monoxide causes acute toxicity that can lead to death.

Milder or initial effects are drowsiness and a headache, which can progress to unconsciousness, convulsions, and death.

Long-term exposure (more than 24 hours) to low levels of carbon monoxide is known to increase the risk of chronic diseases, including cardiovascular disease, and low birth weight for pregnant women exposed.

It is, therefore, critical to ensure that CO emissions from household energy devices are low enough to avoid the long-term health risks that occur even at relatively low levels of CO since these devices can often be used for many hours.

Bibliography

- WHO guidelines for indoor air quality: selected pollutants. World Health Organization Regional Office for Europe; 2010 (<https://apps.who.int/iris/handle/10665/260127>, accessed 9 December 2024).

Case study: a tragedy caused by carbon monoxide poisoning

This case study was developed by Nigel Bruce (University of Liverpool) based on a story from the Kenyan Ministry of Health, courtesy of CLEAN-Air(Africa).

A young mother of a small baby lived in a slum called Mukuru kwa Reuben in Nairobi. Her home, like other homes in this slum, was a single room constructed out of corrugated iron sheets.

The woman cooked in the house's one room using a charcoal jiko. One day, while she was cooking, she decided to run a short errand. The baby was resting peacefully on the bed. It is not safe to leave the door or windows open when leaving a slum home – so she locked both as she left. When she came back, she found that her baby had died. It was a terrible tragedy. She did not really understand why the baby had died – but perhaps it was God's will.

Sometime later, she gave birth to another baby. She was still living in the same home. Once again, she needed to run a quick errand. She was cooking and the baby lay comfortable on the bed. She locked the window and the door and left. On returning, she found that her second baby had also died. It was an unbearable tragedy.

As is the case, she had to inform the authorities about the death, just as she had done with the death of the first child. This time the health officials told her clearly that her children had died from carbon monoxide poisoning. This poisonous gas was produced by the jiko (partial combustion of the charcoal under poor ventilation).

The young mother was understandably very upset. She moved from Nairobi and returned to her home in Western Kenya.

While the death of the first child was based on the mother's unawareness, the second death could have been avoided. The health clinic (including the area chief) should have communicated clearly to this mother the dangers of using a charcoal stove in an enclosed room and the dire consequences of carbon monoxide poisoning. Then she would have been better informed to protect her second baby.

You can learn more about carbon monoxide by checking the case study “A tragedy caused by carbon monoxide poisoning”.

A young mother of a small baby lived in a slum called Mukuru kwa Reuben in Nairobi. Her home, like other homes in this slum, was a single room constructed out of corrugated iron sheets.

The woman cooked in the house's one room using a charcoal jiko. One day, while she was cooking, she decided to run a short errand. The baby was resting peacefully on the bed. It is not safe to leave the door or windows open when leaving a slum home – so she locked both as she left. When she came back, she found that her baby had died. It was a terrible tragedy. She did not really understand why the baby had died – but perhaps it was God's will.

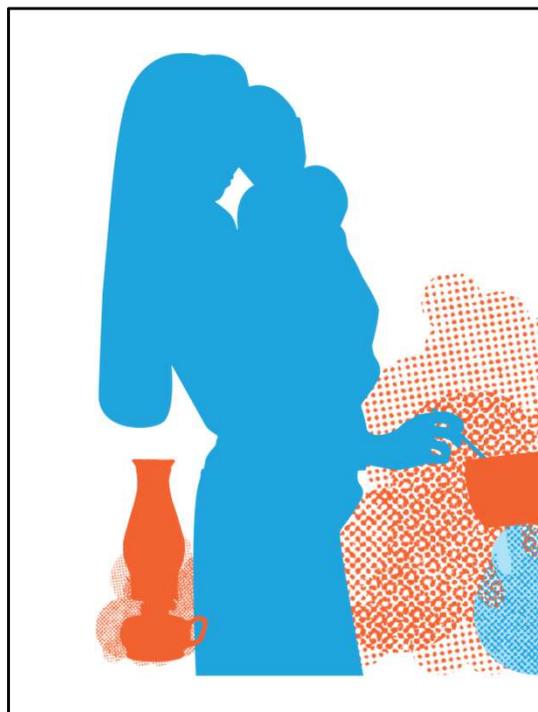
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Note: This case study was developed by Nigel Bruce (University of Liverpool) based on a story from the Kenyan Ministry of Health, courtesy of CLEAN-Air(Africa).



UNIT 3

Safety and social impacts of household air pollution



Women and children perform most of the fuel gathering in households in low- and middle-income countries



Safety and social risks

When we talk about household air pollution we need to consider not only the health effects of exposure to pollutants, but also the safety and social impacts which mostly affect women and girls. Gender inequities related to exposure to household air pollution result from the fact that women and girls, mainly in low- and middle-income countries, are the primary procurers and users of those unclean energy sources at the household level. In the next couple of slides we highlight the main safety and social risks linked to household energy.

Bibliography

- Burning opportunity: clean household energy for health, sustainable development, and wellbeing of women and children. Geneva: World Health Organization; 2016 (<https://apps.who.int/iris/handle/10665/204717>, accessed 9 December 2024).

