A geographic information system for local public health policy

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Voorwoord

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Contents

Chapter 1

General introduction

1.1 Introduction

The existence of differences in health between populations in different geographical areas, large (countries) or small (city-neighbourhoods), have always been a challenge to epidemiologists and policy makers. To epidemiologists, these differences can give insight into the health effects of certain exposures, for policy makers these differences can give rise to well-targeted interventions. Making these health differences clearly visible in those ways can contribute to the reduction of them.

1.2 From health research to health policy

The Collective Prevention Public Health Act (Wet Collectieve Preventie Volksgezondheid; WCPV, 1990) gives municipalities explicitly an important task in the field of health promotion and collective prevention. At the local level the Municipal Health Service is the major executive authority of this act. In the contemporary national health policy in The Netherlands great importance is given to the reduction of existing health differences. Prevention and health promotion are seen as prominent means to achieve this target. The "Health For All" policy of the World Health Organisation (WHO) and the related Dutch health policy reflect this in a clear way (WHO, 1985; WVC, 1986). The "Healthy Cities Project", which was initiated by the WHO, is one of the initiatives of this collective prevention, whereby the local level is chosen as starting point for health policy. The purpose of the project is to give new impulse to local health policy by means of political action, community participation and intersectoral cooperation. Information, based on (amongst others) epidemiological research plays an important supporting and directing role in this process. This information is a prerequisite for composing a so-called local community diagnosis, a review of health indicators and (possible) determinants of health.
For the local authorities, it is of great importance to have insight into the distribution of health and its determinants, to give direction to prevention strategies and health promotion activities. Moreover, the local authorities need to

have tools to evaluate the effects of certain measures. The above mentioned community diagnosis can sometimes accommodate such requirements of the local politicians. However, it is necessary that a community diagnosis is given not only for the total municipality, but also for districts and neighbourhoods. This supports policy makers in setting priorities and direct policy measures at specific areas. The neighbourhood level also gives better opportunities for community participation and an intersectoral approach in health policy.

Health policy requires two things: information and a set of instruments. Information about the health situation, about factors influencing health and about possibilities to intervene in these factors; instruments like laws, political consensus and strategies (van der Maas, 1989). Also at the local level it is necessary that knowledge be "translated" to the designers of those instruments, the policy makers. Making epidemiological knowledge available to and suitable for policy makers is a major task of the Municipal Health Service. To do so tools are needed, specially suited to giving policy makers insight into the health situation of the neighbourhoods. For the Municipal Health Service in Rotterdam this insight gave rise to the development of such a tool that could bridge the gap between health information and health policy and that could be used for ecological epidemiological research.

1.3 Purpose of the study

The general purpose of the study is to develop an instrument to make epidemiological knowledge available to and suitable for policy makers. This instrument should make it possible to gain insight into the health situation in neighbourhoods, thus supporting the development of a local health policy.
Three questions derive from this general purpose:

1. Is it possible to set up a geographic information system, in order to obtain insight into the health situation in neighbourhoods?
2. Can such a geographic information system be used for epidemiological research?
3. Can such a geographic information system be used for developing and supporting local health policy?

The study is divided into two parts. In the first part of the study a review is given of recent developments in health policy at the international, national and local level and attention is given to the concept of community diagnosis. Furthermore the possibilities of geographic information systems for local health policy are discussed.
In the second part of the study the theory is worked out for the situation in Rotterdam. In Rotterdam a geographic information system was developed, which can be seen as a bridge between epidemiology and local health policy: The Rotterdam Local Health Information System (REBUS, Rotterdams

Epidemiologisch BUurtkenmerken Systeem). This information system is used to support policy makers in a direct way by collecting, processing and communicating health information to them and in a more indirect way by performing epidemiological research based on the information that is collected. Most often this will be ecological research with a explorative character.

1.4 Structure

In chapter two the developments in the field of health policy and health research at a local level are described. Attention is given to international and national developments and to the importance of health information at neighbourhood level. In chapter three the principles of geographic information systems are discussed, and the value of these systems for local health policy. Chapter four gives a description of the development of the Rotterdam Local Health Information System. Chapter five gives examples of how the local health information system can be used in practice. In this chapter both examples of combining existing epidemiological information to produce a community diagnosis and examples of new epidemiological research are given. Chapters four and five consist of articles published already, therefore some duplication and overlap with other parts in the book in these two chapters cannot be avoided. Chapter six gives a summary of the main results and contains a discussion about the possible uses of REBUS in local health policy.

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Chapter 2

Health research and health policy at the local level

2.1 Recent developments in health policy

International developments

In 1977 the 30th World Health Assembly formulated a new general target for the World Health Organisation and its member states. This target implied that by the year 2000 all citizens of the world should have attained "a level of health which will permit them to lead a socially and economically productive life". Central elements in this program are: the concern for the lower income groups, the necessity of a reorientation of health care and the importance of community participation and cooperation between relevant sectors in the community (WHO, 1985; Cosijn, 1992).
In 1980 the European Regional Office of the WHO accepted the proposed world strategy for its own region. This was followed in 1984 by the adoption of the European Regional Committee of 38 specific regional targets (WHO, 1985). These targets cover five priority areas, as shown in figure 2.1.1: (1) the health situation; (2) lifestyle; (3) environment; (4) health care provision and (5) support for health development. The European member states agreed to inform the WHO once every three years about the progress made in the Health For All Program (Hancock, 1987).
In 1986 the European Regional Office initiated the so-called "Healthy Cities Project", which aims to make a contribution to health promotion in urban areas. The Healthy Cities Project can be considered the European manifestation of the Health For All program (Hancock, 1987; WHO, 1988). Backgrounds and recent developments of the Healthy Cities Project are described by Ashton (1992).

National developments

The fundamentals of the contemporary Dutch health policy were established in the Nota 2000 (WVC, 1986), published in 1986. Health policy was formulated as a policy not only focused on health care provisions, but as a policy referring to all determinants of health like biological, environmental and lifestyle factors. With the Nota 2000 the Dutch government adopted the international program

"Health for All by the year 2000" of the WHO. According to the WHO the aforementioned 38 targets take a central position in this policy document. These targets are to be achieved by a shared responsibility of the government, community and public organisations. The most important policy aims are: (1) strengthening prevention and intersectoral policy; (2) a health care provision policy based on information about the health status of the population; (3) continuation of the remodelling of the health insurance system and (4) the development of the provision of information for the benefit of health policy (WVC, 1986).
The starting point in the Nota 2000 is the health model of Lalonde (1974). In this model determinants of health are divided into four groups: biological factors, environmental factors, lifestyle factors and health care provision. Health policy as supported by the Nota 2000 is aimed at all these factors, but lifestyle and environmental factors especially, give the best opportunities for implementing the new health policy at the moment. This means that in the near future policy efforts will emphasise these factors.

