

Health impact assessment of air pollution in the WHO European Region – A standardised approach

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Introduction

Health risks posed by air pollution are well recognised. Based on experience from high pollution episodes, occupational health and controlled human or animal exposure studies, individual countries have established normative instruments controlling concentrations of various pollutants in the atmosphere. Recent research on health effects of air pollution has indicated that adverse health effects in normal urban populations of several of the most common air pollutants can be observed at concentrations close to, or below, the WHO air quality guidelines [1].

Ambient concentrations of several air pollutants, such as SO₂, suspended particulate matter, NO₂ and O₃, systematically exceed the recommended WHO air quality guideline (AQG) levels in many locations of Europe [2]. This causes concern related to the impacts of the pollution on population health. Estimated impact on health is compared with the costs to the society related to the measures to be taken to reduce air pollution. This comparison should support management of the risk. In situations where risk elimination is not realistic, risk reduction to an acceptable level can be proposed.

The WHO European Centre for Environment and Health (WHO-ECEH), Bilthoven Division, has initiated in 1999 a programme aimed at evaluating the capacities of Member States to monitor and assess the health impact of air pollution (HIAAP) at local or national level. This programme will provide a comprehensive overview of the magnitude and geographical distribution of air pollution exposures and their health impact in the major urban centres and agglomerations across the WHO European Region.

The HIAAP programme is implemented in collaboration with the WHO Collaborating Centre for Air Quality Management and Air Pollution Control (Berlin) and the European Topic Centre on Air Quality of the European Environmental Agency (Copenhagen).

For that purpose the AirQ software package is being developed by WHO-ECEH and it would enable users to easily assess the impact of air pollution on human health. It gives, e.g., a number of additional deaths and cases of respiratory diseases that can be ascribed to the exposure to certain pollutants. Risks to various health endpoints are attributed to pollutants and are calculated on the basis of recent epidemiological studies.

Methodology of the Study

The approach of the study is based upon is the *Health Impact Assessment* (HIA) which combines information on existing exposure-response relationships with data on population exposure to estimate the extent of health effects expected to result from the exposure in the population. The exposure can be estimated on the basis of ambient concentrations, provided by the existing monitoring network for one (or more) monitoring station(s) in the urban area (agglomeration) of interest for the respective time period. Besides information on population exposure to air pollution, health impact assessment requires information on exposure-response relationships and baseline incidences of health endpoints. This information has been retrieved from scientific literature and various reports of WHO [3].

The impact of a pollutant on human health has been considered in terms of the following health outcomes:

- Mortality – number of deaths or rates (e.g. per unit population) for the respective time period.

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• Morbidity – incidence: number of cases, or rates (e.g. per unit population) for the respective time period.

Relative risk (RR) factors for the selected health endpoints have been derived from the exposure-response functions obtained by epidemiological studies. An overview of reviewed studies on risk factors for selected health endpoints is represented in Table 1.

It is an objective of the project to focus on air pollutants relevant to human health. There is a wide variety of air pollutants that give adverse effects on human health but for the purpose of health impact assessment procedure air quality is considered in terms of the following pollutants:

TSP: total suspended particulate matter

BS: black smoke

PM₁₀ and PM_{2.5}: particulate matter aerodynamic diameters inferior than 10 and 2.5 µm

SO₂: sulphur dioxide

NO₂: nitrogen dioxide

CO: carbon monoxide

O₃: ozone (1-hour average and 8-hour "moving" average)

Pb: lead

BaP: benzo(a)pyrene

Long-term integrated measurements on PM₁₀, PM_{2.5}, TSP and BS can be regarded as well.

Quantification of the health impact (selected outcome) for the exposure to the (predefined) air pollutant is based on the population *attributable risk proportion concept* (AP), i.e. the fraction of the health endpoint, which can be attributed to the exposure in a given population (assuming there is a causal association between the exposure and the health outcome and no major confounding effects on this association). AP for a certain time period can be calculated using the formula given by Krzyzanowski [4].

WHO proposes the principle "one population – one average value for a specified time" for ambient air pollution indicators. This means that a profile of the population exposed and/or a profile of subgroups of the population exposure will be estimated based on the averaging of the available corresponding data from the valid stations, which most accurately represent the exposure of the population under surveillance [5].

A broader discussion on the underlying assumptions and limitations of the methodology used can be found in a number of papers, e.g. in Rothman and Greenland [6] and in Rockhill et al. [7].

Development of the AirQ software package

The most important feature of the Health Impact Assessment of Air Pollution programme (HIAAP) is the development of the AirQ software package. AirQ

Table 1.
Overview of reviewed studies on risk factors for the selected health endpoints attributed to pollutants.

