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EUR/ICP/CEH 087/A
3742B
ORIGINAL: ENGLISH

DATA REQUIREMENTS AND METHODS FOR ANALYSING SPATIAL PATTERNS OF DISEASE IN SMALL AREAS

Report on a WHO Consultation

Rome
22-24 October 1990

1991

EUR/HFA target 19

Note

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Introduction

The Consultation on Data Requirements and Methods for Analysing Spatial Patterns of Disease in Small Areas was held in Rome on 22-24 October 1990. It was attended by 42 experts from 18 countries, 6 observers, 3 representatives of the WHO Regional Office for Europe, 1 from WHO headquarters and 4 from the International Agency for Research on Cancer (IARC). The following items were discussed:

- the separate roles of geographical and environmental studies in epidemiology;
- criteria for the management of currently available health statistics (on mortality and morbidity) and of the results of special or ad hoc surveys;
- the need for quality control and comparability of data;
- requirements for population data to be used for determining expected rates;
- the potential of mapping both disease and environmental exposure, or their surrogates;
- the limit to geographic correlations aimed at linking health with the environment;
- statistical methods for describing geographical variations in the occurrence of a disease, and environmental exposure; and
- methods for assessing the consequences of point sources and the origins of disease clusters.

The participants recognized that several epidemiological techniques exist for analysing variation

in disease incidence among geographically defined populations. However, recently developed small-area statistics (SAS) techniques are expected to improve the resolution of studies.

Background

At a previous consultation in 1988 on European environment and health information systems, it was concluded that public health data would be much more useful if they were linked with indices which were, in a broad sense, geographical. A recommendation was made to carry out studies which would utilize these geographically linked public health data on a scale appropriate to the health or environmental risks involved, through the development of a programme of analytical epidemiology. Because environmental risk factors may be concentrated in space and time, it was recognized that an approach involving the development and use of these methods - i.e. small-area statistics - in the European Region represented an important advance in determining the contribution of environmental factors to health.

Ministers and other representatives of the environmental and health ministries of 29 Member States met in Frankfurt in 1989 and approved the European Charter on Environment and Health. This Charter urges the WHO Regional Office for Europe to expand its efforts not only to understand the relationship between environmental conditions and the health of populations in the various parts of the Region, but also to assess and evaluate various categories of risk related to the health aspects of environmental protection.

Subsequently, at a planning meeting convened at IARC in January 1990, a programme was outlined for the present major Consultation, which was to be the first step

towards developing European ability in this field and which would rely on and expand the Regional Office's catalytic role in environmental epidemiology.

Discussion

The participants submitted a number of background papers (Annex 1) covering: data sources and registries; environmental exposure and risk assessment; record-linkage and confidentiality; and geography and mapping, clusters, point sources and their methodology. They also presented a series of European case studies. Those discussed included: childhood leukaemia around nuclear installations in the United Kingdom and in France; the epidemics of toxic oil syndrome and soya bean-related acute asthma in Spain; the Seveso accident in Italy; mesothelioma and environmental erionite exposure in Turkey; and the information systems set up in the USSR after the Chernobyl accident.

Several technical issues were discussed, and there was full agreement on the following points.

An apparent unevenness of disease occurrence (for example, clusters of disease) or of the geographic distribution of known or suspected risk factors (for example, point sources) is often observed. This unevenness may be either highly localized or may extend over large populations or areas. SAS techniques are scale independent: the administrative details of their use depend on population size, ranging from a few to 250 000 individuals according to the issue involved.

Excesses of disease, either in space or time, may not necessarily reflect variations in the distribution of the cause or causes. The probability of findings being due to chance should always be evaluated. Estimation of this probability, together with the development of

rational and falsifiable hypotheses, should precede further epidemiological studies. In addition, the possibility that local excesses of disease are the consequence of non-environmental hazards (genetic or lifestyle-related, for example) should be borne in mind.

The process of developing etiological hypotheses from geographical variation in disease occurrence is complex. It must be based on statistical grounds as well as on available knowledge of the potential exposure of the index population to exogenous hazards. Imprecisions in this knowledge, particularly when associated with borderline statistical significance of local peculiarities of disease occurrence, often create difficult situations. Different methodological approaches are needed for descriptive analysis or for ad hoc epidemiological studies prompted by the suspicion of a specific environmental etiology.