Safety risks of household air pollution



Physical injury



Burns and scalds



Poisoning



Insects and animal bites



Violence

Frequently carrying heavy loads of fuel on their heads and backs can lead to **physical injury** such as:

- cumulative physical strain
- chronic pain.

And more acute problems such as:

- muscle strains
- spinal injuries
- fractures.

These injuries can also lead to complications during pregnancy.

Burns and scalds from domestic fuel use in households in low- and middle-income countries are tragically common, especially among children. **Kerosene** stoves and lamps are one of the most important causes of household burns.

For every child or adult who dies from burns or scalds, many more are left with lifelong disabilities and disfigurements. Non-fatal burns (the numbers of which are at least 10 times the number of fatal cases) are a leading cause of morbidity – that is, long-term disability (including due to stigma), discomfort and pain – as well as negative socioeconomic consequences. Any household energy device that burns solid fuel can, in principle, be the cause of burns to children and adults from the hot fuel if this falls out of the fire, or the person touches the fuel or falls onto the fire. Clothes such as long dresses are also at risk of catching fire in these circumstances. Some stove and fuel combinations present a higher risk than others, especially those that have an open combustion chamber on the floor that young children can easily reach.

The greatest risk of scalding, especially of children, occurs when a pot with hot water or other liquid or semi-liquid food is knocked over. This is most likely to happen if the pot/stove combination is not stable and/or children are not adequately supervised when cooking is underway. Scalding in this way can in principle occur with any stove fuel/technology, although stoves that are placed on an elevated surface such as a table (i.e. typically gas such as liquified petroleum gas or biogas, electric or ethanol stoves) may be out with the reach of young children.

In addition to emitting high levels of household air pollution when burned in stoves, heaters and lamps, kerosene poses other safety risks in and around the home.

Poisoning by kerosene ingestion is another health risk related to household energy, and unintended ingestion of kerosene is one of the most common causes of child poisoning worldwide. Another important threat to health comes from the **aspiration** of kerosene into the lungs. Inhalation of kerosene fuels can be fatal.

On trips to gather fuel, women and children may also be exposed to **bites** from **insects** and **animals**.

And finally, they may be vulnerable to the threat of violence.

Bibliography

- Burning opportunity: clean household energy for health, sustainable development, and wellbeing of women and children. Geneva: World Health Organization; 2016 (<https://apps.who.int/iris/handle/10665/204717>, accessed 9 December 2024).

WHO Global Burn Registry (GBR)

WHO Global Burn Registry (GBR)

Global Burns Registry

Charts
Filters
Reset filter

To export the data, hover at the top right corner of the data table and select the ellipsis ... and then select "Export data".

Submitted	WHO Region	World Bank Income Region (2010)	Country	City	Respondent	Age at the time of burn injury	Sex	Birthdate known	Supervision	Burn surface area	Smoke injury	Associated injuries	Head of Neck
8/29/2022 8:33:30 AM	SEARO	Lower middle income	India	Gawahati	Patient	25	Male	No		30	No	None	Face;N
8/29/2022 8:17:47 AM	SEARO	Lower middle income	India	Gawahati	Patient	36	Male	No		10	No	None	Face;N
8/29/2022 8:11:53 AM	SEARO	Lower middle income	India	Gawahati	Patient	21	Male	No		15	No	None	Face;N
8/29/2022 7:52:53 AM	SEARO	Lower middle income	India	Gawahati	Patient	41	Female	No		15	No	None	None
8/29/2022 7:42:16 AM	SEARO	Lower middle income	India	Gawahati	Patient	30	Male	No		10	No	None	Face
8/29/2022 7:36:04 AM	SEARO	Lower middle income	India	Gawahati	Patient	28	Male	No		45	No	None	None
8/29/2022 7:25:49 AM	SEARO	Lower middle income	India	Gawahati	Patient	37	Male	No		30	No	None	None
8/27/2022 10:06:00 AM	SEARO	Lower middle income	India	Gawahati	Patient	35	Male	No		55	No	None	Face;N
8/27/2022 9:07:52 AM	SEARO	Lower middle income	India	Gawahati	Patient	16	Male	No		70	Yes	None	Face;N
8/27/2022 8:55:59 AM	SEARO	Lower middle income	India	Gawahati	Patient	50	Male	No		15	No	None	Face;N



To better track the levels of burns caused by household energy use the WHO Global Burn Registry (GBR) provides a standardized platform for data collection, analysis and dissemination regarding burns and their sources.

Bibliography

WHO Global Burn Registry (GBR). [website]. Geneva: World Health Organization; 2023 (<https://www.who.int/teams/social-determinants-of-health/safety-and-mobility/burns/global-burn-registry>, accessed 9 December 2024)

Social impacts of household air pollution



Women

Prevented from using their time in non-household-related activities (e.g. income generation, leisure time, etc.)



Children

Prevented from attending school (especially girls); prevented from spending time on leisure activities



Women and girls can collect fuel for an average of **2 hours per day**.



Girls can collect wood and water for an average of up to **35 hours per week**.



Children can collect wood or water from at least **15 hours per week** to more than **30 hours per week**, depending on the country.

