EUR/ICP/CEH 301
ENGLISH ONLY

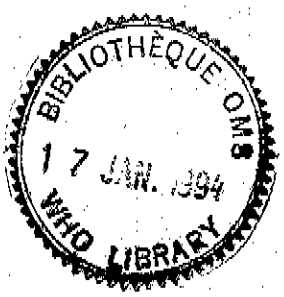
WHO

REGIONAL OFFICE FOR EUROPE

INTERNATIONAL WORKSHOP: SETTING PRIORITIES IN ENVIRONMENTAL EPIDEMIOLOGY

Report on a WHO Meeting

Rome
28 – 30 January 1993



SCHERFIGSVEJ 8
DK-2100 COPENHAGEN Ø
DENMARK

TEL.: (45) 39 17 17 17
TELEFAX: (45) 39 17 18 18
TELEX: 15348

1993

EUR/HFA TARGET 18

TARGET 18

POLICY ON ENVIRONMENT AND HEALTH

By the year 2000, all Member States should have developed, and be implementing, policies on the environment and health that ensure ecologically sustainable development, effective prevention and control of environmental health risks and equitable access to healthy environments.

ABSTRACT

Environmental epidemiology is a rapidly growing field. To make the best use of resources, researchers should concentrate on issues identifed as relevant to public health. The Rome Division of the WHO European Centre for Environment and Health organized a workshop to set priorities for research in this area. The meeting was attended by leading experts in the field. Each participant submitted a paper addressing suggested priorities for research in his or her field of expertise. Using the working papers as a basis of discussion, working groups were formed to clarify priorities in air contamination, water contamination, and radiation and disasters. The participants agreed on the issues that require more research in the hope of avoiding the duplication of efforts and replications of studies on topics on which the evidence was judged sufficient to draw conclusions and to promote public health action. Reseach groups and funding agencies should use the priorities identified to focus their activities on public health issues and use funds cost-effectively.

Keywords

ENVIRONMENTAL EXPOSURE
EPIDEMIOLOGY
AIR POLLUTION
WATER POLLUTION
RADIATION
DISASTERS
EUROPE

CONTENTS

INTRODUCTION

Environmental epidemiology is a rapidly growing field. The assessment of risk to human health from exposure to environmental hazards is often based only on toxicological evaluations: epidemiological data to support these observations are often lacking owing to their complexity and cost. The best use should be made of resources, and research should concentrate on issues identified as relevant to public health.

The WHO European Centre for Environment and Health (ECEH) recognized the need for open discussion by experts in environmental epidemiology and related fields to identify areas of priority research in environmental epidemiology. An International Workshop: Setting Priorities in Environmental Epidemiology was therefore organized by the Rome Division of the ECEH, with the help of the Lazio Region Epidemiology Unit (OER) and the Higher Institute of Health (ISS) of Italy. The Workshop was held in Rome from 28 to 30 January 1993 and was sponsored by the OER.

Sir Donald Acheson was the Chairperson, Dr Michael D. Lebowitz, the Vice-Chairperson, and Dr Göran Pershagen served as Rapporteur. The working papers and the participants are listed in Annexes 1 and 4, respectively. Annex 3 lists various WHO report series containing information that may be useful when setting priorities in environmental epidemiology.

The objective of the Workshop was to identify priorities for research relevant to public health in selected areas of environmental epidemiology. The initial step was to review the available epidemiological evidence and agree on criteria to use in setting priorities. The Workshop could not be comprehensive, but aimed at establishing a consensus among experts on selected issues. The working papers covered the various areas of environmental epidemiology from three different points of view: environmental exposures, epidemiological methodology and major disease groups related to the environment.

During the Workshop, three working groups were established to discuss and agree on priorities for the following exposure categories:

- air contaminants, including airborne contamination from hazardous waste sites, asbestos, benzene and other carcinogens, such as CO, lead, NO_x, SO_2, total suspended particulates;
- water contamination, including waterborne exposure to substances from hazardous waste sites (such as arsenic, asbestos, chemicals of agricultural, commercial, domestic or industrial origin, disinfection byproducts, fluoride, nitrates and radionuclides), and pesticides;
- ionizing and nonionizing radiation and exposure subsequent to man-made disasters.