The successful detection of a localized excess of disease, coupled with a rational hypothesis, generally also requires one or more of the following steps: (i) expansion of the observation in time or space; (ii) verification of the hypotheses through either case-control or cohort studies, taking into account individual exposures; (iii) if warranted, analytical epidemiological studies to investigate other (non-environmental) risk factors, e.g. lifestyle patterns.

However, it was emphasized that whenever a source of environmental pollution is identified, regardless of its dimension, measures to reduce it should be taken immediately and should not await the implementation of epidemiological studies.

The need for an informed public is primary to environmental health risk management. However, the participants were unanimous that any information brought to public attention should be accompanied by a clear

indication of its reliability and of the uncertainty of the etiological inferences at any stage in the data collection and subsequent analysis.

Summary of conclusions and recommendations

Detailed conclusions and recommendations (listed below) were approved for the further development of SAS and other techniques by the Regional Office and by Member States. The recommendations are to be put into practice in coordination with other European and international bodies facing the same problems, such as IARC. The need to avoid duplication of effort by these and other institutions was stressed frequently.

The recommendations relate to health data and disease registries, the availability of denominator data, (for both routine counts and consideration of confounding), record-linkage and confidentiality, requisites for assessing the impact on health of environmental factors, statistical methods, and the need to improve European abilities in environmental epidemiology (including training). As for statistical methods, it was agreed that it was impossible to say which of the methods now available is the most appropriate.

Methodological problems related to vector-borne and infectious diseases were not discussed.

The participants suggested that the Regional Office should turn its attention to SAS and other methods of analytical environmental epidemiology, at the same time utilizing existing regional bodies (including IARC and the WHO collaborating centres). However, as enough resources and personnel are not available everywhere, specific efforts should be made to improve epidemiological ability in Member States or in subregions.

The participants also recognized that situations may exist in the countries of central and eastern Europe requiring special efforts, either to remedy high environmental risk or to identify highly exposed or highly at-risk subpopulations. In these cases it was especially important, they emphasized, to use either local or other resources efficiently.

Mindful of the requirements for effective action, the following points were stressed: the need for multidisciplinary and intersectoral approaches, the need for a strong scientific background and for the development of sophisticated statistical methods, and the need to make better use of existing data.

Detailed conclusions and recommendations

The recommendations addressed to the Regional Office are intended to include its offices in Copenhagen, Rome and Bilthoven and any satellite centres developed as part of the Regional Office or the European Centre For Environmental Health (ECEH).

Numerators: health data and disease registries

Conclusions

C1. Europe has comprehensive coverage with medical certification of the cause of death according to the International Classification of Diseases. Data are available by cause, age and sex and by year and for each country. Data collected for finer geographical divisions are frequently stored at national (or subnational) level.

C2. Morbidity registries are important from the standpoint of the cause and prevention of diseases. Certain requirements govern the choice of disease(s) to be registered, including the requirements that:

- the condition or disease should be important for public health;

- the disease should be clearly definable; and

- high-quality registration should be feasible.

Morbidity registries exist for cancer, congenital anomalies, cardiovascular disease and genetic disorders. With few exceptions, they only cover populations at subnational level. It is not within the scope of this report to recommend fuller coverage.

C3. Other routine health records (hospital-discharge registries, disease notification, etc.) are also a useful source of data. When morbidity information is not captured by these sources, ad hoc studies can be undertaken to assess disease incidence.

C4. Knowledge of the completeness and validity of disease registries is essential if their data are to be used in geographical comparisons. No methods for assessing these parameters appear to be in general use.

C5. Congenital anomalies are a special case, since the validity of observations is severely reduced if they either exclude prenatal diagnoses or include them without stringent validation of the individual data.

C6. For a number of years, several international coordinating centres (EUROCAT,[a] IARC, ICBDMS,[b] MONICA,[c] WHO, for example) have been collecting

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[a] European Registration of Congenital Anomalies and Twins.

