**Indicator 3.9.1**

**Indicator Name, Target and Goal**

*Indicator 3.9.1*: Mortality rate attributed to household and ambient air pollution

*Target 3.9*: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

*Goal 3*: Ensure healthy lives and promote well-being for all at all ages

**Definition and Rationale**

**Definition:**

This indicator is defined as the mortality attributable to the joint effects of household and ambient air pollution, and can be expressed as per 100,000 population for any given population group (e.g. children under 5 years of age).

**Concepts:**

*Ambient air pollution* refers to outdoor pollution resulting from emissions from industrial activity, households, cars and trucks, etc.

*Household air pollution* refers to indoor pollution resulting from the use of polluting cooking fuels such as kerosene, wood, coal animal dung, charcoal and crop wastes.

Ambient and household are often treated separately, although they are strongly interlinked since household air pollution is a large –often underestimated – source of ambient air pollution. They have been dealt with separately by both scientist and policy makers for historical and practical reasons. Household air pollution also include the use of polluting fuels for lighting and heating purposes.

**Rationale and Interpretation:**

The target aims to reduce the number of deaths from hazardous air pollution. This indicator tracks mortality rates attributed to ambient and household air pollution, as air pollution is the biggest environmental risk to health.

Evidence from epidemiological studies have shown that exposure to air pollution is linked, among others, to the important diseases taken into account in this estimate:

- Acute respiratory infections (estimated for all ages);
- Cerebrovascular diseases (stroke) in adults (estimated above 25 years);
- Ischaemic heart diseases (IHd) in adults (estimated above 25 years);
- Chronic obstructive pulmonary disease (COPD) in adults (estimated above 25 years); and
- Lung cancer in adults (estimated above 25 years).

In order to achieve a meaningful reduction in deaths associated with air pollution from particulate matter, it is important not only and firstly to reduce air pollution levels, but also to reduce exposure whenever possible (e.g. for household air pollution using clean cooking technologies, avoiding cooking with children around etc.) and to reduce the prevalence of air pollution associated diseases such as those mentioned above.

**Data Sources and Collection Method**
- **Exposure to ambient air pollution**: Countries regularly reporting annual concentration of PM2.5 or PM10 from ground monitoring networks can use these values, provided that they are representative for the level of exposure in the population (e.g., the monitoring station must be located where people spend a meaningful amount of time, for work, leisure or residential). Otherwise, country population exposure to annual mean concentration of particulate matter (PM2.5, of a diameter equal or less than 2.5 micrometre) are derived from methods using both ground measurements and satellite information, as regularly reported for SDG 11.6.2 for urban areas, but are also derived for urban and rural (see http://www.who.int/airpollution/ambient/AAP_exposure_Apr2018_final.pdf?ua=1) and can be used.

- **Exposure to household air pollution**: Countries having conducted specific and proper indoor monitoring of PM2.5 (e.g., India) may use these values. For the others, the proxy indicator of proportion of population in a country relying mainly on polluting fuels and technologies for cooking, as regularly reported in national household surveys or censuses can be used. This indicator is modelled by WHO and regularly reported as SDG 7.1.2. (see: http://www.who.int/airpollution/data/HAP_exposure_results_final.pdf?ua=1). The source of data for the modelled, reported estimates is country data from national household surveys or censuses.

- **Demographic data**: Population data used were from the United Nations Population Division, The World Population Prospects – the 2017 revision, New York 2017 (5). Country may have their own population estimates.

- **Health data**: The total number of deaths and DALYs (disability-adjusted life years) for each country, by sex and age group for acute lower respiratory infections (ALRI), chronic obstructive pulmonary diseases (COPD), lung cancer, ischaemic heart diseases (IHD), and stroke have been compiled by the World Health Organization (10). Country may have their own health estimates.