The members of the three working groups are listed in Annex 2, and this document summarizes their conclusions.

CRITERIA FOR SETTING PRIORITIES

In identifying priorities for research in environmental epidemiology, a set of criteria were used relating to exposure conditions, health effects and the feasibility of human studies (Table 1). The first two areas received more emphasis; study feasibility was only considered when high priority was given to exposure or health effects. Thus, priority setting was based on both public health relevance and opportunities for research.

With regard to exposure, some items in Table 1 need clarification. Meeting the specifications implies high priority. An exposure affecting large numbers of people will in general result in a higher priority than one involving only a few people. Small groups, however, such as the people in certain occupations, may sometimes receive high exposures that result in substantial individual risks, and this also needs consideration. An increasing trend in exposure will often lead to higher priority, but a decrease in exposure in connection with interventions may create a useful opportunity for environmental epidemiology studies. Other important circumstances include the duration of the exposure and the number of sources of exposure.

The criteria are based on public health issues, that is, the incidence, duration and severity of health effects. The identification of sensitive subgroups may be important in understanding etiological mechanisms and maximizing preventive measures. The participants realized, however, that the identification of susceptible individuals may also have ethical implications for genetic counselling and selective prevention, for example. Public concern may also influence priority setting to some extent.

Some criteria for study feasibility must be met, such as having an adequate time since exposure when conducting a study. Other important criteria are the possibility of getting precise and unbiased data on exposure and disease (or other outcomes) and on confounding factors. Regardless of the funds available, any study should be carried out as efficiently as possible.

WORKING GROUP I: AIR CONTAMINANTS

In setting research priorities, Group I used what is known to determine which contaminants are important, at what levels and in which settings. For the diseases and contaminants that are thought to occur together, and on which information was insufficient, priorities were based on: the estimated risk of disease, the presence of complex mixes of contaminants (and/or specific point sources), the need to establish exposure–dose–response relationships, and special circumstances in specific areas (such as "hot spots", or high rates). The Group's considerations included evidence of susceptibility (or the lack thereof), inability to determine population impact and the importance of diseases on which the effects of pollutants are unknown (for example, the effect of mixes or complex mixes on neurological conditions and the development of cardiovascular and renal diseases).

A great deal is known about common pollutants and disease outcomes, but certain gaps should be bridged; for example, the need to better determine exposure when studying exposure–response relationships. The Group members felt that, although certain classes of pollutants were thought to be present at concentrations of concern, they could not make specific recommendations as either the effects on health seemed less likely or the populations exposed were small. They did, however, make recommendations in cases when they considered current methods insufficient for proper determination of exposure–effect relationships of concern (for example, when the populations exposed were large and the expected effects serious).

Table 1. Criteria for setting priorities in environmental epidemiology research

Criterion	Specification
Exposure	
Frequency of occurrence	Large population exposed High percentage of population exposed Wide distribution of exposure
Level of exposure	Biologically relevant level of exposure
Trends in exposure	Increasing occurrence of exposure Increasing intensity of exposure
Health effects	
Harmful effects	Experimental data indicate harmful effects Biological plausibility
Available evidence in humans	Epidemiological evaluation not conclusive Exposure–response relation data are insufficient
Individual susceptibility	Effects on sensitive subgroups can be evaluated Potential synergism with other factors
Severity of problem	High mortality, morbidity, disability, cost
Feasibility of human studies	
Characterization of outcome	Instruments for case definition and identification available Vital statistics available Surveillance systems available Biological indicators of early response available
Exposed population	A suitable population can be found in particular areas The population exposed is well defined An exposed occupational group can be studied and extrapolation is possible Biological indicators of susceptibility are available
Time since exposure	The induction-latency period is adequate (for long-term effects) Exposure response time sequence can be studied (for short-term effects)
Confounding factors	Known confounding factors can be controlled
Statistical power	The expected risk can be detected
Economic aspects	Reasonable estimated cost of the research

Diseases of the respiratory system other than cancer

Diseases of the respiratory system are of primary concern when the health effects of exposure to air pollution are considered. Numerous studies indicate an association of the incidence of acute respiratory illnesses and the prevalence of chronic respiratory diseases, with the concentration of various pollutants in indoor or outdoor air, including complex mixes of

contaminants. Quantitative assessment of dose–response relationship is difficult, however, partly owing to methodological problems. The high prevalence of exposures to concentrations of concern and important psychosocial effects indicate the need for further studies.