[b] International Clearinghouse for Birth Defects Monitoring Systems.

[c] Monitoring Trends and Determinants in Cardiovascular Diseases project.

mortality and morbidity data. They have acquired considerable expertise in disease classification and in the analysis and interpretation of results.

C7. Legal and operational constraints on making available individual but non-identifiable death certificates and morbidity case records to bona-fide researchers are a serious hindrance to health research.

Recommendations

R1. An inventory of disease and mortality registries should be established, maintained and widely disseminated. This is already done for cancer registries (at IARC) and for mortality registration systems (at WHO). The Regional Office should consider the feasibility of a similar exercise for other health conditions.

R2. Member States should make mortality and morbidity data readily available, in subnational levels of detail, to bona-fide researchers.

R3. Dissemination of morbidity data should be routinely accompanied by information on the completeness and validity of registration, and on the methods used to assess them. Completeness and validity should be declared separately for distinct disease entities. Standard methods and criteria should be developed for the routine assessment of completeness and validity.

R4. For congenital anomalies, cases diagnosed prenatally and followed by termination of pregnancy should be identified and registered, together with the gestational age.

R5. The European Economic Community and the Regional Office should actively encourage national governments to

review any of their legal and operational procedures which constrain the use of morbidity and mortality data from small areas, or data on individuals, and revise them accordingly.

R6. The collection of mortality and morbidity data should remain a national or subnational activity with national coordination. Existing supranational bodies (e.g. WHO for mortality data, IARC for cancer morbidity, EUROCAT for congenital anomalies) should continue their respective activities paying special attention to the quality and comparability of data.

R7. Duplication of efforts by new bodies should be avoided.

Denominator data: censuses, confounders and surveys

Routine counts and estimations of populations

Conclusions

C8. The prime requirement is for accurate and continuously available population counts, including births (by age and sex), from areas not smaller than municipalities. At present there are limitations on the availability of such data. Most small-area data derive from census sources, available at 10-yearly intervals. Not all countries in the European Region provide data from this source at a level smaller than that of the municipality.

C9. The quality of census data varies. Many countries report inaccuracies in relation to specific areas and characteristics, based on post-census surveys, so care is needed in interpreting small-area analyses. Specific problems occur with the place of residence for students, members of the armed forces and other mobile subgroups.

The presence of large institutional populations may be reflected in mortality statistics, since their age distribution may differ markedly from the norm.

C10. Between censuses, small-area data are rarely available, except in countries where population registers exist and are regularly updated by legal requirement. There are problems with changes of residence and refugees. A useful source of information may be the record of persons registered with general practitioners (in the United Kingdom, these registers include 98% of the population and from April 1991 will be held on computer). These registers may suffer from time-lags (e.g. in removal of data on deceased persons). Administrative registers may provide population data between censuses. Estimation procedures give adequate estimates for use with large populations, but not necessarily for small populations. Reference systems should attach an area-of-residence code to individual records, to provide maximum flexibility in analysis.

C11. It is important for the postal code, or other address-linked area boundaries, to coincide with areas used in the census, to be consistent with administrative areas, and to be accurately allocated to a grid reference.

Recommendations

R8. All countries should aim to provide small-area population data - including birth notification - from census sources, using the smallest district level in the census and recognizing that considerations of confidentiality may place a constraint on the area level at which data is released.

R9. Countries should investigate the possibilities of using administrative registers to provide counts rather than estimates between census years.

R10. The area reference used for recording populations and events should be the same as that used for population denominators. Postal codes should be used or introduced.

R11. For the purpose of SAS studies, the use of estimation procedures in intercensus years should be investigated more generally in European countries

Ecological confounding

Conclusions

C12. It is essential to adjust for potential confounding variables, as defined by the aims of any particular study. Potential confounders include age, sex, social status, urban/rural location and other known risk factors or indicators.

C13. Denominator counts by confounder strata are available for socioeconomic variables from census data in some countries, but there is international variability. Other data available from routine environmental monitoring (such as the work of the National Radiological Protection Board in the United Kingdom) are often scanty, episodic and not up to date. For certain data, special surveys may be required.

Recommendations

R12. A statement of the (potential) influence of confounding variables should be required in studies of environmental risk.