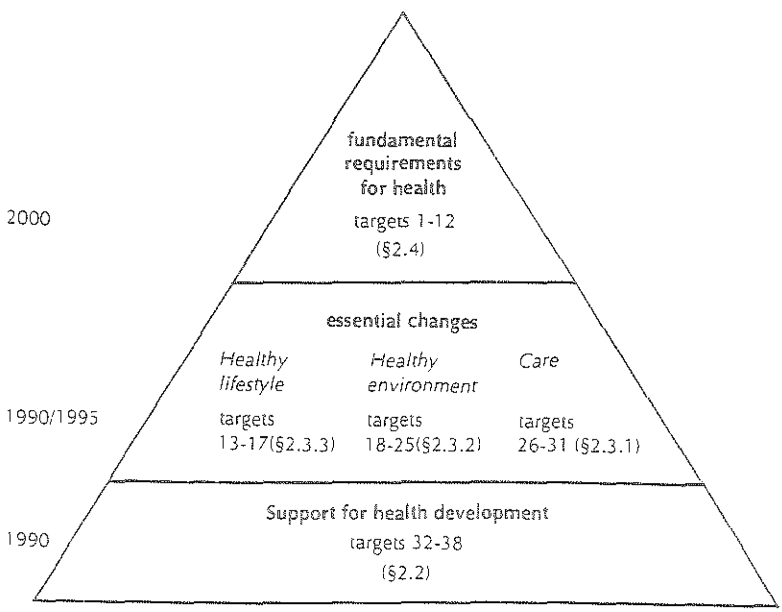

Figure 2.1.1 How the targets of "Health for All" fit together

Local health policy

Development of a local health policy is an essential part of the WHO Healthy Cities Project. The Dutch government also underlined in the Nota 2000 the urgency of regional and local government to develop a health policy, aimed at achieving a certain level of public health. In The Netherlands, local governments have, by means of the Collective Prevention Public Health Act (Wet Collectieve Preventie Volksgezondheid; WCPV, 1990) explicit instruction to develop a local health policy. At the local level the Municipal Health Service is the major authority for the development and support of a local health policy. Besides, there is the new national development of Social Renewal, stimulating local initiatives for improving the living conditions of the local community. In general, the aim is an intersectoral approach the problems encountered (van der West, 1992).
Several cities in The Netherlands have attempted to adopt the proposed health policy at the local level. The four big cities in The Netherlands take a somewhat special position in this. This position is justified by the occurrence of different, specific metropolitan problems. Research shows that more health problems occur in metropolitan areas in The Netherlands than elsewhere. In the first place this seems to be connected with the demographic composition, which is different from the situation in the rest of The Netherlands. Amongst other reasons, in the four big cities more ethnic minorities and more elderly people are concentrated, often both belonging to the lower socioeconomic groups of the community, and, where health is concerned, more vulnerable. In the second place the more unhealthy situation of the big cities is connected to the presence of certain subcultures and the more frequent occurrence of certain health threatening behaviour. In the third place the physical environment plays an important role, i.e. people in urban areas can be confronted more often with problems like traffic annoyance, air pollution and overcrowding (Garretsen and Raat, 1989).
Choosing the city as a level for the development of health policy has several advantages. It is believed that about 75% of the European population will be living in an urban area in the year 2000. Concentrating on the urban population thus affects a great part of Europe. Moreover, a number of determinants of health are just as well defined by local conditions. The scale of the local situation is a great advantage when implementing health measurements and health policy, e.g.:

- a relative small distance between the different cooperating institutions in the field;
- policy makers live close to their work, their decisions have a more direct influence on themselves and their surroundings;
- there is a relatively small government organisation making it possible to react more adequately and more sensitively to special situations;
- because of the smaller distance, the community can have more influence on local policy;
- at a local level it is often easier to combine policy and action (Hancock, 1990).

To define local health policy goals, researching the local health situation is therefore necessary.

2.2 Prerequisites for a local health policy

To be able to realise the above mentioned health targets, four essential conditions have to be met. These conditions are political commitment, an intersectoral approach, community participation and a detailed insight into the health situation of the population. These four prerequisites for a local health policy will be explained briefly below.

Political commitment
Political commitment is a basic necessity for the development and implementation of a new health policy. The local government is responsible for a policy affecting the health status of the community. This political commitment should have an intersectoral structure. Health policy is not restricted to the sector responsible for health care, but as all determinants of health are concerned, politicians outside the health care sector also have to be approached.

Intersectoral approach
As stated above, the health sector will not be able to solve the complex problems related to health on its own. Cooperation with other sectors is necessary to tackle the problems effectively.

Community participation
People must be aware of their own responsibility concerning health. This can be achieved by active participation in the development and evaluation of health policy and the search for health promoting solutions. Community participation can be realised and stimulated effectively at the level of neighbourhood or district. Cooperation between different sectors will be achieved more easily when concrete projects are carried out, with the neighbourhood as a base. Activities can be realised directly when they line up with the living situation of the people concerned. Joining activities with existing neighbourhood networks offer possibilities for operating more efficiently and getting things started with less opposition. Moreover, individual problems can be placed in a collective perspective within a neighbourhood approach (van den Bogaard et al, 1992; van der West, 1992).

Health information as a basis
Health research can give insight into the local health situation and factors influencing health. In this respect, both quantitative and qualitative information is necessary. In a review of the health situation in the four big cities in The Netherlands, Garretsen and Raat (1989) conclude that not enough empirical information is available yet, and that further research is necessary. On the one

hand it is essential that existing health information is completed to be able to visualise time trends and that information will become available for small areas and for specific population categories. On the other hand, it is necessary that data from different policy sectors is connected together.

In this context two Health For All targets are of particular relevance. Target 32 concerns research strategies to support health policy:

> *All Member States should have formulated research strategies to stimulate investigations which improve the application and expansion of knowledge needed to support their Health for All developments.*

The development of research strategies can be supported by the use of information systems, as stated in target 35:

> *Before 1990, Member States should have health information systems capable of supporting their national strategies for Health for All. Such information systems should provide support for the planning, monitoring and evaluation of health development and services, the assessment of national, regional and global progress towards health for all and the dissemination of relevant scientific information; and steps should be taken to make health information easily accessible to the public (WHO, 1985).*

This research should provide knowledge about the health status and factors influencing the health status of the population concerned. The basic tool in such research is community diagnosis (Haglund, 1983). A community diagnosis based on different data resources (epidemiological research, census data, traffic accident data, etcetera) will play an especially important role (Hancock, 1987; Conrad, 1988).

The advantages of collecting data at neighbourhood level are:

- many health related factors are geographically linked (e.g. traffic, noise, soil pollution);
- districts and neighbourhoods are regarded by local authorities as a sound basis for developing (health) policies;
- districts and neighbourhoods are often (but not always) recognizable geographical units, which may encourage participation of the local population.

Of course, collecting this kind of information has its limitations:

- the results are aggregated to the level of the neighbourhood being investigated, which means that no statements at an individual level can be made (the neighbourhood is the object of research, not the individual);
- physical health is not only influenced by local factors: the labour situation may be an environmental factor that is often situated outside the neighbourhood;

- environmental factors within a neighbourhood are not always distributed homogeneously.

2.3 Community diagnosis

Purpose of a community diagnosis

The concept of community diagnosis is not new. In the 18th and 19th century so-called medical topographic descriptions were made. Patterns of mortality and morbidity as well as important factors influencing these patterns in terms of demography, environment and lifestyle were described in quantitative and qualitative ways.
The present day community diagnosis model was introduced by Morris in Great Britain in 1957 (Morris, 1975). A community diagnosis can be defined as "the pattern of disease in a community described in terms of the important factors which influence this pattern" (King, 1966). This concept is based on the idea that health promotion and health action programs in a community should be based on the health situation of the local community. The composition of a community diagnosis will be determined by the proposed health targets. In most cases, a community diagnosis will be placed in a geographical context, that is, it will be defined for a certain type of region (e.g. health region, city, neighbourhood). The purpose of a community diagnosis is threefold: (1) describe and monitor the general state of health of the community and in this way serve as a starting point for explorative health research, (2) function as a warning system, that can identify specific health problems and (3) improve the possibilities for the evaluation of local health policy and health care (Haglund, 1983)
A community diagnosis is based on traditional descriptive epidemiology. When the health situation of a certain area has to be described, geographical comparisons can be used effectively because these comparisons:

- demonstrate high and low risk areas for specific diseases or health risks;
- provide the starting point for mapping the health situation of the population;
- can present data for different risk groups;
- can be used to discuss priorities for resource allocation;
- can be the basis for the planning and development of health policy or health programs (Haglund, 1988).

Components of a community diagnosis

When defining a community diagnosis, a combination of different information flows has to be established, in order to get an extensive description of the community. Four dimensions of a community diagnosis can be distinguished: community profile, health risk profile, health profile and health care profile.

The community profile
The community profile describes the demographic structure of a population in terms of age, sex, ethnicity and family structure.