	SO ₂	O ₃ (8 hr)	O ₃ (1 hr)	NO ₂	PM ₁₀	BS	TSP	CO	PM _{2.5}
SHORT TERM EFFECTS									
Mortality from									
– All causes	X	X	X	X	X	X	X	X	X
– Cardiovascular diseases	X	X	X	X	X	X	X		
– Respiratory diseases	X	X	X		X	X	X		
Hospital admissions for									
– Asthma (age < 15)	X	X	X	X		X			
– Asthma (age 15-65)	X	X	X	X		X			
– Respiratory diseases (age 15-64)	X	X	X	X		X			
– Respiratory diseases (age 64 +)	X	X	X	X		X			
– Respiratory diseases					X				
– Respiratory diseases COPD	X	X	X	X		X	X		
– Cardiovascular diseases					X			X	
Morbidity									
– Cough					X				
– Chronic bronchitis (age > 25)					X				
– Acute bronchitis (age < 15)					X				
– Asthma attacks (children)					X				
– Asthma attacks (adults)					X				
LONG TERM EFFECTS									
– Total mortality					X				X
– Chronic bronchitis					X				X
– Bronchitis (children)							X		

has been developed by WHO-ECEH, Bilthoven Division, during a two year period based on the best available knowledge on health impact assessment of air pollution. AirQ is a user-friendly tool, which offers to the different users a high versatility in calculating the health impact estimates.

Also, a data conversion module, which is part of the software package, has been developed. This module serves as a pre-processor for the air quality data, generating the exposure profiles and other air quality statistics needed for AirQ. The objective is that in the near future the conversion module would be integrated into the AirQ software itself. This would remarkably enhance the user-friendly performance of the software, because it will be able to process directly the most commonly used air quality data standard formats, without the need of a conversion module.

Through AirQ the public health actors and policy makers at local, regional or national level can assess the benefits of various scenarios aiming at reducing population exposure to air pollutants at all levels.

It is the aim of the HIAAP programme to provide through AirQ a standardised health impact assessment procedure to all users. This is important because it gives a common ground for the comparability and validation of health impact estimates. A comprehensive review of methods and strategies for monitoring ambient air quality for health impact assessment is given in a recent publication of WHO Regional Office for Europe [8]. A Russian version of the publication is in the process of preparation.

Another aim of the programme is to use AirQ as a tool for storage and exchange of air quality data in a standardised way. The software generates standard files containing the air quality data and the exposure-response relationships derived from local epidemiological studies (if available). These files can be stored for a later use or can be exchanged between users as part of an integrated process of information exchange.

Criteria for the Selection of the urban Areas or Agglomerations participating in the Programme

Availability of existing validated air quality data

The approach is to use at the extent possible the existing data from different sources, in order to facilitate the work and prevent duplication. To assure the effective use of the existing data on national and local networks and to avoid duplication, AIRBASE, the air quality database set up by the European Topic Centre on Air Quality, has been chosen as the main source. Other air quality data sources consulted were the national air quality web sites of different European countries, different publications and other health impact assessment studies, such as the Air Pollution and Health European Information System

(APHEIS) and the European Community Respiratory Health Survey (ECRHS).

The WHO European Region covers 51 countries with a variety of air quality monitoring systems. Valid data from international sources although improving dramatically, are still relatively scarce. Local sources are most likely to provide meaningful data for health impact assessment because:

- more detailed information on the location of the monitoring stations and air quality time series are available, but parts of this information often do not reach the national databases ;
- the local network managers knowing the area in which the measurements are taking place, can judge better about the quality of the data.

Extension and organization of the monitoring systems in the city

For a comprehensive health impact assessment the data should be complete in terms of temporal and spatial coverage and fully validated. To participate in the programme, the cities should have well established monitoring networks in order to ensure that collected data are suitable for health impact assessment.

Quality and completeness of the air quality data

Target of the programme are the monitoring stations representative for the areas where people live or urban and suburban background stations. The air quality data should be validated through well documented quality assurance and control plans in order to be relevant for health impact assessment.

Basic criteria is the completeness of air quality data used for the exposure profile:

- 75% completeness of measurements (≥ 18 hours per day, ≥ 274 days per year);
- TSP, BS, NO₂ and SO₂ at least 138 valid daily averages for the winter period;
- O₃ at least 138 valid daily averages for the summer period. A detailed description of the criteria that air quality data should meet for health impact assessment applications is given in a recent WHO publication [8].

Population of the city

The project aims at evaluating the health impact on European urban areas where most of the continent's population lives and most of the problems related to the air pollution are encountered.

Geographical coverage of the study

In order to give a comprehensive distribution of exposures, cities from all parts of the WHO European Region have been selected, with particular attention to EU and CEE countries.

