Scientists' recommendations

Environment and Health Research for Europe

An ESF position paper

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Contents

The European Science Foundation acts as a catalyst for the development of science by bringing together leading scientists and funding agencies to debate, plan and implement pan-European initiatives.

Introduction

The 1994 Helsinki Declaration on Action for Environment and Health in Europe marked an important step forward in combating the impact of environmental factors on health. It not only identified the key environmental threats but also recognised that further scientific research was required to help policy makers take effective preventive and remedial action. In particular, there is a need to understand more fully the relative risks and impacts of environmental hazards. Without this knowledge there is a danger that legislation could misdirect resources towards problems that have little real effect on health.

There are various research programmes in Europe investigating these issues at both a European and national level but there is still a need for further initiatives, especially to inform decision makers on how best to address issues of public concern. To fill these gaps and in order to avoid duplication of efforts, the Declaration recommended that the European Science Foundation (ESF) work with the World Health Organisation (WHO) and European Commission (EC) to propose research areas to address this need.

The result was an ESF scientific Task Force embarking on a programme of scientific consultations on Environment and Health (ENHE), involving observers from the WHO and EC. Under the highly effective chairmanship of Professor Jussi Huttunen, Director General of the Finnish National Public Health Institute, and drawing on the skills of over 150 scientists from a broad spectrum of disciplines, for three years this Task Force focused on the identification of research needed to improve the tools for assessing and managing the environmental risks to health identified in the Helsinki Declaration. The aim was not to cover all these risks, only fields where pan-European research could make tangible progress with clear outcomes.

Three types of research are proposed:

- basic research;
- studies to translate the basic science into policy advice;
- risk management research to support policy decisions.

This document provides a summary of the main recommendations of the ENHE Task Force as discussed and agreed at a meeting of scientists convened in Il Ciocco, Italy in June 1998. A fuller description of these and related recommendations is available *(see page 11)*.

Independent experts, including policy makers, scientists and representatives of non-governmental organisations, will evaluate this proposal on research areas in October 1998 at a joint ESF/EC/WHO consensus conference. The aim of this conference will be to agree a common position on research potential which will then be submitted to the Third Ministerial Conference on Environment and Health to be held in London in June 1999.

Designing details of a research programme, by taking into account the latest developments in the area of environment and health, would be the next step following a positive decision by the Ministers in June 1999.

Sir Dai Rees

President, European Science Foundation

Executive summary

Helsinki Declaration

In 1994 in Helsinki, Ministers of Health and the Environment of the European Member States of the WHO, as well as members of the EC, agreed seven broad priority areas where action was required to reduce the impact of environmental degradation on health. These ranged from contaminated food and water to ambient and indoor pollution, urban health, and death and injuries from accidents. The ensuing Helsinki Declaration on Action for Environment and Health in Europe recommended that the ESF should work with the WHO and EC to identify future research needs in these areas.

ESF programme of consultation

In line with the recommendations of the Helsinki Declaration, the ESF launched a Task Force embarking on a programme of scientific consultation, in close liaison with the WHO and EC. Over 150 scientists from some 20 European countries and a wide range of disciplines, from neuro-biologists and toxicologists to epidemiologists and social scientists, collaborated through a series of workshops and field studies to pinpoint areas where further research is required to support the Declaration's goals. At a multidisciplinary ESF update meeting in June 1998, 40 leading scientists examined more than 80 detailed recommendations for further research and drew up a shortlist of the 24 research issues presented in this document.

Selection criteria

Criteria for identifying possible research needs included relevance to:

⇒ Exposures hazardous to physical and mental health and/or well-being;
⇒ Assessment of the associated risks;
⇒ Mechanisms of cause and effect;
⇒ Feasibility and timeliness;
⇒ Significance for the populations of Europe.

Research fields

Ten research fields were thus identified:

⇒ Climate change and stratospheric ozone depletion;
⇒ Social variations in health expectancy in Europe;
⇒ Environmental effects, cognitive function and health;
⇒ Children and accidents;
⇒ Ambient air particulates;
⇒ Indoor air quality and health;
⇒ Water quality and drinking water;
⇒ Effects of immunotoxic agents in the environment and the workplace;
⇒ Chemical risk assessment;
⇒ Genetic susceptibility to environmental toxicants.