R13. Census data should routinely provide disaggregated sociodemographic information. For countries where this information is held on population registers, ways of making it available should be considered which take account of privacy requirements.

R14. Any sociodemographic variables recorded should be standardized, using consistent classification between countries. The WHO Regional Office should propose and develop a list of such variables: housing, occupation, employment status, educational level, smoking history, marital and household status, car ownership, etc.

R15. The Regional Office should encourage Member States to make available, subject to confidentiality considerations, the administrative data, disaggregated to small-area levels, held by government departments and agencies (e.g. on income levels, disability, unemployment and welfare, benefits and car registrations) in order to provide data between censuses.

Special surveys

Conclusions

C14. Special surveys may be necessary to measure environmental characteristics, in order to determine precise denominator counts by confounder strata.

Recommendations

R16. There should be consideration of how special (sample) surveys could provide small-area data where these are not routinely available from other sources.

Record linkage and confidentiality

Record linkage

Conclusions

C15. The usefulness of routine records for research purposes is greatly enhanced if different records can be linked together. Considerable experience has been gained, and a methodology has been developed for linking large sets of records by computer.

C16. The benefits of this method include a considerable reduction in costs compared to setting up special procedures to collect the data.

C17. It would be an advantage to be able to link records between individuals, in addition to linking different records for the same individuals.

C18. Access to the information needed to verify a suspicion arising from apparent clusters requires an attitude favourable to access to population-based records.

Recommendations

R17. Member States should be encouraged to make linkage possible between records including the following: birth records, medical records, insurance records, cancer registers, other disease registers, death certificates, occupational records, registers of exposure.

R18. Where a unique personal number exists for every member of a country's population, it should appear on the documents listed in recommendation R17.

R19. Where the use of a standardized number is not possible, the following identifying information should be used: full name (surname at birth), sex, date of birth.

R20. To make record-linkage more precise, other subsidiary information (place of birth, for example) should be recorded where possible, and should be made available for validation of the computer linkage.

R21. When planning censuses, countries should consider the benefits that can accrue from making it possible to link census records to other records, including those listed in recommendation R17.

R22. If necessary it should be possible to link records between individuals (between different members of a family or those living at the same address, for example).

R23. All records should include an address and if available a postal code or other indication of the smallest disaggregated unit.

Confidentiality

Conclusions

C19. The individual's right to consent and privacy may conflict with the benefits to the individual, or to society as a whole, that may accrue from record-linkage studies.

C20. Record-linkage may be inhibited by national privacy legislation and other legal constraints.

C21. Without proper safeguards, data released for one purpose may be used for other purposes for which no authority exists.

C22. Benefits may accrue to society (and to individuals) from the eventual use of data to which access is prohibited even though no loss of privacy would result from such use.

Recommendations

R23. Each country should draw up a national code of practice for confidentiality and record-linkage in small areas. The code should recognize and define: (i) the rights of individuals with respect to their privacy; (ii) the benefits that can accrue from epidemiological studies, to society as a whole and in some circumstances to individuals; (iii) the conditions governing the use to be made of each set of data and the onward release of data; and (iv) provision for the security of the data.

R24. The possibility should be evaluated of maintaining confidentiality by the anonymous linkage of data, including centrally coded national data on causes of death. If maintaining confidentiality is possible, linkage studies should be done.

R25. Any existing common codes of practice in the European Region, the recommendations of the International Association of Cancer Registries and the Helsinki Accord and its provisions must be respected.

R26. It should be ensured, and made clear, that studies using disaggregated data are carried out and reported without breaking confidentiality.

Statistical methodology

Conclusions

C23. The field of SAS is currently at a stage of rapid development.

C24. Statistical input is critically needed into the design and analysis of studies in environmental epidemiology, including SAS, to make the fullest use of data collected, to avoid overinterpretation of these data and to maximize design efficiency.

C25. Small-area data can be used to produce highly geographically referenced descriptive data on health events, but indiscriminate analysis and inappropriate methodology may lead to misleading information and conclusions.

