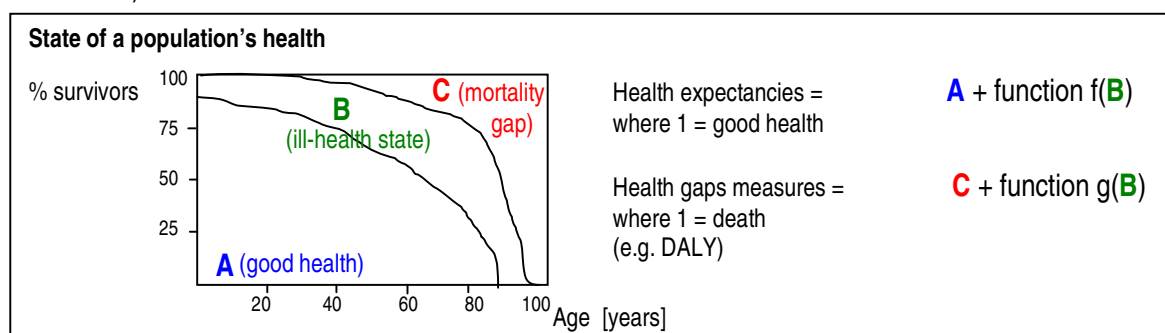


## Quantification of the disease burden attributable to environmental risk factors

### A. GLOBAL BURDEN OF DISEASE

WHO has developed a methodology to evaluate the global burden of disease and to quantify the health state of a population in order to determine strategic planning and set priority actions in public health. Therefore, summary measures of population health (SMPH) were developed, that combine information on mortality and non-fatal health outcomes. The SMPH can be divided in two distinct categories: the health expectancies and the health gap measures (WHO 2002a).

The most commonly used is the Disease-adjusted life year, DALY, a health gap measure, that extends the concept of potential years of life lost due to premature death to include equivalent years of healthy life lost by virtue of individuals being in states of poor health or disability. One DALY can be thought of as one lost year of healthy life and the burden of disease as a measure of the gap between current health status and an ideal situation where everyone lives into old age free from disease and disability (World Bank 2006).



### B. METHODS TO EVALUATE THE ENVIRONMENTAL BURDEN OF DISEASE



Between 2002 and 2004, WHO has published the impacts on health attributable to 26 major preventable risk factors for health – such as childhood and maternal underweight, unsafe sex, tobacco and alcohol abuse, environmental and occupational risk factors, etc. – by WHO regions (WHO 2002b, 2004). To assist countries in developing their own estimates, WHO has coordinated the preparation of practical guidance, in the form of a series of guides, for the estimation of disease burden at national or local levels for selected environmental and occupational risk factors (WHO 2008) – see box for the selected risk factors.

The method used to calculate the environmental burden of disease is based on an exposure approach, supported by a comprehensive analysis of the evidence for the given health risks. Exposure-response relationships for a given risk factor are obtained from epidemiological studies and the derived attributable fractions are then applied to disease burden, expressed in deaths or DALYs, associated with the risk factor.

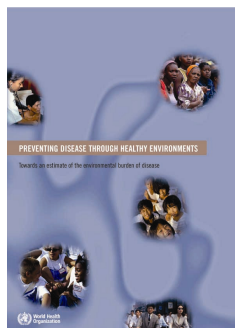
#### Environmental risk factors that are considered in the series of guides (WHO 2008):

- Indoor smoke from solid fuel use
- Outdoor air pollution
- Water, sanitation & hygiene
- Solar ultraviolet radiation
- Climate change
- Lead
- Mercury
- Occupational carcinogen
- Occupational airborne particulates
- Second-hand smoke (in preparation)



### C. EXPERT OPINION METHOD TO QUANTIFY THE ENVIRONMENTAL BURDEN OF DISEASE

In 2006, WHO released a report entitled "Preventing disease through healthy environments: towards an estimate of the global burden of disease" (WHO 2006), estimating how much of global disease could be



prevented by modifying the environment – see box <sup>1</sup>. This work builds on previous efforts that WHO has undertaken to estimate the global estimates of burden of disease caused by 26 risk factors, published in the World Health Report 2002 (WHO 2002b), and involves a systematic review of literature as well as surveys of over 100 experts worldwide. The report gives, for 85 out of the 102 major diseases and injuries classified by WHO, the fraction of disease that can be attributed to the environment and that could be prevented. These environmental contributions are sometimes available by regions, by economic status (high/low income countries), by age group or by gender, depending on the available data and the domain of expertise of the experts.

#### Definition of the modifiable environment (WHO, 2006):

- Air, soil & water pollution with chemicals or biological agents
- Ultraviolet and ionizing radiation
- Built environment
- Noise, electromagnetic fields
- Occupational risks
- Agricultural methods, irrigation schemes
- Anthropogenic climate changes, ecosystem degradation
- Individual behaviors related to the environment, such as hand-washing, food contamination with unsafe water or dirty hands

### D. COUNTRY PROFILES OF ENVIRONMENTAL BURDEN OF DISEASE

In 2007, WHO released the first ever country-by-country analysis of the impact environmental factors have on health for its 192 Member states<sup>2</sup>, analysis that has recently been updated to reflect the newly published WHO country health statistics (WHO, 2009a). These country estimates are a milestone in a first step to assisting national decision-makers in the sectors of health and environment to set priorities for preventive action. Examples of a country profile and a reading guide are presented in annex. It is divided in three parts:

#### 1. Environmental burden of disease attributable to three selected risk factors

The first part presents the yearly burden, expressed in deaths and DALYs, attributable to the three following risk factors:

- Unsafe water, sanitation & hygiene
- Indoor air pollution from solid fuel use
- Outdoor air pollution

<sup>1</sup> Are excluded from the definition: individual choices, such as alcohol & tobacco consumption, drug abuse, diet; natural environments that cannot reasonably be modified (rivers, etc); unemployment (provided that it is not linked to the degradation of the environment); natural biological agents (e.g. pollen); person-to-person transmission that cannot reasonably be prevented by environmental interventions.