Recommendations for future research are made in each of these areas. However, the 10 fields themselves are not presented here in any priority order.

Areas not included

A number of important areas such as diet and smoking and their associated health effects were not included in the original list of potential topics because they were seen as essentially lifestyle rather than environmental issues. Other research areas, such as endocrine disruptors, were considered but not finally included as it was felt that they are being adequately covered by ongoing research.

Overarching research needs

The ENHE Task Force has identified a number of generic issues, which are central to all research approaches. These include the need to formulate a meaningful set of health impact indicators to describe, compare and prioritise environment and health problems.

Obstacles

The programme also highlighted several obstacles to undertaking the research identified. These include the possible difficulties of accessing patient-related information due to existing data protection legislation.

Consensus conference

The ENHE Task Force's 10 research fields and their science-driven recommendations will be discussed at a joint ESF/EC/WHO consensus conference, attended by policy makers and scientists, in October 1998. Here, additional criteria will be applied, such as policy relevance, social and economic benefits, environmental impact and cost, before the recommendations are finalised as a joint paper on European research needs and fed into the Third Ministerial Conference on Environment and Health to be held in London in June 1999.

How the recommendations were arrived at

The ENHE Task Force focused on those priority areas identified in the Helsinki Declaration where pan-European research is needed and where research can make a difference. In addition, new policy priorities which have emerged since then have been taken into account. Particular emphasis was placed on developing qualitative and quantitative risk assessment and management tools for the impact of the environment on health. These issues were discussed in depth by leading scientists throughout Europe in a series of workshops and mini-reviews, organised mainly by ESF with contributions by WHO / ECEH (European Centre for Environment and Health) and by the EC.

Risk assessment

In terms of improving risk assessment, several areas were considered to be of very great importance. These included a better understanding of the variations in susceptibility of sub-groups of the population, as well as the nature and extent of these variations. Greater knowledge about the interactions between health and environmental, socio-economic, psychological and life-style factors was also thought to be key.

Risk management

To facilitate policy evaluation and implementation, scientists concluded that several risk management tools should be further developed. These included tools for comparative risk assessment, valuing health gains, cost-benefit analyses, risk perception and risk communication.

Final recommendations

The results of these workshops and reviews were reported to the ESF and published in an integrated document, entitled *An Environment for Better Health* *(see page 11)*. To focus the proposed areas for research further, this document was discussed in depth at an ESF update meeting in Il Ciocco, Italy, where a multi-disciplinary group of scientists examined the more than 80 original recommendations. Their discussions resulted in the set of final recommendations outlined in the following pages. These complement existing national and European initiatives and will be discussed at a joint ESF/EC/WHO meeting involving policy makers, scientists and representatives of non-governmental organisations in Munich in October 1998.

However, the Board of ESF advises that in a rapidly changing world it would be prudent to maintain a watching brief on emerging environmental threats and on new scientific opportunities arising from research areas, such as genetics, molecular and cellular biology.

ENHE recommendations

Overarching research needs

The ENHE Task Force has identified a number of generic issues, which are central to all research approaches. These include the need to:

Formulate a meaningful set of health impact indicators to describe, compare and prioritise environment and health problems.

⇒ *Develop concepts such as 'disability-adjusted-life-years' (DALYs) for environmental health impact.*

⇒ *Develop monitoring techniques of health impact indicators to forewarn policy makers of major health developments.*

⇒ *Develop cost-benefit analyses to evaluate different abatement policies.*

Climate change, stratospheric ozone depletion and human health

It is now widely recognised that industrial and other human activities are having a significant impact on the Earth's biophysical systems.

Two of the best-known developments are the accumulation of greenhouse gases in the lower atmosphere, notably CO_2; and stratospheric ozone depletion, largely caused by emissions of chlorofluorocarbons (CFCs). Due to the global scale and the long timeframe of these changes, the potential health risks are complex.