Health risk profile
The health risk profile contains three main categories of risk factors, namely lifestyle, social and physical risk factors. The lifestyle risk factors include amongst others the use of alcohol, drugs and tobacco, dietary habits and leisure time activities. Social factors include marital status and social network. A description of the socioeconomic environment is given in terms of income, educational and occupational level of the community. Physical risk factors include the quality of air, soil and water and presence of noise nuisance in the local environment, the quality of housing and neighbourhood services. Factors like traffic safety and criminality also play an important role.

Health profile
The health profile describes the distribution of health and wellbeing in the local community. From the medical point of view objective health indicators like mortality statistics, hospital morbidity statistics, prescribed therapy and medicines are of importance. From the citizens point of view indicators of subjective health, health complaints and medicine use provide important information.

Health services profile
The health services profile provides information about the organisation, the usage and the quality of health care facilities (Haglund, 1988; Elberse and Willemse, 1987).

2.4 Epidemiology, health policy and geographic information systems

Medical geography in The Netherlands

Medical geography can be described as the discipline of geography concerned with the spatial aspects of health and health-related topics. Medical geography offers an important contribution to the knowledge of health and health-related factors. Modern medical geography began in Europe during the late 18th century. At that time, investigators described a place's health and disease related to climate and topography. The yellow-fever epidemics of the late 18th and early 19th centuries and the cholera outbreaks of the 19th century generated the first disease maps (Meade et al, 1988).

One of the most famous maps of that century was the dot map of cholera around Broad Street in London, by John Snow. The clustering of cholera in the vicinity of the water pump suggested that cholera was a water-borne disease, with the pump being the local source of infection (Cliff and Haggett, 1988).
Also in The Netherlands medical geography developed in the 18th and the 19th century. The identification of large health differences between different parts of the country stimulated this development. A growing awareness of the collective responsibility for the health situation in communities lead at the end of the 19th century to the rise in the "Hygienisten" movement (Houwaart, 1989).
Two types of geographic studies were carried out at that time. On the one hand there were descriptions of differences in one or a few aspects of health between different places. One of the most important studies to be mentioned here was the Mortality Atlas of The Netherlands, giving the mortality by municipality over the period 1841-1860. This study showed large differences in mortality in The Netherlands. Not only was data on mortality collected, but also on birth, population, taxes and geology.
On the other hand there were the aforementioned medical topographical studies, giving a detailed description of the health situation according to a standard protocol, containing several aspects of a city or region that could be relevant for the state of health (De Vooys, 1951).
Also at the urban level research was done on the differences in health between the several parts of the city. The Rotterdam physician and town councillor Ballot concluded that specific parts of the centre of the city show a high mortality rate and that population density and the low socioeconomic status of the population were of great influence (Ballot, 1873). A clear municipal policy to reduce the great differences in the social and the health situations did not exist (Van Lieburg, 1986).
Interest in geographic studies decreased with the growing insight into bacteriology. More and more, social factors were included in geographical studies. After 1880 interest in geographical studies decreased, although research was done on health differences in Amsterdam neighbourhoods in the beginning of the twentieth century (Sajet and van Gelderen, 1916; Sajet and van Gelderen, 1919). Only after the Second World War, did interest in medical geographical studies receive growing attention again. (De Vooys, 1951; Groenewegen and Hingstman, 1987).

Use of geographic information systems and health policy

The use of graphs, charts, maps and diagrams is widely recognised by decision makers as a powerful means of information exchange (Scott, 1982). Once valid information has been obtained, the task is to present and communicate the information to others (Jahoda, 1970; Bertin, 1981). The use of graphics is an optimum tool for the visualisation of complex information. Graphical information can be presented in an attractive way and can be eye-catching. Data can be presented quickly and selectively, drawing attention to what is important. Trends

in data are often easily discovered by means of graphic presentation and so too are outliers and anomalies. Spatial distributions and patterns can be readily appreciated and analyzed.
Planning and policy making is fundamentally prescriptive and the role of information therefore differs. A sound base of information from which to make projections and forecasts is generally regarded as essential for developing and justifying policies. Although planners and policy makers appreciate knowledge and information, their use of information is often selective (White, 1981). Moreover, in public policy making the role of information is often not politically neutral. Politicians, for example, will carefully select information to suit particular, normative arguments. Hence, the information is dependent upon both the technical and social context. Whilst the epidemiologist and the policy maker have a common interest in spatial information, it is important to bear in mind that the latter's prescriptive intentions for this will affect attitudes toward information techniques (Openshaw, 1981). The exploitation of these techniques does not make information more neutral, rather it may simply strengthen the prejudice by making the message more convincing.
However these value-added uses of information can only be realised if it is possible to integrate several datasets coming from different sources, and this implies the need for effective cooperation both between separate departments within local authorities and between public bodies. There is a need to create information synergy and it is here that a geographic information system can make a major contribution.
The policy activities within the local government include the preparation of plans for strategic decision making. The results include housing and urban renewal plans, traffic plans and environmental and health plans. Policy activities require information at a high level of generalisation. The information processing often has a non-standard and ad hoc character, and abstract information plays an important role. In general it can be stated that in planning activities geographic information is processed in order to support decision making.
It can be concluded that for supporting local health policy, it is necessary that results of health research are made readily available for politicians and the community. Researchers have to examine policy needs and policy makers need to know better what epidemiological results can provide. In the preceding paragraphs it has already been stated that local health policy has a vested interest in epidemiological information as a basis, that research at neighbourhood level, close to the community, is important in stimulating community participation and that a community diagnosis based on information from different sectors can strengthen intersectoral cooperation. A geographic approach seems to be a promising option.

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Chapter 3

Geographic information systems for local health policy

3.1 Essentials of geographic information systems

Introduction

A geographic information system may be thought of as a specialised form of database system, distinguished by its ability to manage geographic data. Since most modern geographic information systems incorporate analytical models, are interfaced by powerful query languages and can be used in an exploratory way to provide answers to spatial problems, they may also be thought of as geographic decision support systems (Bracken and Webster, 1990). Many of the techniques essential to the computerisation of geographic data storage and processing have enjoyed considerable development, with well-developed theory. These cover areas such as data acquisition, statistical and spatial analysis and cartography. What has happened in the development of geographic information systems is the bringing together of such techniques into a single framework which provides powerful new tools for the management and analysis of spatial data.

Four factors have contributed to the developments in geographic information systems in recent years. First, at a general level, there has been the expansion of quantitative methods in geography. Secondly, there has been the increase in the sophistication of cartographic output through the application of computer technology. Thirdly, there has been the huge increase in the quantity of geographic data available to the individual analyst. And fourthly, there have been the related developments in the theory and practice of database management (Bracken and Webster, 1990). As geographic information systems have grown in sophistication, using innovative and well-proven principles, they have become more than simple information gathering, analysis, or cartography systems. The integration of component functions gives the possibility for truly innovative geographic developments (Morrison, 1986).

The definition of geographic information system used nowadays reflects the progress gained in recent years in identifying the functional components and an appropriate system architecture for their management. Four components can be identified in the architecture of a geographic information system as described in table 3.1.1. Depending on the user type and on the functions of the geographic information system, emphasis will be on one or more specific subsystems. These four subsystems will be discussed briefly in the following paragraphs. For more detailed and extensive descriptions relevant references are included.