To obtain a complete picture of the global importance of access to clean and safe household energy, social impacts must also be considered. Reliance on polluting fuels imposes other heavy costs, especially on women and girls. This is an aspect of energy poverty that is nearly universal, and almost as nearly universally overlooked. More precisely, spending time on gathering fuels and cooking on an inefficient stove prevents women from using their time in non-household-related activities such as income generation or leisure time. It also prevents children, in most cases girls, from attending school, playing or taking part in other recreational activities.

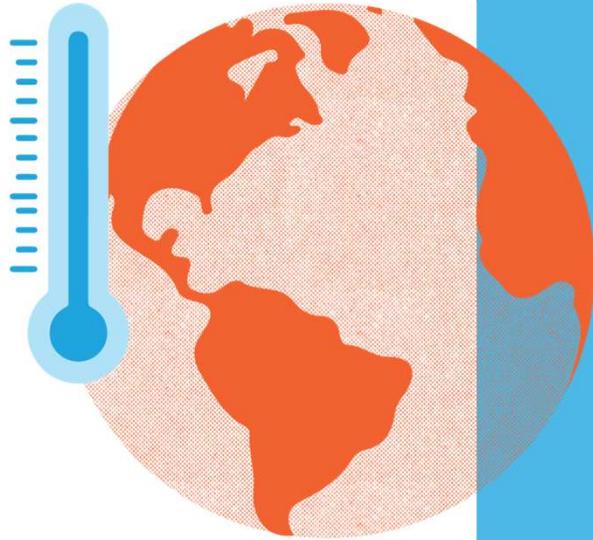
Analysis of surveys conducted by WHO in a range of African countries shows that in households that primarily cook with polluting fuels, there are high rates (> 70%) of children collecting wood or water. Both boys and girls spend a substantial amount of time on this, but girls are more likely to be tasked with gathering fuel than boys. In some countries, gathering fuel and water can occupy 35 hours per week. In most of the countries reviewed, children of both sexes who collect wood or water spend at least 15 hours per week on these tasks, and in some countries more than 30 hours per week.

Women usually spend more time cooking and gathering and preparing fuel than men. According to a recent study in over 22 African countries, the average time spent every day simply on collecting fuel is estimated to be around 2 hours for women and girls.

Bibliography

- Kammila S, Kappen JF, Rysankova D, Hyseni B, Putti VR. Clean and improved cooking in Sub-Saharan Africa: a landscape report. Washington (DC): World Bank Group; 2014 (<http://documents.worldbank.org/curated/en/2015/07/24853349/clean-improvedcooking-sub-saharan-africa-landscape-report>, accessed 9 December 2024).
- Burning opportunity: clean household energy for health, sustainable development, and wellbeing of

women and children. Geneva: World Health Organization;
2016 (<https://apps.who.int/iris/handle/10665/204717>, accessed 9 December 2024).

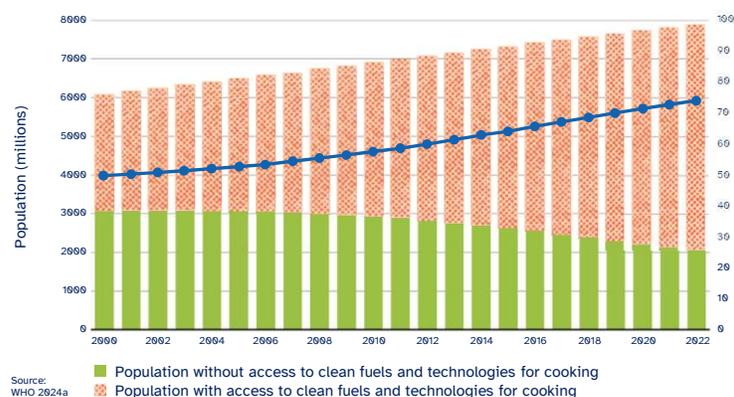


UNIT 4

Other household air pollution impacts

Population (billion) with and without access to clean fuels and technologies for cooking

Change in the absolute number of people (left axis, bars) and percentage of the global population (right axis, line) with access to clean cooking, 2000–22



2.1 billion people still cook using polluting fuel and devices

Trend almost unchanged for > 20 years

Despite the apparent increase in the percentage of the population using clean fuels and technologies for cooking worldwide, the absolute number of people without access to clean fuels and technologies has been relatively unchanged for more than 20 years. The green bars in the chart show the annual population (in billions of people) using polluting energy sources between 2000 and 2022. On a global scale, the number of people with access to clean cooking has risen consistently over the last two decades. However, the total number of people lacking access to clean cooking - began to fall substantially only after 2010, dropping from its historic level of around 3 billion people to 2.1 billion people in 2022.

The orange bars indicate the annual population (in billions of people) with access to clean fuel and technologies, 71% of the global population. Population growth plays an important role in explaining the increase in the percentage of the population having access to clean household energy, although 2.1 billion people still rely on polluting fuels and technologies for cooking.