High priority

The following health outcomes were identified as the most important for assessment and the least understood:

- the incidence and development of various states of asthma;
- the incidence of diseases of the lower respiratory system in children, especially before age 6 (as childhood lower respiratory diseases can often lead to reduced lung function and are associated with other serious, long-term problems in later life); and
- the development and exacerbation of chronic respiratory disease and disorders that obstruct the respiratory passage (including abnormal lung function).

The impact on these issues of indoor and outdoor exposure to particular matter, SO_2, acid aerosols, ozone, NO_2 and mixes of these pollutants should be established. The individual roles of each of these pollutants as well as their interactions should be assessed. To facilitate research, proper methods of exposure assessment should be developed, including methods for the proper siting of samplers used in networks for routine air pollution monitoring. Moreover, methods for the registration and surveillance of asthma and other chronic respiratory diseases and respiratory infections in selected populations should be developed to identify susceptible groups and detect the effects of air pollution.

Medium priority

A number of studies have found and confirmed several less severe effects on the respiratory system. Dose–response relationships, however, need to be established for different environments and susceptible populations, in particular with respect to two issues. The first is acute respiratory diseases in people over the age of 6 and short-term, reversible changes in pulmonary function in relation to mixes of common indoor and outdoor air pollutants (including environmental tobacco smoke or photochemical smog episodes). The identification of active components of mixes of pollutants should be a part of these studies. To carry out such studies, methods using diaries and objective measurement of acute or short-term health effects need to be improved. The second issue is the long-term impact of complex mixes of pollutants on lung growth and decline, and on the development of bronchial reactivity.

Other diseases

Several other diseases have been shown to be related to particular pollutants or complex mixes of contaminants. Even though these diseases are often important public health problems (and arouse concern in the public) not much is known about the environmental etiology and exposure–dose–response relationships. Priorities were selected based on the size of the problem, the lack of sufficient etiological information and the likely distributions of exposure of the population. Cardiovascular diseases, lung cancer and other types of cancer are thought to be related to air pollution, but the relationships have not been sufficiently evaluated. In particular, the significance of total exposure to the pollutants, as well as the impact of complex mixes of pollutants and combinations of sources, has not been understood sufficiently. There are reasons to believe that neurological disorders and both neonatal and early childhood

problems are related to some pollutants, as they are related to lead exposure. Some metals are of particular concern for other diseases (such as renal diseases) although this association is not well documented epidemiologically. Taking account of the severity of the health problems and the prevalence of exposures, the Group divided the problems into areas of high and medium priority.

High priority

One of the priorities the Group identified was the study of short-term and long-term effects of exposure to CO and environmental tobacco smoke on the cardiovascular system. The methods recommended were to monitor personal exposure, using, *inter alia*, biological markers, and to use surveillance systems to register cardiovascular diseases.

Another high priority was studies of lung and other types of cancer, as well as the incidence of birth defects in relation to complex mixes of pollutants. In particular, exposures related to point sources (such as incinerators) and the effects in groups with high levels of exposure (in occupational settings, for example) should be considered. Among the mixes to be studied, byproducts of the combustion of diesel, petrol and natural gas should be considered. Study design and analysis, including small area studies and mixed design methods, need further development for effective evaluation of these relationships.

Medium priority

Topics given medium priority were: the effects of long-term exposure to complex mixes on the people exposed (including immunology); and the relationship of prolonged exposure to metals and solvents to renal diseases and to neurological and mental development.

WORKING GROUP II: WATER CONTAMINATION, INCLUDING WATERBORNE EXPOSURE TO SUBSTANCES FROM HAZARDOUS WASTE SITES, AND PESTICIDES

Group II focused on water contamination, excluding microbiological contamination. As to the contamination of drinking-water by organic chemicals from hazardous waste sites, the Group members recognized the need for a better understanding of the concentration of contaminants in water and a more precise knowledge of the chemicals present. They also emphasized the need for more widespread and reliable health surveillance data.