- **Exposure-risk relationships**: To estimate the relative risk for a disease caused by air pollution exposure from PM2.5, an integrated exposure response function (IER) is used. The IER was originally developed for the Global Burden of Disease Study (Lim et al, 2010; Burnett et al, 2014) and has also been used by WHO (12,13). The IER combines the epidemiological evidence for outdoor air pollution, second-hand smoke, household air pollution and active smoking to estimate the level of disease risk (e.g., stroke) at different levels of PM2.5 concentrations (aka dose). In other words, the same mathematical relationship or measure is used to estimate the risk of heart disease from particulate matter originating from outdoor air pollution as that of second-hand smoke or household air pollution. An updated version of the IER functions is used for ALRI, COPD, lung cancer, IHD and stroke, as in Cohen et al (4) and GBD 2016 (14). However, relative risks derived from national (e.g., France, China) or regional studies (HRAPIE project for Europe) can be used if available.
Computation Method:

Mortality rates attributable to air pollution from particulate matter can be obtained through the comparative risk assessment methodology (Ezzati et al, 2002). It consists of assessing a population attributable fraction (PAF) for each disease associated with air pollution. This fraction is derived from the distribution of the exposure in the population, and applied (e.g. multiplied) to the background disease rate of the disease:

\[
\text{Attributable burden} = \text{PAF} \times \text{background disease (expressed in number, rate of deaths, DALYs, etc)}
\]

The PAFs for ambient and household air pollution are first calculated separately. They are then combined in a way that take into account the overlap, i.e. the fact that household air pollution contributes to ambient air pollution (Ezzatti et al, 2003, Lim et al, 2010).

The mortality attributable to the joint effects of household and ambient air pollution (MAP), expressed per 100,000 people, can be calculated using the formula:

\[
\text{MAP} = \frac{\text{Number or deaths attributable to the joint effects of household and ambient air pollution}}{\text{The total population}} \times 100,000
\]

The numerator can be estimated using an approach that involves the following steps:

1. Measuring how widespread the exposure is in the population
2. Measuring the increased (or relative) risk of a disease resulting from the exposure
3. Applying the fraction obtained by (1) and (2) to the total burden of disease

More information can be found at: [http://www.who.int/airpollution/data/en/](http://www.who.int/airpollution/data/en/)

Comments and limitations:

- Ambient air pollution levels of particulate matter derived from ground monitoring networks can be used as exposure metrics, provided that they are representative for the level of exposure in the population (e.g. the monitoring station must be located where people spend a meaningful amount of time, for work, leisure or residential).

- The proportion of households in a country relying mainly on polluting fuels and technologies for cooking is currently used as a proxy indicator to derived exposure to household air pollution. Households mainly cooking with coal, wood, charcoal, dung, crop residues or kerosene are considered exposed. There are however more and more data available on indoor (e.g. kitchen) PM2.5 measurements due to cooking with polluting fuels. Currently there is a very little to no nationally representative data capturing the type of solid fuel cookstoves. However recognizing the importance of how the fuel and technology impact the level of household air pollution, estimate exposure and disease burden attributed to both the fuel and solid fuel stove in combination (pending data availability) will be considered in the future. The same apply for the use of polluting fuel and technologies for heating and lighting

An approximation of the combined effects of risk factors is possible if independence and little correlation between risk factors with impacts on the same diseases can be assumed (Ezzati et al 2003). In the case of air pollution, however, there are some limitations to estimate the joint effects: limited knowledge on the distribution of the population exposed to both household and ambient air pollution, correlation of exposures at individual level as household air pollution is a contributor to ambient air pollution, and non-linear interactions (Lim et al. 2012, Smith et al. 2014). In several regions, however, household air pollution remains mainly a rural issue, while ambient air pollution is predominantly an urban problem. Also, in some continents, many countries are relatively unaffected by household air pollution, while ambient air pollution is a major concern. If assuming independence and little correlation, a rough estimate of the total impact can be calculated, which is less than the sum of the impact of the two risk factors.

Proxy, alternative and additional indicators: N/A

[1] Example : PAF = 0.18, background number of deaths from lung cancer : 100, attributable mortality = 0.18 x 100 = 18.

Data Disaggregation

This indicator can be disaggregated by sex, disease and age.

References
Official SDG Metadata URL

Internationally agreed methodology and guideline URL
N/A

Other references


Manuscript in preparation (WHO/ University of Exeter). Please consult : www.exeter.ac.uk/globalairquality


More information at : www.who.int/airpollution/data/modelled-estimates/en/


Country examples
N/A

International Organization(s) for Global Monitoring

This document was prepared based on inputs from World Health Organization (WHO).

For focal point information for this indicator, please visit https://unstats.un.org/sdgs/dataContacts/