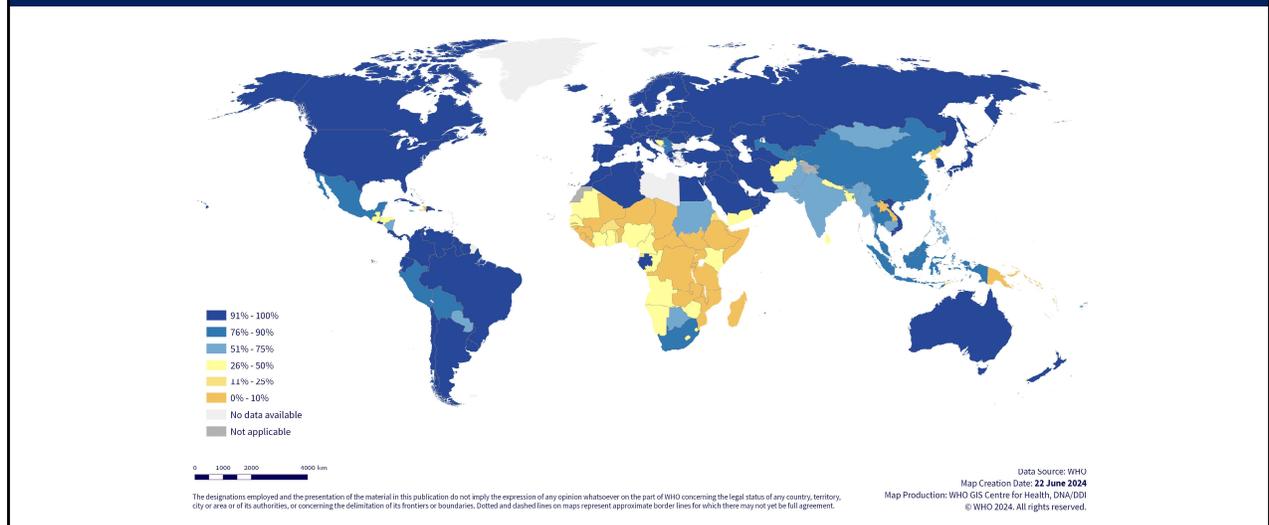
Despite the rising proportions of the population with access to clean fuels and technology, the rise is not sufficient to achieve universal access by 2030 (Sustainable Development Goal 7). If the current trend continues, the target of universal access by 2030 will not be met.

Bibliography

- Air pollution data portal. Global health observatory [online database]. Geneva: World Health Organization; (<https://www.who.int/data/gho/data/themes/air-pollution>, accessed 9 December 2024).
- Chapter 2. Access to clean fuels and technologies for cooking. In IEA, IRENA, UNSD, World Bank, WHO. 2024. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. © World Bank. License: Creative Commons Attribution - NonCommercial 3.0 IGO (CC BY-NC 3.0 IGO)
- Exposure to household air pollution for 2016. Geneva: World Health Organization; 2018

(https://cdn.who.int/media/docs/default-source/air-quality-database/aqd-2018/hap_exposure_results_final.pdf?sfvrsn=51e337b9_3, accessed 9 December 2024).

Proportion of population with primary reliance on clean fuels and technologies for cooking (%), 2022

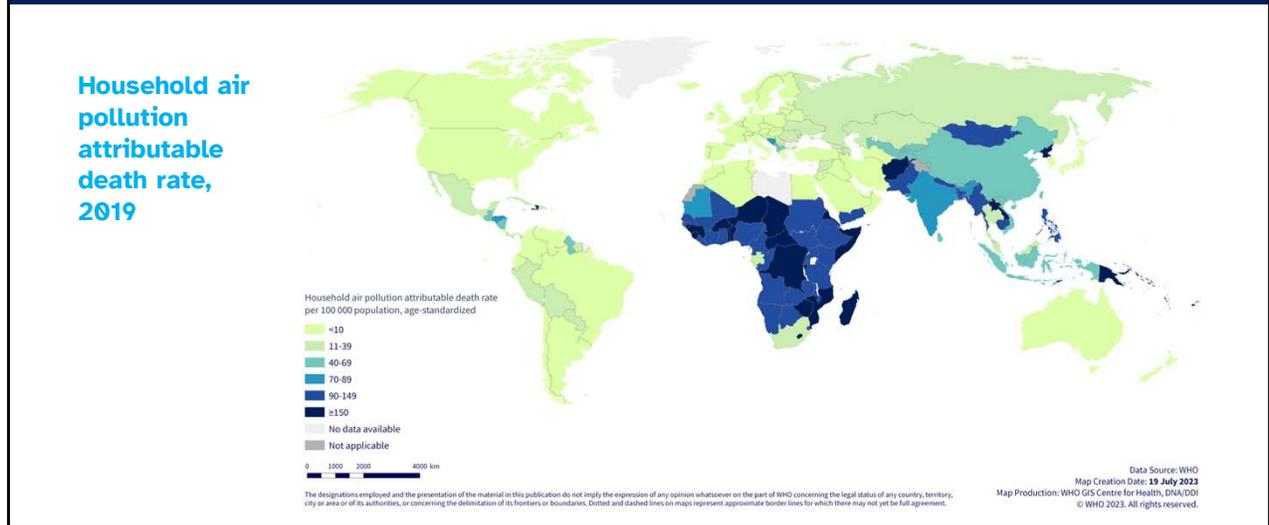


The geographical distribution of the population with access to clean household energy for cooking in 2022 highlights how the African and South-East Asia regions are experiencing the greatest access deficits.