Drinking-water contamination from heavy metals (cadmium and mercury) entering the food chain was noted. Since the issue of food contamination was not within the scope of the meeting, these substances were not discussed.

There is a lack of conclusive, direct epidemiological evidence on whether natural or artificially added chemicals in drinking-water are harmful. Only for exposure to lead was the evidence judged to be sufficient to support an association with significant effects on health. As to the effect of waterborne exposure to substances coming from toxic waste sites, although experimental studies and selected epidemiological investigations have shown harmful effects on human health, the evidence is not conclusive. Links between exposure to pesticides and various types of cancer have been suggested, but the epidemiological data are inconclusive.

Drinking-water

High priority

Nitrates are widespread contaminants of drinking-water and their concentration is increasing in some areas. The relationship between nitrates ingested in water and cancer is biologically plausible, although experiments using laboratory animals have not shown direct evidence of carcinogenicity. The epidemiological evidence of harmful effects on humans is weak. Owing to variations in metabolic pathways between individuals, susceptibility might vary. Studies in this area are judged to be feasible, although special attention should be devoted to exposure characterization, owing to the long incubation period of the types of cancer involved and the need to determine past exposure. The Group emphasized the need to study stomach cancer in stable populations with reasonably good data on past exposure.

Exposure to the byproducts of chlorine disinfection is widespread and population coverage is increasing, although the concentration may have dropped in certain areas. Experimental data suggest harmful effects on human health. The epidemiological data available for cancers of the colon, rectum and bladder are not conclusive. Studies on this issue are judged to be feasible owing to the variation of the sources of drinking-water in countries.

Medium priority

Populations in certain localities are exposed to biologically relevant levels of arsenic in the water; high exposures might be harmful. Experimental data show important health effects, and epidemiological assessments indicate associations with cancer, cardiovascular diseases and perhaps adverse reproductive outcomes.

The harmful effects of lead in drinking-water derived from lead pipes are well known. This could lead to significant exposure, particularly in certain areas of the Region. The extent of exposure to lead in these populations should be evaluated.

Other chemicals were examined to establish the need for further epidemiological investigation. These included asbestos, fluoride, ozone used for disinfection, cadmium and lead. Water hardness was also considered. Studies on these items were judged of low priority.

Organic contaminants in drinking-water including substances coming from hazardous waste sites

High priority

The extent of the population's exposure to chemicals originating from hazardous waste sites is not well known. Two groups could be considered: large populations exposed to low levels of various chemicals, and hot spots of high population exposure. The levels of the contaminants are suspected to be high enough to have adverse health effects, and there is general agreement that the problem is increasing. The study of this issue is therefore particularly timely. The role of many of the chemicals in causing harmful health effects has been clearly shown in experimental settings and in epidemiological studies dealing with other routes of exposure. Various types of cancer, adverse reproductive outcomes and neurological symptoms are the effects of greatest concern.

Pesticides

High priority

The study of the health effects of environmental exposure to pesticides deserves high priority. The use of such substances is widespread and certain subpopulations suffer from high exposure. The exposure level might be high in general, and the trend in exposure is increasing worldwide, although there are different trends for various substances. Experiments on laboratory animals have provided substantial evidence of harmful effects on health, including carcinogenicity. There is also an extensive database of adverse effects on human health following acute intoxication. Evidence of health effects from chronic exposures is heterogeneous, but suggests adverse effects on health (such as cancer, birth defects and other adverse reproductive outcomes, neurological diseases and immunological disorders) for a number of substances in occupational settings.

Future studies should address the following issues:

- Populations that have been affected by acute episodes of intoxication should be carefully studied and followed up to determine long-term effects.
- Exposure characterization should be made more precise and studies using only the general category "pesticides" as the exposure variable should not be performed. Exposure, at least at group level, should be more precisely classified.
- Evidence available in the field of reproductive health is still poor and based on a rather broad classification of disease. Studies in this area should be more extensive and focus on selected types of birth defect and certain other outcomes of pregnancy.
- Owing to the long-term effects of pesticide exposure, biological markers of past cumulative exposure should be developed to identify and better characterize exposed groups. Concentrations of active metabolites of pesticides in blood and urine should be used to study the association with such outcomes as neurobehavioural effects.
- More attention should be given to other outcomes, such as immunological changes. This type of effect may well be considered an indicator of early response as well as a marker of exposure.