Table 3.1.1 Components of a geographic information system (Marble and Amundson, 1988)

Component	*Description*
Data acquisition and input	*A data input subsystem which collects and/or processes spatial data derived from different sources*
Data organisation	*A data storage and retrieval subsystem, which organises spatial data in a topologically structured form, which permits it to be quickly retrieved on the basis of either spatial or non-spatial queries, for subsequent manipulation, analysis or display. This subsystem must also permit updates to be made to the spatial database*
Manipulation and analysis	*A data manipulation and analysis subsystem which performs a number of tasks such as changing the form of the data through user-defined aggregation rules or producing estimates of parameters for transfer to external analytical models*
Report generation	*A data reporting subsystem which is capable of displaying all or selected portions of the spatial database in terms of standard reports and a variety of cartographic formats*

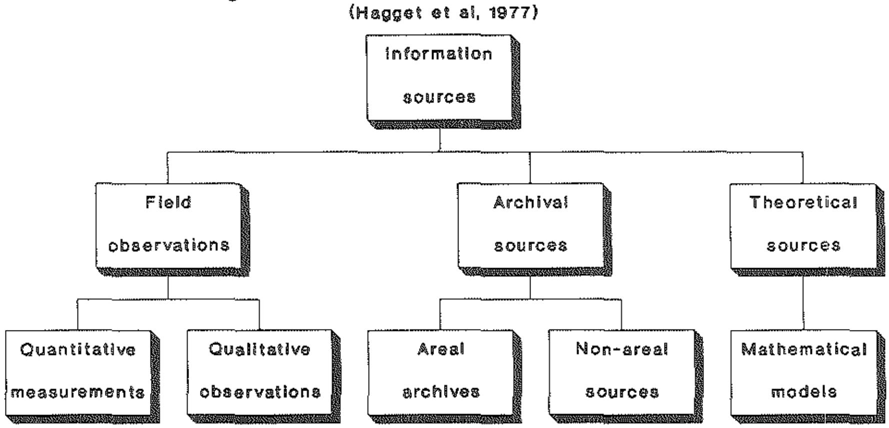
Data acquisition and input

The first steps in developing a database for a geographic information system are to acquire the data and to place them in the system. Data to be input to a geographic information system can come in a wide variety of forms and from very different sources. A broad classification of sources as given in figure 3.1.1 shows the extent to which geographic information is dependent upon secondary sources (Haggett et al, 1977). Already existing sources are likely to be the most important, which often means that the collected data is far from ideal, both in terms of spatial and temporal attributes and in the definitions of the variables themselves.

Most geographical information has both spatial and temporal attributes. The spatial unit will often be rigidly defined. In practice, the choice of a spatial base for survey information varies, often arbitrarily, and may include census enumeration tracts, grid squares or street blocks. The choice of spatial unit invariably involves judgement on the level of aggregation, and may also involve a further cost-effectiveness judgement on the part of the researcher. It is important that care is taken to choose a base which fulfils the requirements of adequate spatial detail, administrative efficiency and ease of definition. The choice of an observational base is neither simple nor neutral (Bracken and Webster, 1990). Temporal regularity raises a similar set of issues. Data may only be available for discrete intervals of time. The main difficulty is often created by the small number of observations in time. A general rule is to avoid the risk of trend analysis from too few observations. A more difficult problem is that both spatial and temporal irregularities may be present, which may interrelate (Cliff and Ord, 1981).

The above mentioned data typology of Haggett et al (1977) does not show the difference that exists between its different branches in terms of flexibility and quality of information. For example data acquired through field observations are likely to be more suited to the user's needs than data from archival sources because of the control possibilities available to the researcher. A spatially referenced data source such as a property rating register of a local authority is theoretically capable of spatial aggregation to any level of interest, but is not likely to be rich in information. In contrast, a published source of social trends may contain a large amount of valuable information, but this information will be constrained spatially to a given level of aggregation to protect individual privacy.

Figure 3.1.1. Sources of information
(Hagget et al, 1977)



From a very simple point of view two different categories of datasets can be distinguished: existing datasets and self–generated datasets. Existing datasets are those that are already compiled and available in some form, although they may require a great deal of effort to make them appropriate for a particular use. In contrast, there are many circumstances where datasets have to be generated or developed. In table 3.1.2 an overview is given of the advantages and disadvantages of both categories of datasets.

Three general points should be mentioned in this context. Firstly, at the individual level a researcher conducting his or her own survey will have a high level of control over the process of data generation. It is obvious that such an approach does not normally permit extensive geographical coverage. In contrast, the use of secondary data normally allows a more extensive temporal and spatial coverage but at the expense of being constrained by the data gathering limitations of the original sources of information.

Secondly, there are often institutional constraints. Many users of geographic information work within organisations which constrain their activity not only in terms of the task required, or the resources, but also in the form and scope of the data which can be made available. Many organisations use purpose–designed information systems to suit their particular functions and these systems often involve local specialisations. These systems normally relate to an administrative geographical area. Political and commercial restrictions may arise when data are made available to third parties. However, within organisations, data often has the advantage of temporal and spatial consistency.

Thirdly, in addition to varying levels of control over the scope and nature of the data, a similar distinction can be made concerning access to computing techniques. An individual researcher conducting a field survey may have access to a variety of data generation instruments, and be able to analyze the data with stand alone packages or write a task–specific program. There may be a wide choice over the design of databases and over analytical options. In contrast, the very extensive nature of much secondary data involving large data files often imposes both hardware and software constraints to the analyst. For example, analysis may depend upon the ease with which the data can be transferred from one system (e.g. mainframe) to another (e.g. microcomputer). Detailed technical information on the data acquisition process can be found in e.g. Bracken and Webster (1990) and Star and Estes (1990).

Data organisation

The data organisation subsystem of a geographic information system plays a central role in the overall system. The data management function makes the data available to the user, without having to learn the details of the database itself. The functions of data management are to provide a set of tools to the user, to permit the efficient use of a database and serve as the entry points to hardware and software facilities.

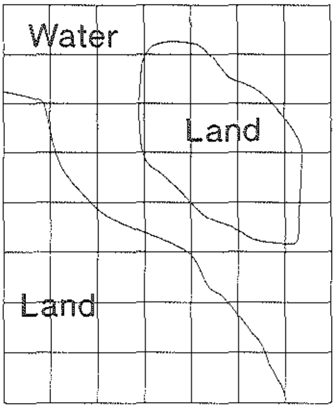
Table 3.1.2 Advantages and disadvantages using existing datasets or self-generated datasets in geographic information systems

	Existing datasets	*Self-generated datasets*
Level of control over the process of data-generation	*Low*	*High*
Geographical and temporal coverage of the dataset	*Extensive*	*Limited*
Geographical and temporal consistency of the collected data	*High*	*Low*
Political and commercial restrictions to make data available	*Large*	*Small*
Costs	*Low/average*	*High*
Hardware and software constraints	*Large*	*Small*

A database may be defined as a structured collection of information on a defined subject (Martin, 1986). A database management system is the software that permits one or more users to work efficiently with the data. The essential components of a database management system must provide the means to define the contents of a database and store, add, modify, delete and retrieve data. Designing and optimising a database management system is a complex subject, discussed in many texts (e.g. Martin, 1986).
Often, a large proportion of the data entered into a geographic information system requires some kind of preprocessing in order to make it conform to a data type, georeferencing system, and data structure that is compatible with the system. These preprocessing procedures are used to convert a dataset into a form suitable for permanent storage within the geographic information system database.

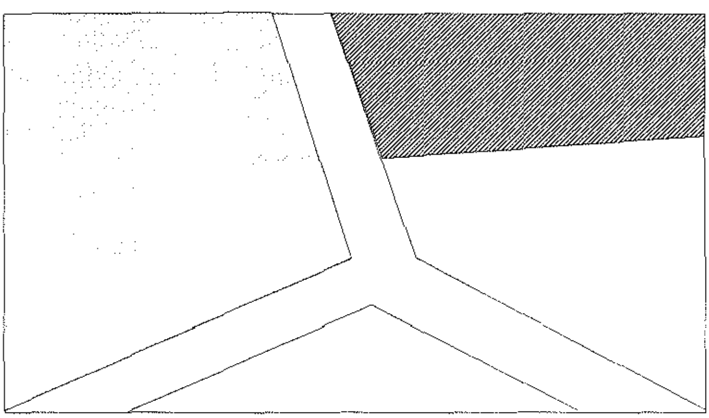
Basically, two different methods can be distinguished to organise the data in a geographic information system: the raster model and the vector model. In the raster model the surface of a map is modelled by means of a regular grid or raster placed over the map. For a spatially distributed parameter of interest, each enumeration unit (grid-cell) is given a value which represents the magnitude of that parameter in that cell. The accuracy of the modelled map depends on the chosen resolution of the raster structure (see figure 3.1.2).
In the vector approach a map is modelled by explicitly defining its component geometric entities. The data structure produced will contain three types of entity: points (e.g. a hospital), lines (e.g. roads) and areas (e.g. districts)(see figure 3.1.3). Non-topographic attributes like values of a parameter of interest or labels belonging to a point will either be stored as an integral part of the data structure or stored in a separate structure and referenced by pointers. More technical details can be found in e.g. Bracken and Webster (1990).