There are likely to be both direct and indirect effects on health, although it is acknowledged that major health consequences of climate change might be unlikely for some years to come. Therefore, immediate high priority for such work must depend on strong policy support. In terms of direct effects, stratospheric ozone depletion will cause ultraviolet radiation-induced disorders, including skin cancers, cataracts and possibly immune suppression. More variable climatic patterns, in turn, will increase the frequency of severe weather, such as heatwaves and floods, leading to injuries, psychological disorders and altered rates of heat- and cold-related illnesses and deaths.

The indirect impact of climatic change is potentially more wide-reaching. Warmer temperatures, caused by increased greenhouse gases, will stimulate the production of certain air pollutants, especially photochemical oxidants, while more humid conditions will enhance the production of aero-allergens, such as mould spores. This may increase the risk of asthma and allergic disorders, as well as acute and chronic respiratory disorders. Disturbances to ecological systems, including crop productivity and sea levels, could also alter the distribution and incidence of vector-borne diseases, such as diarrhoea and infections, as well as the risk of malnutrition.

Research into how variations in climate and ambient UVR influence health risks is still in its infancy, having only started in the 1990s. To make further progress, two broad categories of research would be required: empirical studies into the relationship between climatic/UVR variations and health outcomes; and integrated mathematical modelling to estimate future impacts on health.

Recommended research issues

- Conduct empirical epidemiological studies into how current and recent climatic variations in Europe affect health.

Issues that would be addressed include:
⇒ climatic influences on the production of certain air pollutants, such as photochemical oxidants, and aero-allergens;
⇒ changes in the geographic range and seasonality of vector-borne infections (such as leishmaniasis, Lyme disease and malaria) and environmentally-transmitted infections (e.g., waterborne infections such as cryptosporidiosis and foodborne infections);
⇒ health impacts, incuding physical, microbiological and psycho-social, of extreme weather events, such as floods and storms;
⇒ estimation of the overall public health (especially mortality) impact of seasonal thermal stresses.

- Extend existing epidemiological research to quantify dose-response relationships between ultraviolet radiation and types of skin cancer, ocular cataract, other ocular disorders, and immune system functions.

- Develop methods of integrated mathematical modelling for scenario-based assessments of the future health risks of climate change, as well as increased exposure to UV radiation due to ozone depletion.

Outcomes

i Clarification of the range of public health impacts caused by climatic change and increased exposure to ambient UVR.

ii Early evidence of any emerging health problems associated with climatic change and ambient UVR.

iii An enriched information base to support decisions about national / European compliance with international conventions on emissions of greenhouse and ozone-destroying gases

iv Greater understanding of the scope, magnitude and time-frame of future health impacts if environmental degradation is not constrained or terminated. This data will help policy makers to make decisions on future releases of atmosphere-disrupting gases.

Social variations in health expectancy in Europe

Socio-economic inequalities in health exist in all countries and there is mounting evidence that these divides are widening.

In Finland, for example, men aged 25 who have received higher education are likely to live over six years longer than their counterparts who undertake just basic education. Even greater differences can be found for morbidity, depending on the measure used.

The existence of these inequalities is well-researched and documented but, as a recent ESF exploratory workshop found, less work has been done on explaining why these differences persist. Advances could be made in a short space of time by coordinating tools and concepts through a pan-European, multidisciplinary research initiative. An important part of this approach would be to extend and develop a pan-European geographical information system (GIS), complementing work initiated by the ESF and WHO-ECEH.

Recommended research issues

- Investigate health inequalities, their causes and underlying mechanisms, between countries, focusing on gender, educational, economic, socio-cultural and health policy factors. These would be related to both social and material environments as well as cognitive functions.

• Expand ongoing longitudinal studies in several European countries, using standardised measurements of stressful social environments.

⇒ Carry out life-course studies to investigate the links between socio-economic, biological and psycho-social factors in childhood and diseases in adolesence and adulthood (e.g. Ischaemic Heart Disease, cancers, musculo-skeletal disease). This would involve applying concepts and measures that have been developed within the framework of "pathway models".