Bibliography

- Air pollution data portal. Global health observatory [online database]. Geneva: World Health Organization; (<https://www.who.int/data/gho/data/themes/air-pollution>, accessed 9 December 2024).

Where are household air pollution deaths most common?



Looking at the global distribution of preventable deaths as a result of household air pollution in 2019, the areas with the highest numbers of deaths per 100 000 population are those same areas that lack access to clean household energy.

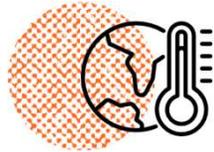
Bibliography:

- Air pollution data portal. Global health observatory [online database]. Geneva: World Health Organization; (<https://www.who.int/data/gho/data/themes/air-pollution>, accessed 9 December 2024).

Household air pollution is also a...



**Gender
issue**



**Climate
change
issue**



**Socioeconomic
issue**



**Awareness and
risk perception
issue**

In addition to health, HAP is also closely related to important issues such as gender, climate change, socioeconomic status, awareness and risk perception.

A gender issue

Women and girls

- often spend more time cooking, gathering and preparing fuels;
- spend an average of 2 hours each day collecting fuel (up to 35 hours per week).

Consider

- safety risks related to fuel collection **also greater for both women and young girls** (e.g. physical injuries and chronic musculoskeletal problems);
- risk for adverse pregnancy outcomes.



Women are considered to be at higher risk of experiencing negative health effects of exposure to household air pollution than men. WHO has reported that women and children account for more than 60% of all deaths from HAP. Non-fatal health outcomes also contribute a significant burden on women and children, especially girls.

The different health outcomes of exposure to household air pollution between men and women is not explained by physiological differences. Rather, in low- and middle-income countries women (and children) are generally more exposed to household air pollution from the use of polluting fuel and technology combinations for cooking, heating and lighting. Women (and children) are the primary procurers and users of unclean energy sources at the household level, and spend more time than men cooking, fetching water, and manually processing grain or other food.

Bibliography

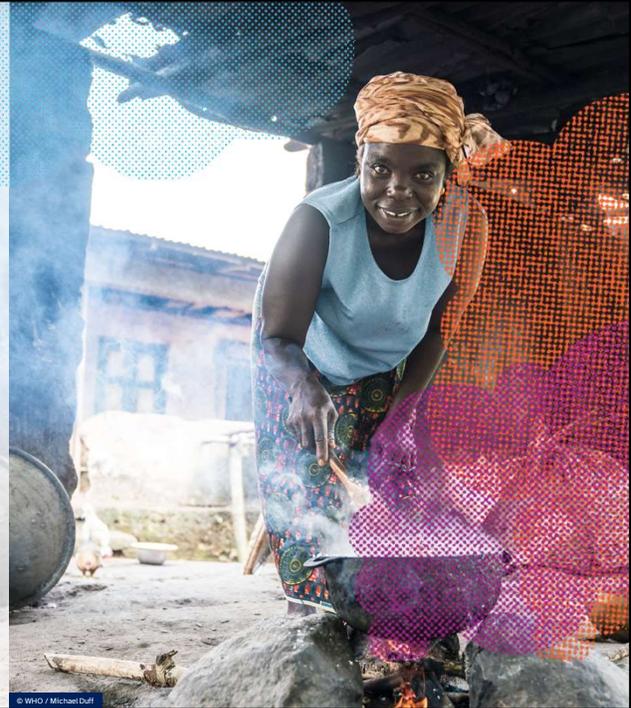
- Calogero C, Sly PD. Developmental physiology: lung function during growth and development from birth to old age. In: Frey U, Merkus PFJM, editors. Paediatric lung function. Sheffield, UK: European Respiratory Society Journals Ltd; 2010. European Respiratory Monograph 47.
- Clear the air for children. New York: United Nations Children's Fund; 2016 (https://www.unicef.org/media/49966/file/UNICEF_Clear_the_Air_for_Children_30_Oct_2016.pdf, accessed 9 December 2024).
- Metabolically derived human ventilation rates: a revised approach based upon oxygen consumption rates. Washington (DC): United States Environmental Protection Agency; 2009 (<https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=202543>, accessed 9 December 2024).
- Burning opportunity: clean household energy for health, sustainable development, and wellbeing of women and children. Geneva: World Health Organization; 2016 (<https://apps.who.int/iris/handle/10665/204717>, accessed 9 December 2024).

- Air pollution is a global children's health issue. Geneva: World Health Organization; 2020 (<https://www.who.int/multi-media/details/air-pollution-is-a-global-children-s-health-issue>, accessed 9 December 2024).

A climate change issue

Household air pollution is closely linked to climate change because:

- It adds **carbon dioxide** (CO₂) to the atmosphere.
- It emits short-lived climate pollutants (SLCPs).
- Collecting firewood fuel for cooking practices contributes to deforestation and environmental degradation.