<sup>2</sup> WHO counts 193 Member states since 2006, but the latest country health data available is from 2004, date at which only 192 countries were members of the organization.



These results are calculated according to the exposure-based approach (as described in section B) using exposure data that were available globally (indicators such as access to improved water sources, annual mean of particulate matter [PM10], etc.). A detailed explanation of the method for each specific risk factor can be found in the corresponding guide and in the original publication (WHO 2004, 2008 & 2009a).

## **2. Preliminary estimates of the total environmental burden of disease for the country**

The health data presented in the second part – total number of deaths and DALYs per capita and percentage of the national burden of disease attributable to the environment – represent the disease burden that could be avoided by modifying the environment as a whole (see box in section C). The method used is described in section C [the attributable environmental fractions used here are regional and not national as is the case for the indicators used in the first part of the country profile; WHO country health statistics were used (WHO 2009b)].

## **3. Environmental burden by disease category**

The last part of the profile (see the table in the last page) is a breakdown by disease group of the information given in part 2. It indicates the yearly number of DALYs per capita attributable to environmental factors by disease group. The country rate gives the number of DALYs per capita, indicating which diseases is mostly affected by environmental factors in the country (allowing an intra country comparison). Values on the left ("lowest country rate") and on the right ("highest country rate") give an idea of the extreme values that were found within the 192 countries for which the exercise was done. This enables an inter-country comparison, which is highlighted with the graph and allows a rapid overview of which disease is predominantly affected by the environment in the country of interest compared with other countries.

## **E. REMARKS ON THE METHODS**

### **Additivity of the disease burden attributable to different risk factors (section B)**

The disease burden for selected risk factors represents the burden that could be prevented if the particular exposures were removed. This means that in principle the same burden could be reduced by acting on different risk factors, and therefore the burden from the various risk factors listed should not be summed up (unless only one of the risk factors is taken into account when certain diseases are impacted more than once). In the case of the national profiles (part 1), where only acute respiratory infections are addressed twice (by outdoor air and solid fuel use), the overestimate is likely to be minor, as solid fuel use is mainly an issue in rural areas and outdoor air in urban areas.

### **Uncertainty**

A number of potential sources of error may arise when estimating the environmental burden of disease. These can come from (a) the measure of exposure, (b) the exposure-risk relationship, (c) the assumptions made in the applicability of the exposure or exposure-risk relationship to the country of concern, (d) the health statistics, and (e) the expert opinions, if used. While it is generally not possible to estimate a formal confidence interval (given that the uncertainty of the various data sets are not always known), it is possible to estimate a range of possible values the environmental disease burden may take (a sort of sensitivity analysis), based on different input parameters and assumptions. Such an analysis is not provided in the preliminary country profiles of the environmental burden of disease, but should be performed in the national process of reviewing these profiles. Elements for performing such a sensitivity analysis are provided in the guides documenting the methods for estimating the disease burden (WHO 2004 & 2008).



## References

- WHO (2002a). "Summary Measures of Population Health: Concepts, Ethics, Measurement and Applications. Eds Murray, C.J.L. et al., World Health Organization, Geneva. Access: <http://whqlibdoc.who.int/publications/2002/9241545518.pdf>
- WHO (2002b). World Health Report, "Reducing risks, promoting healthy life". World Health Organization. Access: [www.who.int/whr/2002](http://www.who.int/whr/2002).
- WHO (2004). "Comparative Quantification of Health Risks - Global and regional burden of disease attributable to selected major risk factors", Eds. M. Ezzati et al., World Health Organization. Access: [www.who.int/publications/cra](http://www.who.int/publications/cra).
- WHO (2006). "Preventing disease through healthy environments - Towards an estimate of the environmental burden of disease", World Health Organization. Access: [www.who.int/quantifying\\_ehimpacts/publications/preventingdisease.pdf](http://www.who.int/quantifying_ehimpacts/publications/preventingdisease.pdf).
- WHO (2008) Environmental Burden of Disease Series, World Health Organization. Access: [www.who.int/quantifying\\_ehimpacts/national](http://www.who.int/quantifying_ehimpacts/national).
- WHO (2009a). Country profiles of environmental burden of disease, World Health Organization. Access: [www.who.int/quantifying\\_ehimpacts/countryprofiles](http://www.who.int/quantifying_ehimpacts/countryprofiles).
- WHO (2009b). Global Burden of Disease, World Health Organization. Access: [www.who.int/healthinfo/global\\_burden\\_disease/estimates\\_country](http://www.who.int/healthinfo/global_burden_disease/estimates_country)
- World Bank (2006). Global burden of disease and risk factors, Eds A. Lopez et al., The World Bank & Oxford Press, 2006. Access: [www.dcp2.org/pubs/GBD](http://www.dcp2.org/pubs/GBD).

*For further information, please contact:*

*Programme on quantifying environmental health impacts, Department of Public Health and Environment,  
World Health Organization, 1211 Geneva 27, Switzerland*

*Website: [www.who.int/quantifying\\_ehimpacts](http://www.who.int/quantifying_ehimpacts); email: [EBDassessment@who.int](mailto:EBDassessment@who.int)*