Figure 3.1.2. Raster structure



w	w	w	w	w	w	w
w	w	w	l	l	w	w
l	w	w	l	l	l	w
l	w	w	l	l	l	w
l	l	l	w	w	l	w
l	l	l	l	w	w	w
l	l	l	l	l	w	w
l	l	l	l	l	l	w

Figure 3.1.3. Vector structure



Manipulation and analysis

In this paragraph the focus will be on the analysis function of a geographic information system. In the manipulation and analysis subsystem three important functions can be distinguished. One function deals with spatial manipulation, the selection of observational unit and choice of the proper scale of analysis. The other two functions deal with data exploration and data confirmation.

Spatial manipulations

Frequently, the original data that is available for analysis is not quite right for the task in hand. It may be necessary to manipulate the attribute data, the locational data, or both.

In the first place, the attributes themselves may require modification. The original coding of attribute data may not be appropriate for later analysis. The categories of information in the datasets need to be modified in some way to make them appropriate for the intended use. This arises frequently with both nominal and ordinal variables. For example, the categories of alcohol use may be too detailed for a particular purpose. *Recoding* of the data is thus necessary. A more complex situation arises when working with more than one data layer. *Overlay procedures* combine two or more data layers resulting in a new data layer with the required information. For example, one data layer contains information about noise levels, and another data layer contains information on private houses. A new data layer could contain information about private houses within areas of certain noise levels. Two other techniques for developing descriptions from multiple attributes are called *supervised and unsupervised classification*. In a supervised classification multivariate descriptions of the different classes of interest are defined. For example, a certain class of deprived area can be defined in terms of unemployment, educational status, alcohol and tobacco consumption, psychosocial problems, quality of housing etcetera. Other classes are defined in a similar fashion. The geographic information system can then be used to assign all the regions in the dataset to one of the defined categories. In contrast, unsupervised classification is much like the statistical clustering procedures used in ecological studies. In unsupervised classification an attempt is made to identify different areas with the similar attribute relationships. It is then up to the analyst to determine a meaningful label for the classes. Such routines can be a good tool for summarising complex multi-layered datasets, as well as a good exploration tool, to help build hypotheses about spatial pattern and structure (Noyt-Meir and Whittaker, 1977).

In the second place, the data may not be at the right level of aggregation and/or the spatial database is at the wrong scale, which means that locational data has to be manipulated. One of the available techniques is *spatial aggregation*, involving the increase in size of the elemental unit in the database. Another spatial manipulation involves the *determination of the centroid*. A centroid is a common way to describe the "average" location of a line or polygon. It can be defined as the centre of mass of a two dimensional object. With the centroid as the location key, it is possible to find the distance between objects. Centroids may be necessary for connectivity operations, to be able to identify items in proximity to each other, for example for the selection of the location of health services. More detailed descriptions of spatial operations can be found in Star and Estes (1990), for example.

Spatial statistics

Spatial analysis ranges from simple description to model-driven statistical inference (Anselin, 1990). Put simple, techniques can be classified as exploratory (data-driven) and confirmatory (model-driven) techniques. In exploratory data analysis (EDA) the data is used in an inductive manner to gain new insights (Tukey, 1977). These inductive approaches are used to gain insight about pattern relations from the data, without necessarily having a pre-conceived theoretical notion about which relations are to be expected (Gould, 1981). This is by far the most common approach, whereby three different forms are distinguished. In the first approach, the role of the analysis is limited to pure description and indication of potentially interesting spatial patterns (Openshaw et al, 1991). In a second approach to combining EDA and geographic information systems, data is exported into a standard statistical package. The types of analysis carried out use standard EDA-tools, such as boxplots, scatterplots or Chernoff faces (Farley et al, 1990). A third approach is to link maps dynamically to other graphs. Maps, histograms and scatterplot views of the data are combined, allowing for intuitive and visual impression of the correspondence between value association and locational association, to be made.
In contrast to the recent progress in EDA, very little has been achieved in terms of confirmatory analysis. With confirmatory analysis, the point of departure is a theoretical hypothesis or model. This would include most of the traditional techniques of spatial data analysis, such as hypothesis testing, estimation of spatial models simulation and prediction. Most applications involve regression analysis, thus failing to exploit the full information on topology.

There are three ways in which the analysis function in a geographic information system can be linked to the geographic database:

1. full integration of all spatial analysis within the geographic information system software;
2. construction of modules for spatial analysis that link efficiently with the geographic information system;
3. separating the geographic information system and spatial analysis and import and export data in a common format between the two.

The first approach is basically non-existent at the moment, due to the lack of analytical capabilities in most available geographic information systems. The second approach consists of developing self-contained modules for various types of spatial analysis. These modules are linked to existing geographic information systems, and therefore limited to a particular combination of information and technique (Walker and Moore, 1988). The third approach seems to be the one most used in practice. When this occurs, it is important to be able to create an intermediate output file, so that data may be transferred to an appropriate system, one of the well-known statistical analysis packages (e.g. SPSS, SAS, MINITAB, GENSTAT, BMDP). The ability to extract data from the geographic information system in a standard format is an important consideration. There are a number of considerations in the problem of extracting data for use in other software systems. A key element of the problem is the ability to extract a specified subset of the database. Tools should be available to delimit the data of interest spatially, temporally, and by the desired attributes. Another key component is the ability to determine the specific organisation and format for the exported data.

There are a variety of statistical techniques that are common to modern geographic information systems. These techniques have value in many places in the overall information flow in a geographic information system. Whether for quality assurance during preprocessing, summarising a dataset as a data management report, or for deriving new data during analysis, several statistical procedures are commonly required.

Problems in the statistical analysis of spatially distributed data concentrate on five main issues: modifiable units and changing scale, the ecological fallacy, spatial autocorrelation, latency and mobility, and small numbers.

The modifiable units problem arises, because data may be aggregated spatially for different sized units. The difficulty is that correlation measures will generally increase as the size of the areal unit is enlarged. No general solution for this problem has emerged. Fortunately, regression coefficients appear to be more robust under scale changes (King, 1979).

The discussion above has singled out the instability of correlation measures under changes in the units of observation. Related to this is the problem of ecological fallacy. Researchers use ecological data to test and establish hypotheses about individuals and their interaction with their environment. Even when suspected associations are discovered, they must be investigated subsequently with the traditional methods of epidemiology which require examination of individual cases.

That measures of association vary with changing scale is partly due to spatial autocorrelation. The smaller the spatial unit, the greater the probability that nearby units will be spatially dependent (Tobler, 1989).