C26. Map-smoothing is useful and promising for extending the resolution of disease maps. Further development of this approach is a high priority. Correlation studies and ecological analysis are fraught with problems, but in some form they are important for attempts to link diseases with environmental factors. Methods of validating these results by estimating the consistency between sexes and age groups, the high correlation between areas that are very close together and so on, need to be developed.

C27. The potential is high for identifying false clusters and generating false-positive associations with environmental features from small-area data. Responding to suspected clusters will become an increasingly time-consuming public health activity. An approach needs to be found which directs resources into areas where the likelihood of finding true causes of diseases is greatest.

Recommendations

R27.[a] The Regional Office should encourage the ECEH to establish: (i) fellowships which allow core scientific staff to undergo short-term training at recognized centres of excellence; (ii) posts for visiting scientists to spend periods at the ECEH units; and (iii) regular seminars, working-group meetings and symposia.

[a] The participants insisted that these recommendations be addressed explicitly to the offices of the European Centre for Environment and Health (ECEH).

R28.[a] The Regional Office should ensure that the ECEH acquires expertise in biostatistical and epidemiological methods, including SAS.

R29. The Regional Office should encourage support for workshops, seminars and individual research efforts in Member States on mapping-methodology, correlation studies and ecological analyses.

R30. The Regional Office should set up a mechanism to develop a Code of Practice for use by research units with access to large databanks. This Code should include principles for writing a protocol for specific activities, which whenever possible should specify in advance: (i) the subsets of data to be analysed; (ii) the analyses to be performed; (iii) the scientific hypotheses to be tested; and (iv) the best forecast of the likely outcomes, arrived at possibly by specifying subjective prior probabilities. The protocol should be filed and protected in such a way that the original specific aims are still available after the analysis.

R31.[a] ECEH and cooperating centres should develop and disseminate guidelines on methodology suitable for small-area analysis, including that related to the production and interpretation of maps. The guidelines should also take into account that: (i) any findings from small-area studies need to be scrutinized with great care and should if possible be confirmed by independent data; (ii) provision must be made for critical and sceptical analyses of negative or positive results: this is an important and time-consuming activity which must be adequately budgeted for; (iii) strategies for

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[a] The participants insisted that these recommendations be addressed explicitly to the offices of the European Centre for Environment and Health (ECEH).

investigating clusters need to be monitored regularly for effectiveness; and (iv) indiscriminate identification of clusters found by interfacing large banks of routine event, population and environmental data should be discouraged.

Relating environmental risks to health

Conclusions

C28. The overall objective is to assess the health impact of environmental factors which can only be controlled by routine multisectoral monitoring programmes (i.e. addressed to the soil, water, air, etc).

C29. SAS, and other methods used in environmental epidemiology, can lead to hypotheses associating health outcome and potential environmental exposure (or risk factors). This type of study, however, is not sufficient to establish and quantify causal relationships between putative environmental risks and public health status. For that purpose it is crucial to perform epidemiological studies which consider individual levels of exposure (to risk factors and potential confounders) as related to a specific health outcome.

C30. Estimates of individual exposure may be derived, with various levels of confidence and accuracy, from, for example: (i) routine monitoring data collected for the control of selected environmental pollutants; (ii) surveillance programmes (e.g. of food quality); (iii) monitoring of the occupational environment; (iv) job-exposure matrices; (v) information related to

the use of consumer products; (vi) household radon and other indoor air quality surveys; and (vii) surveys on the distribution of biological markers of exposure.

C31. Occupation provides a potential source of high levels of exposure to toxic substances which may contribute to significant health effects. Although the latter are not always, or simply, correlated geographically, they can contribute to the outcome of SAS or other studies on the geographical distribution of disease. Nevertheless, ad hoc non-geographically based studies may be required in many circumstances.

C32. Systematic and routine recording of occupational and related exposures in medical records is a complex priority issue which requires careful planning to ensure adequate levels of standardization and quality control of data.

C33. National legislation often requires the monitoring of certain exposure or environmental parameters. These data, however, are often difficult to obtain, while the exposure covered by the regulations is not always to the most appropriate or urgent substances. In most cases, data-recording is based only on the extent to which exposure conforms to national standards or guideline levels, and is often at the aggregate level only.