Household air pollution is a **climate change related** issue.

Anthropogenic emissions of carbon dioxide, other greenhouse gases as well as other short-lived pollutants are the main drivers of climate change.

Household air pollution is closely linked to climate change because:

- It adds **carbon dioxide** to the atmosphere.
- It also emits short-lived climate pollutants (or **SLCPs**).
- Collecting firewood fuel for cooking practices is not only a burden for many women and children across the globe, it also contributes to deforestation and therefore to environmental degradation and climate change more broadly.

Bibliography

- Short-lived climate pollutants. [Internet]. Climate and clean air coalition (CCAC) (<https://www.ccacoalition.org/content/short-lived-climate-pollutants>, accessed 9 December 2024).
- WHO guidelines for indoor air quality: household fuel combustion: executive summary. Geneva: World Health Organization; 2014 (<https://apps.who.int/iris/handle/10665/144309>, accessed 9 December 2024).

Short-lived climate pollutants (SLCPs)

= air pollutants with a shorter atmospheric lifetime than CO₂ – spanning a few days to a couple of decades – but their warming potential is much greater.

- **Tropospheric ozone (O₃)**
- **Methane (CH₄)**
- **Hydrofluorocarbons (HFCs)**
- **Black carbon (BC) – component of PM_{2.5}**

Household biomass burning contributes to 50% of man-made black carbon emissions



Some SLCPs (black carbon, tropospheric ozone) are known to harm human health



Among all warming pollutants, black carbon is estimated to be the second-most important contributor to global warming after CO₂

SLCPs are air pollutants with a shorter atmospheric lifetime than CO₂ – spanning a few days to a couple of decades – but their warming potential is much greater.

SLCPs include:

- tropospheric ozone
- methane
- hydrofluorocarbons
- black carbon.

As air pollutants, some SLCPs – particularly black carbon and tropospheric ozone – are known to harm human health.

Among all warming pollutants, black carbon is estimated to be the second-most important contributor to global warming after CO₂. Household biomass use is a leading source of black carbon around the world, estimated to account for between 25 and 50% of global black carbon emissions.

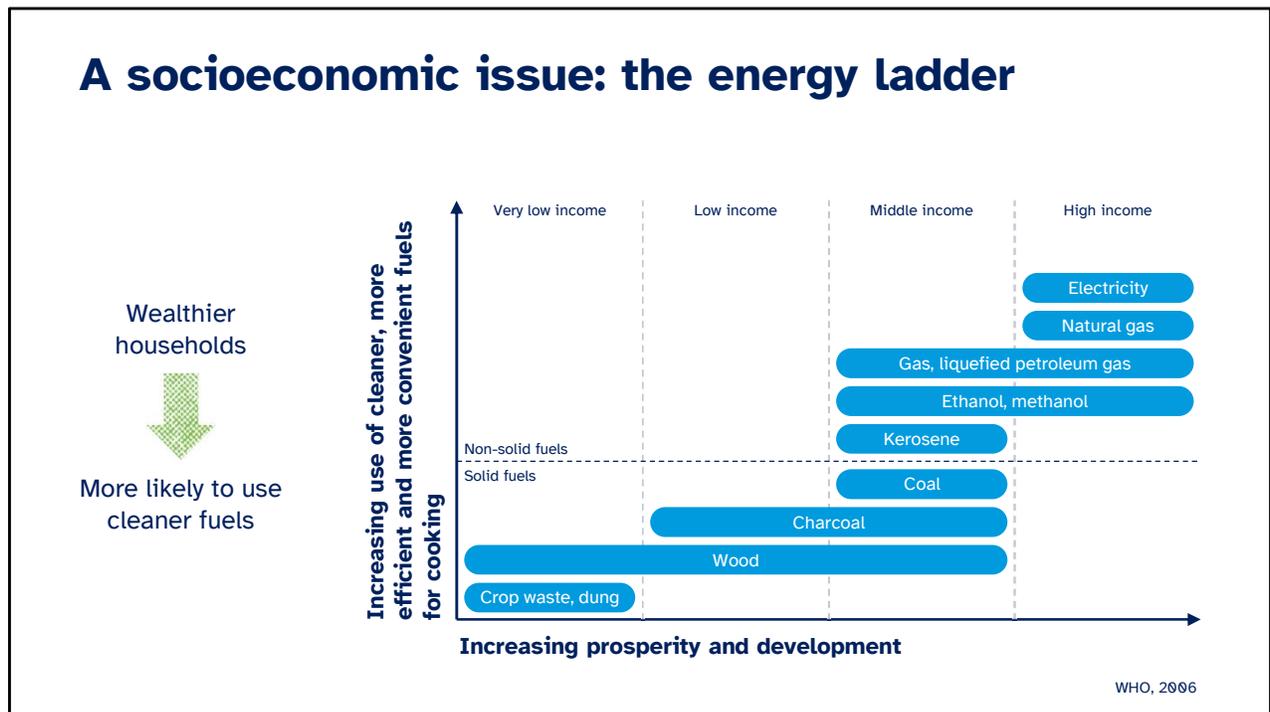
Bibliography

- Bond TC, Doherty SJ, Fahey DW, Forster PM, Berntsen T, DeAngelo BJ et al. Bounding the role of black carbon in the climate system: a scientific assessment. *J Geophys Res: Atmos.* 2013;118(11):5380–552. doi:10.1002/jgrd.50171.
- Burning opportunity: clean household energy for health, sustainable development, and wellbeing of women and children. Geneva: World Health Organization; 2016 (<https://apps.who.int/iris/handle/10665/204717>, accessed 9 December 2024).
- Malley C, Lefèvre E, Kuylenstierna J, Borgford-Parnell N, Vallack H, Benefor D. Opportunities for increasing ambition of nationally determined contributions through integrated air pollution and