The fourth problem to be mentioned here arises because frequently there is a time lag between exposure and emergence of a disease. This problem is further complicated by population mobility and migration across the boundaries of the spatial units of analysis. Levels of mobility vary over space and imply that the reliability of any inferences that emerge from geographic epidemiological studies will be lower in areas of high mobility. Migration can in fact create misleading conclusions, real relations can remain undetected, or spurious associations will set false trails (Bentham, 1988). A study of Cohen (1992) shows that in the United States at the average 70% of people's lifetime is spent within 25 miles of their residence at time of death. Based on census data on migration an average

was expected of about 20%. For over half the US population, 90% of their lives are spent within 25 miles of their residence at time of death.
A major source of inaccuracy in spatial databases is the variable size of the enumeration districts, leading to what is called the "small number problem" (Jones and Kirby, 1980). This problem occurs whenever a percentage, ratio or rate is calculated for any geographic area for which the population of interest is sparse or the numerator is a rare event. In that case, small random fluctuations in the variable of interest (numerator) may cause large fluctuations in the resulting percentage, ratio or rate. This problem gets even stronger when the phenomenon of interest is a relatively rare event, as in the case of mortality or morbidity. Indicators of this type are often used for epidemiologic surveillance and public health planning. The problem of small numbers can be overcome by aggregation over time, space or disease type. All these methods of aggregation have disadvantages. Aggregation over time can conceal time trends, aggregation over geographic areas can conceal geographic variation and aggregation over disease type will cause epidemiologic confounding when diseases of differing etiology are aggregated. Another method is the calculation of probabilities of a given observation to occur by chance for each geographical unit. Alternative approaches include categorising percentages, ratio's or rates or excluding geographical units below a minimum population number. Methods and problems concerning spatial and small area statistics are described extensively in Kennedy (1989), Cressie (1991) and Elliot et al (1992).

Report generation

A geographic information system must include software for displaying information on a variety of output media. Three general forms of output can be distinguished. Cartographic functions should permit the production of the kinds of maps that clearly depict the spatial distribution of various kinds of phenomena. Several other (non-cartographic) graphic products can be of value when presenting results from spatial analysis. Furthermore, the ability to create non-graphic products from a geographic information system is essential. In the following sections some of the most important kinds of output products will be discussed briefly.

Maps
In table 3.1.3 an overview is given of the most important types of maps. In Cliff and Haggett (1988) a wide variety of examples of maps used in the field of health research are presented. In figure 3.1.4 examples of maps can be seen.

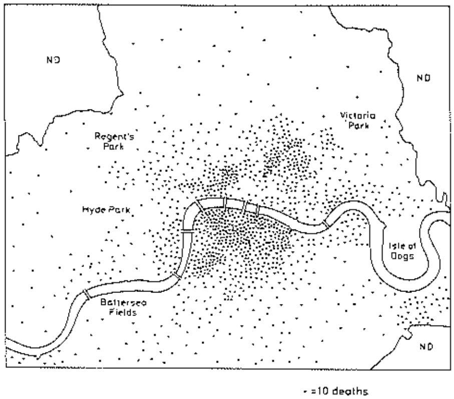
Graphics
Results of analysis from a geographic information system may be effectively displayed by means of non-map graphics. Accessible information on graphics design and presentation may be found in Tufte (1983) and Meilach (1986). Both volumes present examples of quality graphs that were intended to convey

information efficiently. An overall guiding principle of graphics presentation is that a graphic must be able to stand alone: if a great deal of explanation is required to be able to understand the graphic, its design or construction has not been successful.

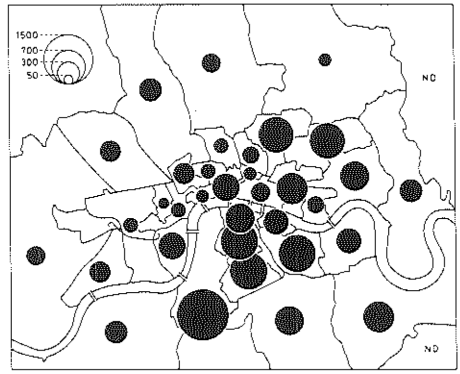
Non-graphical products
Firstly, there should be a variety of statistical procedures built into the system, so that any number of descriptive reports about the data can be produced. Secondly, there must be ways to extract the data from the system, when the desired numerical or statistical operations are not available in the geographic information system.

Table 3.1.3 Overview of the most important types of maps

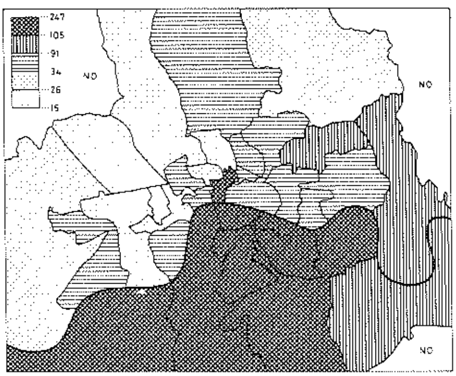
Type of map	*Description*
Dot map	*Dot maps depict spatial distribution by varying numbers of uniform dots. Each dot represents the same amount of a given value. Similar to these maps are maps with proportional circles, where the area of the circles on the map is proportional to the value of the displayed phenomenon. One difficulty with the proportional circle method is that the ordinary observer tends to underestimate the size of the larger circles in relation to the smaller ones.*
Choropleth map	*Choropleth maps are typically used to communicate the relative magnitude of continuous variables as they occur within the boundaries of unit areas. The areas are predefined in that they represent existing boundaries. Choropleth methods are best used for data which fall into well-defined groups or classes.*
Isopleth map	*Isopleth maps are used to represent locations of equal value, and to emphasise gradients among the values. Isophlets run continuously across a map and therefore imply that the data upon which they are based also vary continuously over the map surface.*
Isodemographic basemap	*In an isodemographic base map the areal extent of the districts is proportional to the population size of the district rather than to its geographical area.*
Perspective block diagram	*A method of representing a three-dimensional distribution is by drawing a perspective block diagram. But, while block diagrams are extremely useful as devices for obtaining a rapid impression of the characteristics of any surface, they are weak analytically, because it is difficult to read off exact values from the diagram.*



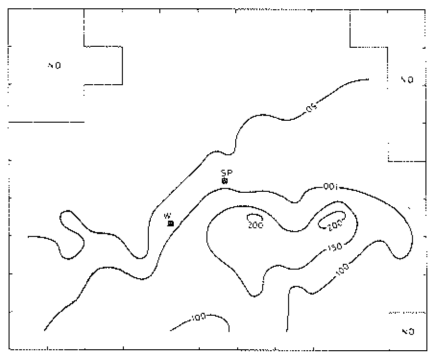
Dot map



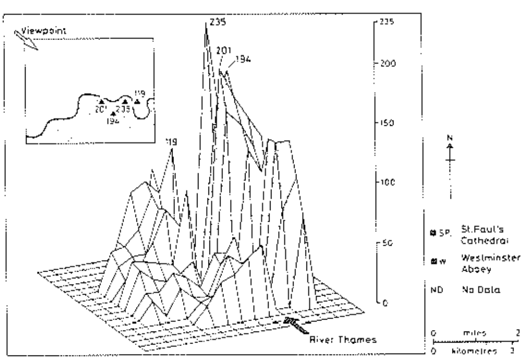
Dot map



Choropleth map



Isopleth map



Perspective block diagram

Figure 3.1.4 Examples of different types of maps

3.2 Geographic information systems for public health policy at the local level

Categorisation of users for local geographic information systems

The type of information to be produced with a geographic information system is highly dependent on the kind of user. Within an organisation there are many different tasks, all with different information needs. Different types of users place different demands on a geographic information system and by following the user–needs approach, the type of spatial analysis required from a geographic information system can be defined. In this way, it is possible to explore the criteria that must be met to be effective in a wide range of policy–analytic situations. Four main groups of users can be distinguished, all of them having specific requirements for spatial information (Scholten and van der Vlugt, 1990).
The *information specialists* comprise a group of users who tend to be more focused on technical, methodological and developmental issues than on applications in decision making environments. The main problems that are dealt with are the application of advanced statistical and mathematical methods to the processing of data material.
Researchers preparing policy studies often work closely together with information specialists, although as software and hardware have improved and have become more powerful, the distinction between these two groups may become less pronounced. Instead of specialising in methods and techniques, workers in the field of applied research are more involved with policy preparation in a specific area of spatial planning.
The task of *policy decision makers* is the evaluation of policy options, and information supplied by research is but one of a number of factors in this process. The growing awareness of geographically determined problems and the increasing complexity and amount of spatial data means that there is an increasing need for a decision supporting environment for these users. A necessary condition for the creation of this environment is that the information and intelligence supplied to the decision makers and the rules for evaluating alternatives should be uncomplicated, unambiguous and easily understood as policy makers can better use their skills and time in analytical decision making rather than with the complexities of automation technology and statistical and mathematical methods.
The fourth group comprises *interested citizens, pressure groups, special interest groups and various social (local oriented) organisations*. The members of this group are characterised by a need to be kept informed continually about issues involving demographic structure, physical and social environment and health. It is believed that there is a large potential demand for information systems in which the most important up–to–date information on these topics is made available. It is in this field that geographic information systems could contribute effectively in enhancing the democratisation of decision–making.