C34. Data on past as well as current exposure are important but they are often scarce or of uncertain reliability. The strength of exposure studies could be increased by using more precise methods. Exposure studies could be extended to include those based on biological markers when appropriate, but the latter are of limited application for the reconstruction of those non-recent exposures relevant to diseases with a long induction period, such as cancer.

C35. Studies of the effects of environmental exposure on health outcome typically require collaboration by experts from different scientific disciplines (epidemiologists, toxicologists, biostatisticians, environmental scientists, etc.). To be effective, research centres will need substantial numbers of well trained scientists covering all the fields of expertise necessary for environmental health risk assessment.

C36. Participants from the central and eastern European countries spoke of increasing public concern for the health status of populations in that subregion and for the possible relation between such health status and environmental contamination. This calls for objective evaluation of the environment's effects on health. The necessary initial epidemiological studies can be based on the existing data information systems.

Recommendations

R32. The Regional Office should consider methods for designing and implementing monitoring programmes to meet existing guideline requirements (e.g. for air quality).

R33. The Office should encourage Member States which do not have routine monitoring programmes for environmental pollution to develop and apply them, giving consideration to their potential ability to estimate exposure data on individual levels, when appropriate.

R34. The Office should encourage Member States to develop their capacity to collect information relating to individual exposure from various sources, e.g. those indicated in conclusion C30.

R35. The linking of occupation to public health records, the inclusion of occupation in censuses and surveys, and the identification of occupation and/or specific occupational risk exposure in health records (especially those kept by general practitioners) should be encouraged.

R36. The Regional Office should investigate mechanisms for developing and implementing standards for reporting occupation and occupationally related exposure in medical records.

R37. Environmental exposure data need to be made more readily accessible to the scientific community for research purposes. Countries also need to consider updating and revising their regulations on exposure monitoring, especially to meet changing circumstances and data needs.

R38. Exploratory feasibility studies on the use of biological markers of exposure in epidemiological studies should be encouraged.

R39. National governments should be encouraged to increase the resources available for specific exposure-monitoring exercises where the collection of additional exposure data is warranted by adequate scientific observations.

R40. Efforts should be made to improve the consistency and comparability, at European level, of individual exposure estimates derived from different sources (see conclusion C30.).

R41. The Regional Office should encourage the establishment of formal expertise and resources for environmental health risk assessment, and the improvement of facilities and opportunities for training and exchange of expertise.

R42. The effort to evaluate the relationship between health status and the environment in central and eastern European countries should include more effective and in-depth analyses of available data. With other international specialized agencies, the Regional Office should assist with training, consultation, cooperation on particular problems, and technology and methodology transfer.

R43. Efforts should be directed to establishing and maintaining methods and criteria for controlling the environment and health in central and eastern Europe. Advantage should be taken of experience in the West in order to make the most efficient use of available resources.

European cababilitv for environmental epidemiology

Conclusions

C37. The systematic routine small-area data collection of both health events (numerators) and demographic data (denominators) - which include high resolution geographical components (e.g. postal code or residence) - is a prerequisite for SAS studies using routine data. These studies are an important and valuable first step in investigating the potential effects of environmental contamination, if any, in small areas. If they have sufficient statistical power, they may provide reassurance that there is no demonstrable adverse health outcome at the small-area level. Alternatively, they may identify areas which are a cause for concern, whereupon subsequent inquiries will be necessary. These must include the validation of data, and may lead to special surveys (e.g. case-control or cohort studies). Special surveys at the small-area level have also been set up directly in response to local problems, although it should be recognized that these are expensive and time-consuming, and require detailed data collection,

validation and exposure-related measurements. Such surveys should not be initiated for diseases which are regularly registered.

C38. Many institutions in the European Region perform environmental epidemiology, although only a limited number are able to perform SAS studies. There is a need to provide linkages between these institutions and to explore the possibilities of extending the SAS capability.

C39. A number of issues of data availability, data quality, and data analysis must be dealt with throughout the Region, requiring a coordinated approach to environmental epidemiology using SAS techniques. Similarly, a number of current studies are at various stages of completion. A coordinated effort, by institutions capable of providing the necessary expertise and technical abilities, is needed to make the best use of existing knowledge in the European Region.