WORKING GROUP III: IONIZING AND NONIONIZING RADIATION AND DISASTERS

Group III initially discussed approaches to organizing information on environmental health concerns. The members of the Group chose to first define the agents worthy of detailed assessment and then, for each, to complete the check-list of criteria, define research needs, and suggest research approaches that would address the key limitations. The Group also considered exposure to microwave radiation, radar, and routine nuclear power plant emissions but felt, although potentially interesting, this area had lower priority. The agents of clear concern to public health and environmental epidemiology were then enumerated: radon exposure, industrial disasters, ultraviolet radiation and extremely low-frequency electric and magnetic fields. Each of these was discussed in some detail, followed by a discussion of all the agents to set priorities. Again, an initial restriction was made to agents of clear scientific interest and public health importance; the further classification of these into medium or high priority was based on additional considerations, such as the extent to which current research would be likely

to resolve the issue and the extent to which research would bear on public health action. The recommendations of other groups on research priorities were incorporated when applicable.

High priority

Extremely low-frequency electric and magnetic fields

A key reason for addressing this issue is the high prevalence of exposure throughout the industrialized world. At present, it is unknown whether the exposure is at a level that produces adverse biological effects, and the severity of the problem is uncertain. Epidemiological research points towards cancer in children, particularly leukaemia, as well as leukaemia and brain cancer in adults exposed at work. Further research is needed to evaluate mechanisms of action on biological systems, define the proper measure of exposure, explain the reasons for the increased incidence of cancer in electrical workers, and resolve whether childhood cancer truly is associated with residential exposure to magnetic fields.

Among these considerations, the key issues encouraging further study are the prevalence of high exposure and degree of public concern. The scientific interest is very high at present but the ultimate public health importance has yet to be determined. A number of large studies of both residential and occupational exposures are in progress.

Disasters

A disaster may be defined as a disruption of the human ecology that exceeds the capacity of the community to function normally. This definition includes both natural and man-made disasters. The Group considered radiation and chemical accidents together.

Disaster implies high exposure in a sufficiently large population, although biologically relevant levels of exposure can be unknown. They affect the entire population, including vulnerable groups such as children, fetuses and the chronically ill. Trends in potential exposure are different in different countries (developed versus developing) and can vary from one industrial process to the other.

Epidemiological studies can more easily detect short-term effects. The control of confounding factors and the statistical power of studies depend on the type of exposure and on the size of the population, which cannot be defined *a priori*.

The focus should be on the preparation for research as new events occur rather than additional studies on historical disasters. Sensitive populations should be identified. The relationships between acute and delayed effects should be clarified, as should the effects of persistent exposure. Biological markers of exposure should be developed and studied in relation to late health effects. Research is needed on the psychological aspects of both exposure and diseases at the community level.

Trained task forces of experts should be established and made ready to react to disasters in Europe. An inventory of potential disaster sources and high-risk areas should be prepared in countries. For example, the destruction of nuclear weapons may be a problem in the future. Populations at risk should be educated on how to face emergency situations and, in the event of a disaster, complete information should be disclosed to researchers. Systems for long-term surveillance of affected populations should also be established.

Medium priority

Indoor radon exposure

As discussed in detail in a monograph by the International Agency for Research on Cancer (IARC),[a] radon is an established cause of cancer in humans, with a clear dose–response relationship linking exposure to lung cancer in miners. Exposure to radon is extremely widespread and occurs at levels at which biological effects can be expected. The main outcome of concern, lung cancer, is both common and fatal. The most important questions yet to be answered concern the ability to extrapolate lung cancer risks from one population and setting to others, other types of cancer (particularly leukaemia), and the development of biological markers of exposure and early response.

The continued study of radon is important in view of the number of cases of disease potentially attributable to this agent. On the other hand, several large, methodologically sound studies are in progress and should provide evidence on the association between indoor radon and lung cancer. These studies are similarly designed and allow for international collaboration in pooled analyses. Other important scientific questions remain but have somewhat less importance to public health.