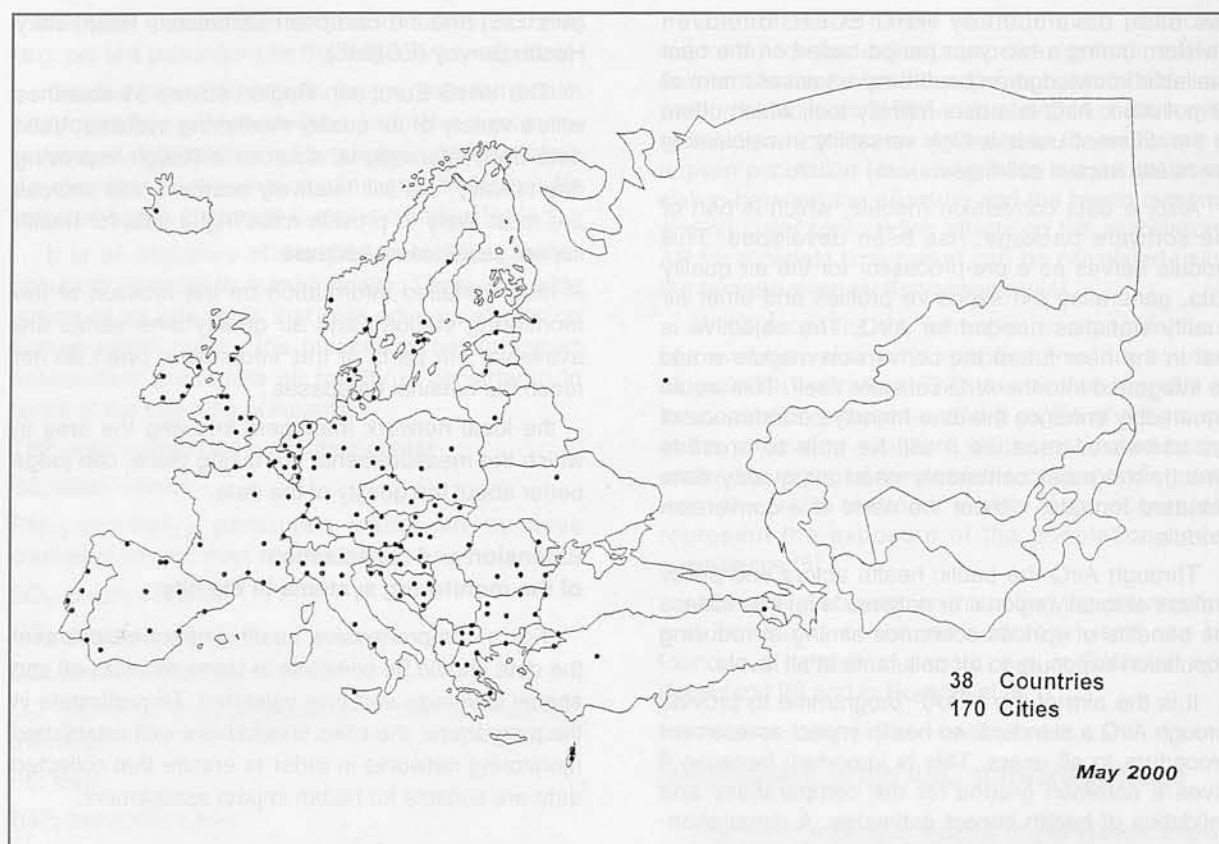


Figure 1.
Geographical distribution of HIAAP programme coverage.

Present Development of the Programme

The programme is actually going through its most important stage: dissemination of the AirQ software package to the end-users and collection of health impact estimates from each of the cities. The study has embraced the whole WHO European Region, including all EU members and CEE as well as 4 countries from NIS. A particular approach will be followed with NIS countries due to the peculiarities of their air quality monitoring systems.

Summarising, 170 urban areas and agglomerations from 38 member countries of the WHO European Region participate in the HIAAP programme. The geographical distribution of the programme coverage is given in Figure 1 – half of the total number of the cities has already received the AirQ package and the process is towards completion. WHO-ECEH aims to complete the collection of health impact estimates from the cities within summer 2000. Cities are requested to calculate the impact estimates based on the air quality data provided from their networks for the last available year.

Conclusions

Air pollution related programmes make up the bulk of the WHO-ECEH's activities. The main aims

driving these activities are to prevent or reduce health risks caused by air pollutants and to provide tools for managing these risks. These programmes are addressed to different target groups that are involved in the risk management and decision making process such as air quality monitoring network managers, policy makers at various levels, other stakeholders that influence policy making, etc.

In this framework, WHO-ECEH has initiated last year a programme aiming at assessing the impact of air pollution on human health in the WHO European Region.

The methodology for conducting the study is provided by an extensive review of the existing knowledge on health impact assessment carried out by WHO-ECEH. The tool through which the study will be carried out is the AirQ software package. This user-friendly software not only provides a standardised methodology for carrying out health impact assessment, but also serves as a media for storing and exchanging air quality and epidemiological data.