Geographic information systems for public health policy

The importance of geographic information systems has risen sharply over the last few years, both in the academic field and in governmental organisations. Notwithstanding this large-scale interest, the possibilities of geographic information systems remain largely unexplored in the field of public health. Much spatially referenced health related data is generated, collected and analyzed, but the capabilities and potential of geographic information systems to aid in these processes has only been applied on an ad hoc basis (Rhind, 1987; Drury, 1987). The quality and specific characteristics of routinely collected health data might be contributory factors to the lack of development in geographic information systems in this field. Furthermore, the lack of spatial detail and spatial consistency between the various datasets has restricted their applicability within geographic information systems (Twigg, 1990).

Health policy is conducted at different governmental levels. The global level is covered by organisations like the WHO and its regional offices. At the national level the responsibility of public health affairs lies within the national ministries of public health. At the local and regional level, municipalities are responsible for certain aspects of public health within their own region. Although each level might deal with the same field of interest, a considerable difference in policy can be found between these levels. In essence, this is a consequence of the different scale of observation, related to the size of the area of responsibility.

The World Health Organisation is concerned with policy making on a global scale, studying global trends and promoting new policy programs. Geographic information systems are used at this level to clarify differences between different member states in the aspects of the health situation. These insights can be used to support new global or continental strategies on health. One example to be mentioned here is the Health For All database of the European Regional Office. This geographic information system makes it possible to gain insight into several health indicators per country in Europe (WHO, 1992). However, one of the great difficulties at this level is collecting the required data in a comparable way.

At the national level information is needed regarding the national health situation and health care provision. The National Institute of Health and Environment has compiled Regional Health Profiles for each of the 65 public health regions in The Netherlands. The purpose of these profiles is to provide health information to local politicians for directing intervention and research programs in their own region (Bloemberg et al, 1992).

Local public health services are concerned with health care planning, health promotion and epidemiological research in their own region. They not only need to have insight into the health situation of the total region, as displayed by the Regional Health Profiles, but as described in chapter two, local authorities also have several reasons for demanding information at a low level, such as the neighbourhood level. A geographic information system delivering policy information at the neighbourhood level can support health policy makers. Using a geographic information system makes it relatively easy to locate districts with health problems and to identify factors which may be related to these health problems. This information could be important for local health policy. The data amassed can be put to various uses, one of which is giving an impression of the general character of a community and its amenities in relation to the living conditions and state of health. Sometimes a general description is required, but it is also possible to focus attention just on one particular aspect. The indicator function is also very important: the geographic information system may indicate whether there are health threats that have hitherto gone unnoticed. Instead of waiting and seeing, or simply responding to the actions of worried local inhabitants, problems are actively sought out. Another possible use is to analyze the relationship between the state of health of the population and the various characteristics of the neighbourhood they live in. The effect on public health and welfare can be examined for specific environmental factors as traffic, the availability of recreation facilities or the quality of housing. Urban geography is another possible approach, allowing differences to be established and examined between inner-city and peripheral neighbourhoods, of long-established and modern areas of the town. The effects of specific environmental factors on public health and welfare can be explored. The provision of facilities in a community is very much bound up with the relationship between the extent of the care facilities there and the degree of health and wellbeing. The results of such searches will be passed on to one or more of the following authorities:

- other departments of the local health authority, especially in connection with actions by other executive departments if the results relate to lifestyle;
- other local governmental services and councillors. The system provides a basis for intersectoral policy;
- central government in cases when a local government's powers are exhausted or exceeded, for example in the case of variations in the quality of public health due to socioeconomic factors.

Policy makers and managers find it useful to have health data indexed on urban areas, since it is generally easier to form policies at a local level than it is to aim them at risk groups that are often rather inaccessible. A local geographic information system not only addresses local authorities but also a number of other interested organisations: hospitals, district nursing organisations, general practitioners, and other workers in the field. Other local authority departments, such as the police, public housing, town and country planning and traffic planning can also be interested in this type of information. By making this information available to a wider range of authorities, the local health authority would hope to stimulate intersectoral policy making.

Characteristics of a geographic information system for public health policy at the local level

Within the local government three activities can be distinguished in which spatially referenced information plays an important role: technical, administrative and policy activities.
The technical activities deal with the physical aspects of the built environment. They fulfil design, building and installation tasks and are responsible for control and maintenance. In this environment geographic information systems have to be able to produce detailed, high precision technical maps. The systems have to support the daily operations of the department.
The administrative activities include the management of large databases that are necessary for the legal and fiscal management tasks of a municipality. These base systems deal typically with the registration of population, landownership, real estate and public institutions.
The policy activities within the local government include the preparation of plans for strategic decision making. Typical products are for example housing and urban renewal plans, traffic plans, environmental plans and health promotion plans. Policy activities require information at a higher level of generalisation than management activities. The information processing often has a non-standard and ad hoc character, and abstract information plays an important role.
Because of the multi-functional role of local authorities, and because of the need to use information for operational (administrative functions), managerial (control functions) and strategic (planning-related functions) purposes, the issues which surround information collection and use in local authorities are very complex. In some cases there are many potential users and uses within a local authority and the information collected has to be capable of being delivered to these various users in the right form and at the right time to meet their particular needs.
Taking account of this diversity of activity, and the need to plan, it is possible to identify certain main information requirements. Local authorities need many different types of information: for example, they need regular information relating to social, health, demographic, economic and land-use conditions; the availability of resources; and the needs and aspirations of the community. Most local authority activities are carried out on varying geographical units. Information is needed about each area in a form which meets the needs of particular service managers or the elected representatives involved. To meet these needs, information has to be available at a small area level, to be capable of flexible use and capable of being integrated with other data sources. The data also has to be capable of being integrated to other areas for which it may be required. Characteristics of information systems for local policy support are summarised in table 3.2.1.

Geographic information systems in the field of health research and public health policy have in general three main functions: monitoring and evaluation, policy formulation and planning and research.

The monitor function of a geographic information system comprises the continues mapping of indicators of health and health related factors, in order to signal public health problems and health problem areas. In this way a geographic information system can be used to show spatial patterns in public health. The evaluation function comprises ways to evaluate the effects of policy interventions.
When health problem areas have been identified, alternative approaches to solutions need to be developed. A geographic information system may serve in drafting the consequences of alternative scenarios. The understanding of the geographical distribution of health problems can be important for the allocation of health care provisions.
The third main function of a geographic information system is the research function. The collected data can be used to explore spatial associations between indicators of health and health related factors.
There are several issues which must be addressed if geographic information systems are to be successfully implemented in local government. Firstly, the strategy to implement geographic information systems must be policy–led, not process–led or technology–led. Concern with why the local health authority is doing what it is doing and its impact on health is far more important than examining the current administrative processes or what current technology will allow. Furthermore, it is essential to adopt a corporate approach if a certain degree of synergy between dataflows is to be realised. Although a corporate approach is more or less essential, it should not be confused with central control. Central control of information is perceived as being unresponsive and expensive. Decentralised control of information, within a centrally coordinated framework of standards is regarded as the most valuable approach. For the implementation of geographic information systems it is essential that a convention on locational referencing is adopted centrally and that rules on the use and updating of the basemap are accepted decentrally.