climate change planning: a practical guidance document. Climate and Clean Air Coalition; 2019 (<https://www.ccacoalition.org/en/resources/opportunities-increasing-ambition-nationally-determined-contributions-through-integrated>, accessed 10 May 2024).

- Ramanathan V, Carmichael G. Global and regional climate changes due to black carbon. *Nature Geosci.* 2008;1:221–27. doi:10.1038/ngeo156.
- Reducing global health risks through mitigation of short-lived climate pollutants. Scoping report for policy-makers. Geneva: World Health Organization; 2015 (<https://apps.who.int/iris/handle/10665/189524>, accessed 9 December 2024).

A socioeconomic issue: the energy ladder



Household air pollution is also a **socioeconomic** issue.

With increasing prosperity, cleaner, more efficient and more convenient fuels replace traditional biomass fuels and coal. Climbing up the “energy ladder” tends to occur gradually, and most low- and middle-income countries households occupy several steps at once, since they often use a combination of fuels to meet their needs. High-income countries are not immune from the use of unclean fuels and technologies. Residential fuel combustion in HICs can occur in colder climates during winter, when households burn wood for residential heating. This is an important source of exposure to PM.

Wealthier households in low- and middle-income countries are more likely to rely on cleaner, more efficient fuels and technologies for cooking.

Bibliography

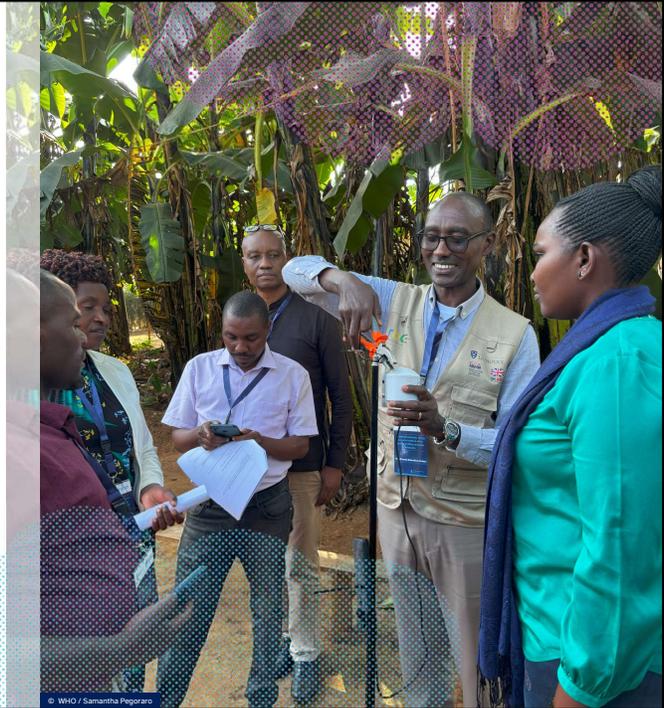
- Rehfuess E, World Health Organization. Fuel for life: household energy and health. Geneva: World Health Organization; 2006 (<https://apps.who.int/iris/handle/10665/43421>, accessed 9 December 2024).

Attitude of households towards cleaner stoves



People often do not perceive household air pollution as a significant health risk

- Upfront investments required for cleaner stoves are often too high.
- Households are more likely to spend money on other goods.
- People tend to choose cleaner stoves not primarily for health benefits, but because they save time, money, use less wood, and often have a more appealing design.



Studies show that people often do not perceive household air pollution as a significant health risk.

Affordability is a key factor. Upfront costs/investments required for cleaner or transitional stoves are too high and serve as a barrier or reason not to use clean fuels and technologies.

Households are more likely to spend their limited income on other household goods and leisure than on cleaner stoves and fuels.

People tend to choose cleaner stoves not primarily for health benefits but because they save time and money, use less wood, and often have a more appealing design.

Increased awareness is needed of the benefits of clean household energy to protect both people's health and safety, as well as the climate.