Upon completion the programme will try to give a comprehensive overview of the impact of exposures to relevant air pollutants in Europe and recommend to the Member States strategies and policies for risk reduction.

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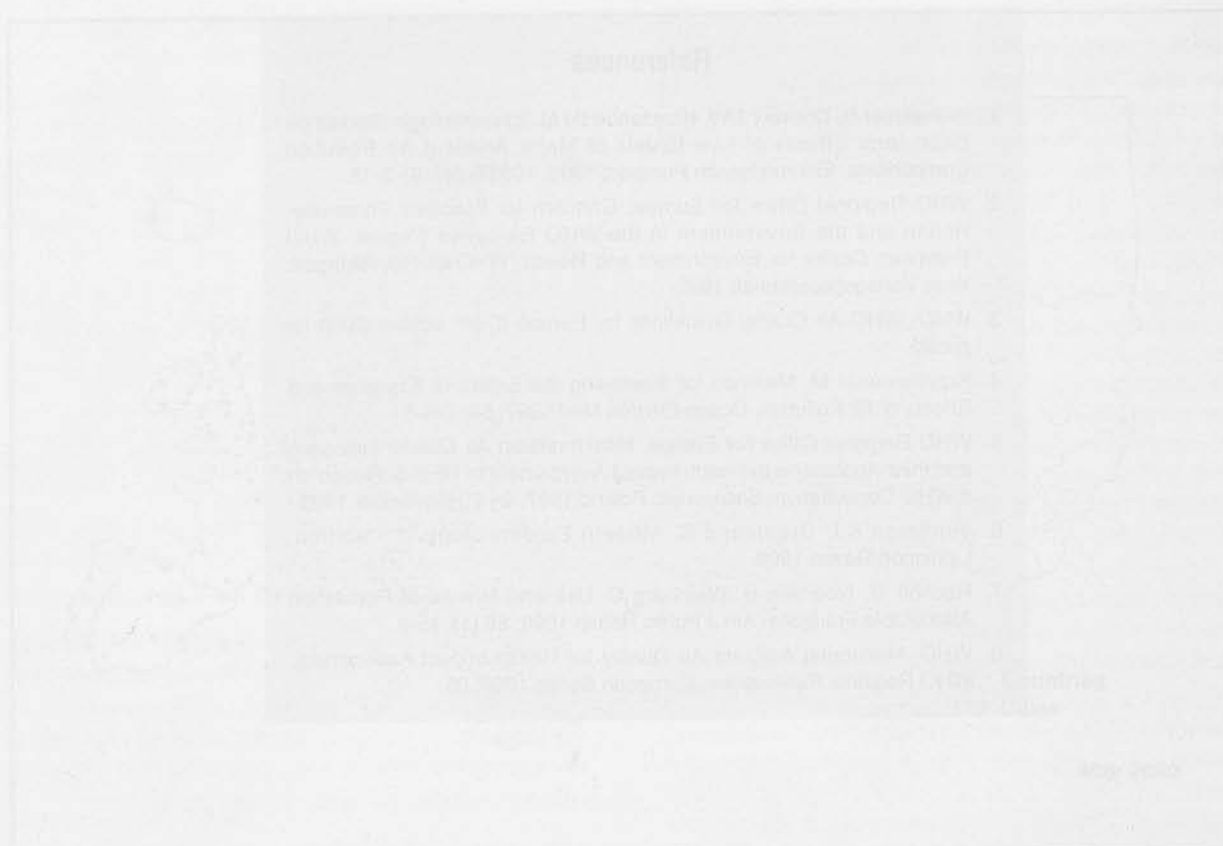


Figure 1
Geographical distribution of WHO Programme countries

Present Development of the Programme

The programme is actually going through its most important stage: determination of the WHO software package to the countries and collection of basic input estimates from each of the countries. The study has embraced the whole WHO European Region, including all EU members and CEE as well as

other states, in order to present or reduce health risks exposed to the atmosphere and to provide tools for managing them. The WHO programme has developed a set of input estimates to be collected from each country and management and an air quality monitoring network. The programme has also developed a set of input estimates to be collected from each country and management and an air quality monitoring network. The programme has also developed a set of input estimates to be collected from each country and management and an air quality monitoring network.

Erratum : Dans le numéro spécial « 40^e anniversaire de l'APPA », p. 1 et p. 31, dans l'article « Development of a personal multi-pollutant exposure sampler for particulate matter and criteria gases », au lieu de L.-T. CHANG, lire L.-T. CHANG.

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Conclusions

Air pollution is a serious problem in the WHO-CEE countries. The main aim

of the programme is to provide a comprehensive overview of the impact of exposure to ambient air pollution in Europe and to develop a set of input estimates to be collected from each country and management and an air quality monitoring network.