C40. Many countries do not have the resources to develop appropriate small-area data, and/or may not have the personnel and training abilities which would enable them to carry out SAS studies.

C41. How health data at the small-area level should be related to local environmental data is not yet obvious, although in time it may be desirable for these data to be merged, perhaps in the geographical information system (GIS) domain, if it is properly used.

C42. A wide variety of data appropriate to SAS are currently held in many repositories throughout Europe.

C43. In addition to the Regional Office, other international organizations (ECE,[a] CEC,[b] IARC, for example) are involved in environmental epidemiology.

C44. Separate strategies are needed for the following purposes: (i) to respond to the results of SAS studies; and (ii) to initiate future ad hoc studies, for example in response to emergency situations, and to follow up acute exposure due to local releases of hazardous agents, etc.

Recommendations

R44. Countries routinely holding disaggregated data with a geographical component should make them available for SAS, in the initial investigations of possible health consequences of environmental contamination. Where data are available but not routinely held in disaggregated form, making them available at the small-area level should be a priority.

R45. The Regional Office should identify focal points in each Member State, in an attempt to: (i) identify environmental and health issues and geographical areas of concern; (ii) determine the feasibility of conducting SAS studies; and (iii) assess the resources necessary and available for such studies.

R46. The Office should identify problems common to several States and coordinate joint efforts in the form of multinational programmes, particularly for specific geographical areas (e.g. central and eastern Europe, the Baltic, the Mediterranean).

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[a] United Nations Economic Commission for Europe.
[b] Commission of the European Communities.

R47. The Regional Office should identify, in addition to the national focal points, institutions which can accept responsibilities under the WHO Environment and Health Programme, with particular emphasis on SAS.

R48. The roles of IARC, WHO collaborating centres and other institutions should be defined so that networks can be set up as appropriate.

R49. National focal points, aided by the Regional Office and its collaborating centres, should survey current and completed studies on environment and health in small areas, in which SAS and other methods have been employed. Details should be collected of how the studies came about, e.g. through local public concern, explosions and subjective perception of risk. The survey should cover both "positive" and "negative" studies. Recognition should be given to existing inventories, e.g. those produced by the clearing-house for studies in cancer epidemiology run by IARC and the German Cancer Research Centre (DKFZ).

R50. Member States should facilitate access to disaggregated data with a geographical focus, and where appropriate should develop routine data systems for analyses at small-area levels.

R51. The Regional Office should identify existing staff training programmes in environmental epidemiology, including SAS methodology, and identify future training needs in Member States and in the Region. WHO should develop course materials in environmental epidemiology, especially SAS methodology.

R52. WHO should start pilot studies to investigate the utility of applying GIS in SAS.

R53. The Regional Office should determine the feasibility and benefits of exchanging information and expertise between institutions, emphasizing countries in central and eastern Europe (cf. the CCEE Programme).

R54. The Regional Office should identify environmental epidemiology activities carried out by other organizations, to take advantage of the expertise available and to avoid duplication of effort.

R55. A formal collaborative mechanism to respond to acute environmental episodes should be established between the national focal points in the different Member States, WHO collaborating centres, other relevant organizations and the Regional Office itself.

Annex 1

LIST OF WORKING PAPERS AND BACKGROUND MATERIAL[a]

Working papers

ICP/CEH 087/A/6	Bayesian methods for mapping disease risk, by D. Clayton
ICP/CEH 087/A/7	The role of geographical studies in epidemiology, by J. Cuzick
ICP/CEH 087/A/8	Congenital anomalies and small area studies of environmental effects, by Dr Helen Dolk
ICP/CEH 087/A/9	The geographical distribution of childhood leukaemia and non-Hodgkin lymphomas in Britain, by G.J. Draper
ICP/CEH 087/A/10	Health and environmental data for small area studies in the Netherlands, by Dr Marjon Drijver
ICP/CEH 087/A/11	Small group discussions - Group V: Record linkage and confidentiality, by R. Frentzel-Beyme

[a] Available from the Risk Management Systems unit, WHO Regional Office for Europe, Scherfigsvej 8, 2100 Copenhagen O, Denmark.