Ultraviolet radiation

According to the recent evaluation by IARC,[b] ultraviolet radiation is considered a carcinogenic agent. The evidence comes from melanotic and non-melanotic skin cancer.

In relation to exposure the priority is high considering the size of the population exposed, the wide distribution in the population, and the increasing trend, mainly due to lifestyle.

The epidemiological evidence on causality is conclusive. High-risk groups have been identified. Skin melanoma shows an increasing trend in most countries, although the incidence of this type of cancer is relatively low.

The diseases associated with exposure to ultraviolet radiation are rather well characterized, while the definition of exposure at population level can be challenging, particularly in relation to lifestyle. Exposure involves large populations; consequently, the statistical power of the studies should not be a problem.

More research is needed on effects other than skin cancer (such as cataract) as well as on other sources of exposure than the sun (ultraviolet and fluorescent lamps) and genetic susceptibility.

CONCLUSIONS AND RECOMMENDATIONS

1. International collaboration is often of great value in environmental epidemiology. For example, to cover a large range of exposure and achieve sufficient statistical power, studies from different countries may be combined. Further, international collaboration can also contribute to the harmonization of methodology. International organizations, particularly WHO, could play a key role in initiating and coordinating these activities.

---

[a] *Man made mineral fibers and radon*. Lyon, International Agency for Research on Cancer, 1988 (Monographs on the evaluation of carcinogenic risks to humans, Vol. 43).

[b] *Solar and ultraviolet radiation*. Lyon, International Agency for Research on Cancer, 1992 (Monographs on the evaluation of carcinogenic risks to humans, Vol. 55).

2. Registers of health effects such as birth defects, cancer and mortality are useful for environmental epidemiology. It is essential that such registers be maintained and that their quality be continuously assessed. More use should be made of existing registers in environmental epidemiology studies.

3. Studies in environmental epidemiology should never replace or postpone the amelioration of environmental conditions strongly suspected of causing harmful health effects. Epidemiological studies may be used to assess the impact and effectiveness of environmental intervention programmes.

4. Adequate funding is crucial in environmental epidemiology research, which often involves the study of weak associations. This generally necessitates large studies and methods that can accurately estimate exposure; however, both tend to be costly. Further, environmental exposures are often greatest in countries where resources are most scarce. International funding agencies should allocate more resources to environmental epidemiology, particularly in the heavily polluted areas in the central and eastern countries of the Region. Other forms of multilateral and bilateral collaboration are also important.

5. In general, training in environmental epidemiology in the European Region is inadequate. It should be strengthened at the undergraduate, postgraduate and professional levels. International collaboration coordinated by WHO is already taking place, but these activities need additional support.

Annex 1

WORKING PAPERS[a]

ICP/CEH 301/6	Pesticides by Dr A. Blair
ICP/CEH 301/7	Air pollution by Dr D. Wegman
ICP/CEH 301/8	Ionizing radiation with special reference to the post-Chernobyl situation by Dr I.V. Osechinsky
ICP/CEH 301/9	Non ionizing radiation by Dr D.A. Savitz
ICP/CEH 301/10	Radon by Dr O. Axelson
ICP/CEH 301/11	Water by Dr K. Cantor
ICP/CEH 301/12	Disasters by Dr P.A. Bertazzi
ICP/CEH 301/14	Asbestos by Dr B. Terracini
ICP/CEH 301/16	Cancer by Dr L. Simonato
ICP/CEH 301/17	Biological indicators by Dr P. Vineis
ICP/CEH 301/18	Respiratory diseases by Dr M.D. Lebowitz
ICP/CEH 301/19	Reproductive health by Dr B. Källén
ICP/CEH 301/20	Lung cancer by Dr G. Pershagen
ICP/CEH 301/22	Small area studies by Dr P. Elliott
ICP/CEH 301/23	Waste by Dr A.B. Miller
ICP/CEH 301/24	Exposure assessment by Dr B. Brunekreef
ICP/CEH 301/25	Training for environmental epidemiology in Europe: needs, requirements and capacities Dr W. Jedrychowski

[a] Copies can be obtained from the Rome Division of the WHO European Centre for Environment and Health, Via Vincenzo Bona 67, 00156 Rome, Italy.