⇒ Combine biological and psycho-social approaches to analyse the adverse effects of chronic stressful social environments, including housing and the workplace, on mortality and morbidity.

⇒ Special attention should be given to developing appropriate outcome measures of the consequences of social disruption including unemployment and homelessness, as well as the relationship between increased violence and deteriorating economic conditions. The impact of economic changes on the living conditions of vulnerable groups, such as those living in crowded or unhealthy buildings, should also be considered.

Outcomes

i Clearer understanding of why health variations occur which will help in addressing problem areas more effectively.

ii Identification of 'at risk' groups.

Environmental effects, cognitive function and health

The chemical and physical environments can interfere with cognitive functions in several ways.

Exposure to chemical substances such as metals and organic solvents can damage the central nervous system and impair mental functions. Physical factors that affect cognitive function include noise, heat, cold, vibration and light conditions. These can be a particular problem in schools and the workplace, impairing learning and memory.

In addition, cognitions and beliefs can themselves influence health outcomes. Symptoms and distress are common, and possibly increasing. Beliefs that these symptoms are caused by the environment are also widespread, both as background beliefs and in response to environmental incidents. How people perceive these environmental influences can also have an impact on their health. There are also emerging new environmental syndromes, such as amalgamism, electrical and chemical sensitivity. However, these may differ in their nature, prevalence and impact across Europe.

Recommended research issues

• Develop research networks and incorporate relevant outcomes into existing or planned studies of environmental effects on mental and cognitive functions.

• Develop measures of symptoms, perceived exposures, health beliefs and their influence on health outcomes.

• Identify psycho-biological mechanisms of symptom formation.

• Establish prevalence, impact, attributions and outcome of unexplained symptoms and syndromes in a cross national perspective.

• Improve risk management strategies for environmental incidents via systematic reviews of best psycho-social management.

Outcomes

i A better understanding and specification of psycho-social and psycho-biological mechanisms of environment-related health impairment.

Children and accidents

Unintentional childhood injuries are a major cause of morbidity and mortality.

Globally, it is estimated that over 400,000 children die from 'accidents' each year. Accurate pan-European data do not exist but the WHO estimates that injuries account for around 15% of all deaths of children under five years old.

There is widespread acceptance that these injuries are not random or 'accidental' but the product of a complex interaction of a variety of factors, from physical living conditions and education to the psychological characteristics of the child's family. Because these are not random events there is a real possibility to prevent them through intervention.

Recommended research issues

• Initiate pan-European intervention studies to prevent unintentional injuries to children and adolescents.

⇒ Develop appropriate methodologies for injury research with particular emphasis on controlled evaluations of injury prevention programmes for pre-school children and adolescents. Multiple approaches should be used including systematic reviews of interventions, comparative studies of exposure risk, and statistical methods to compare injury surveillance data in the different regions and countries in Europe.

⇒ Measure health gains and economic benefits.

Outcomes

i An assessment of the societal costs and psycho-social consequences of injuries and the cost benefits of injury prevention programmes. The latter will include direct and indirect costs of childhood injury and information about the economic gain that can be achieved by appropriate intervention.

Ambient air particulates

Everyone inhales respirable particles, but the concentrations in most European cities have been found to have a severe impact on their residents' health.

For example, in the population of Holland, it has been estimated that existing concentrations of respirable particles provoke asthma attacks in thousands of children each day and lead to dozens of deaths and hospital admissions.

Although the effects of brief exposures have been well documented, it is clear that long term exposure has a greater impact on health.

Fine particles pose the greatest threat to health and 60% of these come from anthropogenic sources, with the remainder produced naturally. However there are considerable uncertainties about the size of the health impacts of these particles, especially in terms of their contribution to the risk of chronic disease and mortality. In addition, further information is required about the particles that present the most serious risk, their critical concentration,

where they come from and how they are dispersed.

Recommended research issues

- Conduct epidemiological studies of the effects of long term exposure to respirable particulate matter. These should include prospective studies with precise assessments of exposures and health outcomes; as well as retrospective studies with estimates of past exposures.