ICP/CEH 087/A/12	Geographic correlations across populations with a wide real scatter of rates, by R. Peto et al.
ICP/CEH 087/A/13	Record linkage, by E. Pukkala
ICP/CEH 087/A/14	Measurement of traffic-induced air pollution patterns and its adverse health effects in small areas - a forthcoming project in North-Rhine-Westfalia, Federal Republic of Germany, by U. Ranft
ICP/CEH 087/A/15	Introduction to methods for geographical studies of spatial aggregation, by S. Richardson
ICP/CEH 087/A/16	Use of mortality data in small area studies, by A.D. Lopez
ICP/CEH 087/A/17	Monitoring incidence of myocardial infarction, by A. Ahlbom, N. Hammar
ICP/CEH 087/A/18	Methods for the assessment of disease clusters, by Freda E. Alexander
ICP/CEH 087/A/19	Exposure to soyabean dust and acute asthma, by J.M. Anto, J. Sunyet
ICP/CEH 087/A/20	The Seveso accident, by P.A. Bertazzi
ICP/CEH 087/A/21	Toxic oil syndrome, by Mercedes Diez et al.
ICP/CEH 087/A/22	Availability and use of small area data in Scotland, by Vera Carstairs
ICP/CEH 087/A/23	Relating the environment and public health, by G.A. Zapponi

ICP/CEH 087/A/24	The state registry of persons irradiated after Chernobyl accident, by V. Ivanov
ICP/CEH 087/A/25	Environmental risk factors, clusters in small population, its connections with disability according to public health system's data, by N.V. Vartapetova
ICP/CEH 087/A/26	Methods for point sources, by J.F. Bithell
ICP/CEH 087/A/27	The incidence of childhood leukaemia around nuclear installations in Britain: The Sellafield Story, by V. Beral
ICP/CEH 087/A/28	Analytical epidemiology approaches in small area studies, by B. Terracini
ICP/CEH 087/A/29	Non-parametric approaches to disease mapping, by A. Biggeri
ICP/CEH 087/A/30	Mapping environmental exposures, by D.J. Briggs
ICP/CEH 087/A/31	Discussion on statistical methods for mapping, by N. Breslow
ICP/CEH 087/A/32	Non parametric approaches to disease mapping, by C. Cislaghi
ICP/CEH 087/A/33	Experiences in environmental epidemiology in Italy, by P. Comba

ICP/CEH 087/A/34	Regional clusters of congenital anomalies in small areas of Hungary, by A. Czeizel
ICP/CEH 087/A/35	Discussion on statistical methods of mapping, by J. Estève
ICP/CEH 087/A/36	Data requirements and management in small area studies, by P. Elliott
ICP/CEH 087/A/37	Overall mortality and cancer mortality around French nuclear sites, by C. Hill
ICP/CEH 087/A/38	Some comments on using Stone's method for investigating increased relative risk around a point source, by M. Hills
ICP/CEH 087/A/39	Mapping disease, by M. Smans
ICP/CEH 087/A/40	Mortality and morbidity data for small area studies of cancer, by O.M. Jensen
ICP/CEH 087/A/41	Levels of air pollution and effects on health in the population of Athens, by K. Katsouyanni
ICP/CEH 087/A/42	Data availability for small area studies in Yugoslavia, by M. Kozuh-Novak
ICP/CEH 087/A/43	Data availability for small area studies in Poland, by M. Krzyzanowski
ICP/CEH 087/A/44	The application of geographical information systems in public and environmental health, by M.J.C. de Lepper

ICP/CEH 087/A/45	Statistical methods for point sources, by D.C. Thomas
ICP/CEH 087/A/46	Population data for small area studies, by I.O. Thomsen
ICP/CEH 087/A/47	The assessment of disease clusters - addressing questions of public concern, by J. Urquhart
ICP/CEH 087/A/49	A network of cancer registries in the EEC, by M. Coleman
ICP/CEH 087/A/52	Mesothelioma due to environmental erionite exposure in two Anatolian villages in Turkey, by Y.I. Baris

Annex 2

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