Annex 2

COMPOSITION OF WORKING GROUPS

Working Group I: Air contaminants (airborne contamination from hazardous waste sites, asbestos, benzene and other carcinogens (CO, lead, NO_x, SO_2, total suspended particulates.

Dr Michael D. Lebowitz (*Chairperson*)
Dr Paul Elliott
Dr Bert Brunekreef
Dr Göran Pershagen
Dr Benedetto Terracini
Dr David Wegman

WHO and Group organizers

Dr Pietro Comba
Dr Francesco Forastiere
Dr Michal Krzyzanowski (*Rapporteur*)

Working Group II: Water contamination including waterborne exposure to substances from hazardous waste sites (arsenic, asbestos, chemicals of agricultural, commercial, domestic or industrial origin, disinfection byproducts, flouride, nitrates and radionuclides) and pesticides

Dr Rodolfo Saracci (*Chairperson*)
Dr Aaron Blair
Dr Ken Cantor
Dr Bengt Källén
Dr Anthony B. Miller
Dr Paolo Vineis

WHO and Group organizers

Dr Roberto Bertollini (*Rapporteur*)
Dr Carlo Perucci

Working Group III: Radiation (ionizing and nonionizing) and exposure subsequent to man-made disasters

Dr David A. Savitz (*Chairperson*)
Dr Olav Axelson
Dr Pier Alberto Bertazzi
Dr Wieslaw Jedrychowski
Dr Igor V. Osechinsky
Dr Lorenzo Simonato (*Rapporteur*)

WHO and Group organizers

Dr Tord Kjellström
Dr Roberta Pirastu

Annex 3

WHO REPORT SERIES FOR SETTING PRIORITIES IN ENVIRONMENTAL EPIDEMIOLOGY

WHO recommends that, prior to undertaking epidemiological research concerning a particular hazard, scientists should consult relevant international review reports. Many of these are published by WHO. Of particular note are the various report series listed below. Individual reports in these series deal with a specific environmental hazard and have undergone a substantial international review process. In addition to providing an extensive overview of current knowledge of and data on environmental hazards, the reports list research recommendations that may provide useful direction for new epidemiological studies. These reports are distributed to more than 3000 libraries and institutions worldwide. If your library does not have copies, please ask your librarian to contact the address below.

Environmental Health Criteria Series

This series was launched in 1976 in response to concern over the risks posed by chemicals and physical hazards in the environment. Substances and other hazards to be evaluated are selected according to an internationally agreed list of priorities. Drafts are prepared by individual experts or national institutions, circulated worldwide for comment, and then reviewed and revised by one or more international groups of experts to make the information as complete and accurate as possible. Each report includes recommendations for future research. By 1993 more than 100 chemicals and a dozen physical hazards had been evaluated.

Technical Report Series

Since the inception of WHO in 1948, this series has served as a mechanism for collecting the views of international experts on technical issues crucial to the improvement of human health. Each volume records the consensus reached by a group of experts commissioned to advise the world's scientific and medical communities on the best way to tackle a selected health or medical problem.

IARC Monograph Series

In 1969, the International Agency for Research on Cancer initiated a programme on the evaluation of the carcinogenic risk of chemicals to humans, which included production of critically evaluated monographs on individual chemicals. The programme was later expanded to include evaluation of the carcinogenic risk associated with exposures to complex mixtures and other agents. The monographs are based on evaluation by experts of all published carcinogenicity data, provide authoritative scientific guidance to all concerned with the reduction of human exposure to carcinogens, and indicate where additional research efforts are needed.

Food Additives Series

Published since 1972, this series serves as a record of the extensive toxicological data assessed by the Joint FAO/WHO Expert Committee on Food Additives when establishing acceptable daily intakes for intentional food additives and tolerable intakes for contaminants. Each volume concentrates on a selection of food additives, contaminants, or veterinary drug residues found in food, and provides fully referenced evaluations of all biological and laboratory data relevant to safety assessment. Readers are also alerted to methodological flaws that may cast doubt on the validity of reported safety data. The volumes are of particular value to toxicology researchers.