Bibliography

- Beltramo T, Blalock G, Levine DI, Simons AM. The effect of marketing messages and payment over time on willingness to pay for fuel-efficient cookstoves. *J Econ Behav Organ.* 2015;118:333–45. doi:10.1016/j.jebo.2015.04.025.
- Bensch G, Grimm M, Peters J. Why do households forego high returns from technology adoption? Evidence from improved cooking stoves in Burkina Faso. *J Econ Behav Organ.* 2015;116:187–205. doi:10.1016/j.jebo.2015.04.023.
- Mobarak AM, Dwivedi P, Bailis R, Hildemann L, Miller G. Low demand for nontraditional cookstove technologies. *Proc Nat Acad Sci USA.* 2012;109(27):10815–20. doi:10.1073/pnas.1115571109.
- Pattanayak SK, Jeuland M, Lewis JJ, Usmani F, Brooks N, Bhojvaid V. Experimental evidence on promotion of electric and improved biomass cookstoves. *Proc Nat Acad Sci USA.* 2019;116(27):13282–

7. doi:10.1073/pnas.1808827116.



Key messages

- Around a **quarter of the world's population still relies on polluting fuels and technologies** for household-related activities in 2022.
- **Household air pollution refers to the incomplete combustion of carbon-based fuels** used for cooking, heating, and lighting.
- Fine particulate matter and carbon monoxide are the **most measured indicators for household air pollution exposure**.
- **Household air pollution is estimated to be responsible for 3.2 million deaths in 2019** and poses serious safety risks such as burns and poisoning.
- **Household air pollution creates gender inequities as it disproportionately affects women and girls**, usually the primary cooks and fuel gatherers.
- **SLCPs from dirty household fuel combustion contribute to climate change**, and polluting fuels are often harvested unsustainably.
- There is a need **to increase the awareness about the benefits of clean household energy**, both for protecting people's health and safety and for mitigating climate impact.

Key messages for this module include:

About a quarter of the world's population still relies on polluting fuels and technologies for household-related activities in 2022.

Household air pollution refers to the incomplete combustion of carbon-based fuels used for cooking, heating and lighting.

Fine particulate matter and carbon monoxide are the most measured indicators for household air pollution exposure.

Household air pollution is estimated to be responsible for 3.2 million deaths in 2019 and poses serious safety risks such as burns and poisoning.

Household air pollution creates gender inequities as it disproportionately affects women and girls, usually the primary cooks and fuel gatherers.

SLCPs from dirty household fuel combustion contribute to climate change, and polluting fuels are often harvested unsustainably.

There is need to increase the awareness about the benefits of clean household energy, both for protecting people's health and safety and for mitigating climate impact.

Glossary

Ambient air pollution: Air pollution in the ambient environment, i.e. in outdoor air, but able to enter homes.

Household air pollution: Air pollution generated by household fuel combustion, leading to indoor air pollution and contributing to ambient air pollution.

Charcoal: A form of carbon produced by the destructive distillation of wood (i.e. the heating of wood out of contact with air in a low-oxygen environment). The dense black substance that results is made up mostly of carbon and produces more heat and energy per kilogramme than wood.

Coal: A black, solid, carbon-rich material found underground, among the most prevalent fossil fuels.

Combustion: Chemical reaction in which a material combines with oxygen with the evolution of heat (“burning”). The combustion of fuels containing carbon and hydrogen is complete when these two elements have been completely oxidized to carbon dioxide and water. Incomplete combustion may lead to appreciable amounts of carbon remaining in the ash, emission of some of the carbon as carbon monoxide, and the reaction of the fuel molecules to emit a range of products of greater complexity than that of the fuel molecules themselves (if these products escape combustion, they are emitted as smoke).

Kerosene: Atmospheric (petroleum) distillate having a volatility intermediate between that of gasoline and gas oil, and a distillation range between 150 and 300 °C. It is treated to meet the requirements for different uses, including lighting, heating and as fuel for gas turbines for aircraft.

Solid biomass fuel: Wood, animal dung, crop wastes and charcoal used as fuel.

Solid fuel: Solid materials burned as fuels; includes coal as well as biomass fuels.

Traditional: Local methods of cooking using cultural practices and methods.

Bibliography

- Glossary. Clean cooking catalog (<http://catalog.cleancookstoves.org/glossary>, accessed 9 December 2024).
- Glossary on air pollution. Copenhagen: WHO Regional Office for Europe; 1980 (<https://apps.who.int/iris/handle/10665/272866>, accessed 9 December 2024).

Contributors and acknowledgements

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This module contains a large set of slides from which the presenter should select the most relevant ones to use in a specific presentation. These slides cover many facets of the problem. Present only those slides that apply most directly to the local or regional situation. Where relevant, you can adapt the information, statistics and photos within each slide to the particular context in which this module is being presented.

This module belongs to the Air Pollution and Health Training toolkit (APHT) targeting health workers. It has been developed in collaboration with more than 30 experts from government agencies, WHO collaborating centers, non-state actors, including medical and environmental health associations, as well as academic institutions. The methodology used for development included a mapping of existing air pollution and health training opportunities targeting health workers which informed gaps and needs for a global set of materials. Experts identified through existing collaborations with WHO contributed on the definition of outline and populating the training modules with contents. Peer review and pilot test coordinated by WHO ensured the collection of feedback and input for finalization of the products.

WHO made all possible effort to ensure geographical and gender balance for the development of the training toolkit acknowledging limitations in terms of expertise, experience and overall feasibility. You can use and have access to other APHT modules where relevant. To see the full package visit: <https://www.who.int/tools/air-pollution-and-health-training-toolkit-for-health-workers>

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