- Apply toxicological and clinical research tools to study acute and chronic cardiovascular and respiratory responses to inhaled ambient particles.

⇒ Identify the physico-chemical properties of the particles that cause these responses.

⇒ Determine the dose-response relationships for these particles.

- Identify the sources of defined groups of respirable particles, in indoor and external environments, to enable the linking of exposure to particulate matter sources.

Outcomes

i Data on exposure-response relationships.

ii Identification of the specific particulates that produce respiratory responses.

iii Identification of the most important sources of PM10, enabling more cost-effective risk control.

Indoor air quality and health

On average, people spend around 95% of their time indoors and 70% of this time is spent in their homes.

Chemical pollution from non-vented combustion appliances, smoking, furniture, carpets and building materials is one of the most abundant and obvious problems in homes. Poorly vented combustion appliances, for instance, are often major contributors to high concentrations of nitrogen dioxide and carbon monoxide. Energy saving measures often make this problem worse by further reducing ventilation. In addition, radon gas from building materials and soil is thought to play a significant role in the incidence of lung cancer. Other difficulties include the risk of respiratory and cardiovascular diseases from tobacco smoke; and chronic irritation from building materials that evaporate, such as formaldehyde and other volatile organic components.

Biological indoor pollution possibly presents the biggest threat but this is the least well-researched area. Dust mites, for instance, produce major allergens that are believed to play an important part in aggravating asthma - an increasingly prevalent problem for children in Europe. Bacterial toxins and mould-cell wall components might also contribute. Other potential biological threats include house dampness and pets.

Recommended research issues

- Establish the role of indoor environments in allergy and asthma and unravel the interactions between individual susceptibility and exposure to indoor pollutants in relation to allergy and asthma.

- Establish the impact of mould exposure on health problems through non-allergic mechanisms.

Outcomes

i Identification of the role of indoor air pollution in the aetiology of allergy and asthma with a focus on risk prevention.

ii Identification of the role of moulds in causing health problems and determination of the need for risk preventative actions.

Water quality

As one of the world's most densely populated regions, Europe not only has a large and growing demand for water but also carries out a number of activities that can pollute this important resource.

There are three types of pollutant: micro-biological, chemical and physical. Exposure to micro-biological agents poses the greatest threat to health. Between 10% and 20% of all cases of gastroenteritis in Europe, for instance, are due to *Campylobacter jejuni*, water-borne outbreaks of which are frequently recorded. Moreover, the risk of infection from waterborne pathogens, including protozoa and viruses, is likely to increase as limited ground water resources lead to a shift towards extracting drinking water from surface water, which is more vulnerable to contamination. Poor hygiene in regions suffering economic and political instability is exacerbating these microbial threats. Recently there have been outbreaks of cholera in Eastern Europe, as well as dysentery and infectious hepatitis in large parts of Europe and Russia.

The situation is complicated by the numbers and quantity of chemicals that can find their way into both recreational and drinking water, either through direct discharge into water or indirectly, for instance through soil. In Europe, around 100,000 chemicals are used and 2,000 of these are used in quantities of more than 1,000 tonnes a year. However little is known about their impact on human health and their complex interaction with soil and other media, as well as the food chain.

To date, water research and management has been reactive, rather than proactive. On the basis that prevention is better than cure, this situation needs to be reversed. This is particularly important given that every member of the population uses water.

Recommended research issues

- Conduct epidemiological studies to identify the impact of background transmission of water-borne pathogens on health; and the role of water in the general transmission of infectious disease.

- Develop quantitative risk characterisation methodologies for infectious agents and algal toxins. This should be done by improving uncertainty analysis and probability distributions using appropriate mathematical and statistical methods.

Outcomes

i An accurate estimate of the relative disease burdens that are due to 'background' water, rather than isolated outbreaks of contamination.

ii Quantitative risk characterisation methodologies would help establish the health gain of taking remedial action.