For details of the availability and price of the above publications, or for copies of WHO publications lists, please contact: WHO, Distribution and Sales, 1211 Geneva 27, Switzerland, or your national WHO sales representative.

Annex 4

PARTICIPANTS

Temporary Advisers

Sir Donald Acheson
Visiting Professor of International Health, London School of Hygiene, United Kingdom (*Chairperson*)

Dr Olav Axelson
Department of Occupational Medicine, University Hospital, Linköping, Sweden

Dr Pier Alberto Bertazzi
Istituto di Medicina del Lavoro, Università degli Studi di Milano, Milan, Italy

Dr Aaron Blair
Occupational Studies Section, National Cancer Institute, Bethesda, MD, USA

Dr Bert Brunekreef
Department of Epidemiology and Public Health, Wageningen Agricultural University, Netherlands

Dr Ken Cantor
Environmental Epidemiology Branch, National Cancer Institute, Bethesda, MD USA

Dr Pietro Comba
Higher Institute of Health, Rome, Italy

Dr Paul Elliott
Environmental Epidemiology Unit, London School of Hygiene and Tropical Medicine, United Kingdom

Dr Francesco Forastiere
Lazio Regional Epidemiology Unit, Regional Health Authority, Rome, Italy

Dr Wieslaw Jedrychowski
Department of Epidemiology and Preventive Medicine, University Medical School, Cracow, Poland

Dr Bengt Källén
Department of Embryology, University of Lund, Sweden

Dr Michael D. Lebowitz
Respiratory Sciences Center, University of Arizona, College of Medicine, Tucson, AZ, USA (*Vice-Chairperson)*

Dr Anthony B. Miller
Department of Preventive Medicine and Biostatistics, Faculty of Medicine, University of Toronto, ON, Canada

Dr Igor V. Osechinsky
Head, Department for Population Investigations, National Haematological Centre, Moscow, Russian Federation

Dr Göran Pershagen
Department of Epidemiology, National Institute of Environmental Medicine, Karolinska Institute, Stockholm, Sweden (*Rapporteur*)

Dr Carlo A. Perucci
Director, Lazio Region Epidemiology Unit, Regional Health Authority, Rome, Italy

Dr Roberta Pirastu
Higher Institute of Health, Rome, Italy

Dr David A. Savitz
University of North Carolina at Chapel Hill, NC, USA

Dr Lorenzo Simonato
Registro Tumori del Veneto, Padua, Italy

Dr Benedetto Terracini
Department of Biomedical Sciences and Human Oncology, Turin University, Italy

Dr Paolo Vineis
Department of Biomedical Sciences and Human Oncology, Turin University, Italy

Dr David Wegman
Department of Work Environment, College of Engineering, University of Lowell, MA, USA

Representatives of Other Organizations

International Agency for Research on Cancer
Dr Rodolfo Saracci
Lyon, France

Observers

Dr Mary M. Agocs
National Institute of Hygiene, Budapest, Hungary

Dr Paolo Crosignani
Divisione di Epidemiologia, Istituto dei Tumori, Milan, Italy

Dr Maurizio Di Paola
ENEA-CASACCIA, Rome, Italy

Dr Carrado Magnani
Servizio di Epidemiologia dei Tumori, Turin, Italy

Dr Marco Marchi
Department of Statistics, University of Florence, Italy

Dr Paolo Paoletti
Istituto di Fisiologia Clinica del CNR, Pisa, Italy

Dr Riccardo Puntoni
Istituto Nazionale per la Ricerca sul Cancro, Genoa, Italy

Dr Adele Seniori Costantini
Occupational Epidemiology Branch, Centro per lo Studio per la Prevenzione Oncologia (CSPO), Florence, Italy

World Health Organization

Regional Office for Europe

Dr Roberto Bertollini
Epidemiologist, WHO European Centre for Environment and Health, Rome Division

Dr Michal Krzyzanowski
Epidemiologist, WHO European Centre for Environment and Health, Bilhoven Division

Miss Candida Sansone
Secretary, WHO European Centre for Environment and Health, Rome Division

Miss Manuela Zingales
Secretary, WHO European Centre for Environment and Health, Rome Division

Headquarters

Dr Tord Kjellström
Prevention of Environmental Pollution, Division of Environmental Health