Assessment of human health effects of immunotoxic agents in the environment

Industrial chemicals, pesticides and many other toxic agents in the environment can provoke immune responses, either directly or indirectly, that lead to skin, respiratory tract and alimentary tract allergies.

Generally, these immuno-modulating substances occur at low levels but greater research is required to establish the effect on health of long-term exposure to them. To do this, longitudinal epidemiological studies are required, supported by accurate exposure assessment techniques and validated biomarkers. Suitable biological measures for contact allergies already exist but new methods are needed to accurately identify chemicals and proteins that cause allergic reactions in the respiratory and alimentary tracts.

Recommended research issues

- Develop methods to assess the allergenicity of chemicals that are either inhaled or consumed, including genetically modified foods. Achieve a European consensus for all test methods applied to genetically modified foods.

- Develop biomarkers of immunotoxicity (stimulation or suppression). These could include vaccination titres to novel antigens for which insight into determinants is required.

⇒ The occurence of infectious diseases as determined by environmental factors should also be included in ongoing longitudinal cohort studies of children.

Outcomes

i A series of indicator tests for the allergenicity of chemicals that are either consumed or inhaled.

ii An agreed approach to testing novel foods for allergenicity.

iii A series of biomarkers that can be included in epidemiological studies of the environmental causes of immune disturbances. These markers could be used to identify primary initiators of immunotoxicity as well as factors that play a role in modulating immunity, such as a mental stress.

Chemical risk assessment

The risks posed by chemicals in the environment cut across most of the priority research areas identified by ENHE.

Methods and systems to accurately quantify these risks are urgently needed if policy makers are to arrive at informed cost-benefit analyses and predict future risks.

Recommended research issues

- Improve external and internal human exposure assessment, including modelling.

⇒ To achieve this, the characterisation of exposures, bioavailability and duration of exposure will have to be enhanced. Biomarkers of exposure will also have to be developed.

- Improve the methodologies of chemical effect assessment to reduce uncertainties in the quantification of risks.

⇒ These should cover both *in vitro* and *in vivo* comparisons, minimising the use of animals wherever possible.

⇒ Develop biomarkers of effect (such as mutation spectra) for defined endpoints.

⇒ Understand the mechanisms which lead to detrimental effects.

• Develop quantitative chemical risk characterisation based upon experimental and human data. There should be a major emphasis on estimating how people vary in their response to chemical exposure.

Outcomes

i Improved methods to estimate the risks of human exposure to environmental chemicals.

Genetic susceptibility to environmental toxicants

Most important chronic diseases in industrialised societies, including heart disease and cancer, are due to a number of factors, including the impact of environmental toxicants on physiological processes.

There is now mounting evidence that genetic variation can modify the impact of these toxicants. As we are a genetically heterogeneous species, the interaction of these traits with environmental toxicants could play an important part in explaining why some individuals are more susceptible to particular diseases than others. Although many genetic polymorphisms have been identified, the biological consequences of some of these remain unkown.

Recommended research issues

• Develop methodologies for identifying high-risk groups or sub-populations. This could include:

⇒ Establishing criteria for designing studies and adequate methods of statistical analysis.

⇒ Identifying sub-groups with different susceptibilities, for example the early onset of disease or sensitivity to low exposure levels.

⇒ Epidemiological studies of gene/gene and gene/environment interactions.

⇒ Identifying genetic markers for exposure and susceptibility.

⇒ Determining polymorphic distribution of proteins in multicentre studies involving different European populations. To estimate population contributed risk imposed by a specific genotype or a combination of genotypes.

Outcomes

i Identification of sub-sets of the population that are at greater risk.

Further reading

An Environment for Better Health
The integrated document of the ENHE scientific programme including workshop reports and field reviews.
Available on-line at http://www.esf.org/mp/ENHEa.htm or on paper from the ESF Communications Unit (Contact details overleaf).

Participants, science update meeting, Il Ciocco, Italy, June 1998

More than 150 researchers from a broad spectrum of disciplines have contributed to the ENHE programme of consultation. The recommendations presented in this document were discussed and agreed at a final workshop in June 1998 at Il Ciocco, Italy.

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