Practical problems

Geographic information systems to support public health policy tend to be built on existing secondary data sources, both registrations and health surveys. This means that they are susceptible to all the problems of such sources.

Lack of spatial detail
In official health statistics, there is a general lack of spatial detail. Many of the health registrations are set up for administrative and management purposes, not requiring detailed geographical information. Most published health data is reported at a high level of aggregation. For example, cause specific mortality statistics in The Netherlands are only published at the municipal level (at least for the larger cities, for smaller municipalities mortality figures are only published in an even higher aggregated form). The request for the systematic monitoring of health and health care within small geographic areas has largely

been ignored (Twigg, 1990). It should be noticed that privacy aspects often interfere with this request.

Table 3.2.1 Characteristics of information systems for local policy support

1	*The information system should be able to provide the information required, but should avoid both information overload and information starvation*
2	*The information has to be available to be used selectively and used to measure progress towards planning objectives*
3	*The information system should be able to provide information on a small area basis but should also have the flexibility to produce information about other spatial units which are of interest to the organisation*
4	*The system must be capable of holding or generating past and current information to allow time-series analysis*
5	*The system should contain forecasting or simulation modules to enable trend extrapolation and policy testing*
6	*The data held must be of defined quality*
7	*The information system must be capable of being integrated, because of the multi-functional nature of local government. Policy development requires that actions across a broad range of functional areas are coordinated often within spatially defined communities*
8	*The information must be capable of displaying or presenting information in a manner which aids the understanding of spatial distributions and spatial patterns at a variety of geographic levels and for a wide variety of users*

Spatial inconsistency

It is not only the lack of spatial detail, but also spatial inconsistency between the various sources of information that is a problem. Due to the fragmented nature of health services provision, the geographical characteristics vary strongly. When research tasks are multi-faceted, as is the case with the compilation of health profiles, and depend on many sources of information, the integration or linkage of data is a difficult task. Not all local institutions involved may use the same geographical division of districts and neighbourhoods. To solve this problem, some way of data conversion will be necessary by means of aggregation of the data to a higher level. This aggregation will cause loss of information, and is not even always possible, when geographical boundaries do not coincide or they shift over time.

Information quality
One of the main worries concerns the quality of information in the system. If good data can help to form good policy, dubious data may lead to dubious policy. Data has to be collected from existing sources and hence the quality of the information depends on the quality of the sources of information. Moreover, when depending on secondary sources, the available information may not always be the most useful indicator. Important sources are health surveys in which only a limited number of health topics can be handled. In addition to this, this data is only collected for a certain age group.

Technical problems
Technical problems arise mainly at the stage of data–collection. Institutions may use different codes for the same areas or the same codes for different areas. Spatial data is not always collected in automated registrations, in which case data entry will be necessary. Not all institutions use compatible hardware and/or software, which may lead to data transfer problems.

It can be concluded from this chapter that geographic information systems offer opportunities for several groups of users. This is true as well for the support of local public health policy, although several practical problems have yet to be overcome.

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Chapter 4

Design of the Rotterdam Local Health Information System

4.1 Collecting health information at a local level*

Introduction

The development of a Rotterdam Health Information System has its origins in the action program 'Health for All by the Year 2000', initiated by the World Health Organisation (WHO). The thirtieth World Health Assembly resolved in 1977 that:

> *'The main target of governments and WHO in the coming decades should be the attainment by all citizens of the world by the year 2000 of a level of health that will permit them to lead a socially and economically productive life'*

In 1984 the 'Health for All' strategy for Europe was further developed: the European Regional Committee of the WHO defined 38 specific targets for its region (WHO, 1985). These targets cover a number of areas for special attention, one of them being the provision of support for health development.
Targets 32 and 35, closely related as they are, are of particular relevance in this context. Target 32 concerns research:

> *All Member States should have formulated research strategies to stimulate investigations which improve the application and expansion of knowledge needed to support their Health for All developments.*

Research should provide knowledge about health and health related factors. The development of research strategies can be supported by the use of information systems, as stated in target 35:

> *Before 1990, Member States should have health information systems capable of supporting their national strategies for Health for All. Such information systems should provide support for the planning,*

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* ***Garretsen, H.F.L., Gilst, E.C.H. van, Oers, J.A.M. van. Collecting health information at a local level. Health Promotion, 2, p121–133, 1991***

monitoring and evaluation of health development and services, the assessment of national, regional and global progress towards health for all and the dissemination of relevant scientific information; and steps should be taken to make health information easily accessible to the public (WHO, 1985).

This target refers to the setting up of health information systems at a national level. Information is needed on issues like lifestyle, preventable risks, services provided (including those outside the official health care system), patterns of claims on the service and so on. Information is also needed on health promotion and health related issues from other sectors.

In 1985, the Regional Office of the WHO in Europe initiated the Healthy Cities Project, as its contribution to the Health for All program (WHO, 1987). The Healthy Cities Project focuses specially on those areas in Europe, where big cities are situated, because the expectation is that in the year 2000 about 75% of all Europeans will live in big cities. A methodological attempt is made to improve the health status in these big cities. The effect is based on an ecological approach with consideration for environmental factors, lifestyles, health care and biological factors influencing health.

It is often easier to pursue relevant health policies at an urban level. Many factors are determined by local circumstances and therefore differ from town to town. Also good community involvement can be achieved faster at a local level than at regional or national levels. For these reasons the Healthy Cities Project makes the availability of a local health information systems highly desirable (van den Bogaard et al, 1989).

The Epidemiology Department of the Municipal Health Service for Rotterdam area has developed such a health information system (van Oers et al, 1988). Here this system will be discussed in detail. Hereby attention will be given to the aims and the design of the system, and some general results are presented. Finally, the possibilities and limitations of the system as far as health policies and the stimulation of community involvement are concerned, will be discussed.

Aims and design

Aims

The Rotterdam Local Health Information System (REBUS) is designed as a continuous information system for the health situation in Rotterdam. This means that as far as possible and useful all data are collected yearly, to make longitudinal comparisons possible.

The central aims of the information system are as follows:

- monitoring the health situation and related factors in the city of Rotterdam at district and neighbourhood level;
- contributing to the development of a local health policy to reduce the noted differences in the health situation of the population.

Linking quantitative and qualitative information
The information system contains data relevant to health. This is to say, not only information on health itself is collected, but also on health related issues from other sectors.
Presently, information is collected from various sources, which can be categorised as follows:

- data on mortality and morbidity, statistics from social institutions, and statistics covering health related areas like housing, employment, leisure time activities;
- data collected from the population itself by means of questionnaires and health surveys;
- documentary information (gathered from the local newspapers and limited-circulation leaflets);
- ideas and views of key informants of the community as expressed in personal interviews, group discussions or in questionnaires.

In short, the system is a collection of quantitative data (numerical material from various statistics and health surveys) linked with qualitative information (with emphasis on content: underlying information derived from documentation, key informants, etcetera).
The first resource for qualitative information includes articles on health and health related factors which are published in local newspapers and newsletters. These often yield very specific information about the community.
The second resource consists of key informants. Key informants are persons who are supposed to be well informed on the health situation in a specific neighbourhood. Because they live or work in a specific neighbourhood, representatives of residential organisations and interest groups, officials connected with the allocation of housing, educationists, local policemen, general practitioners, social workers or health visitors are included. Three methods are available for obtaining information from key informants: (1) personal interviews, (2) group interviews and (3) postal questionnaires with open questions.

Qualitative information makes it possible to account for, illustrate and, if necessary, supplement purely statistical findings. In addition, it can provide triggers for organising activities and mobilising the population. Combining research methods can also be a way to neutralise inherent errors and avoid the bias of one particular method. The qualitative and quantitative data collected will be integrated as far as possible in an analysis and interpretation phase which will be treated at a two-year interval.

Collecting data at district and neighbourhood level
Epidemiological information is normally given per group of the population: the mortality rate for males of a particular age-group or for a particular occupation, for example. The data in REBUS is different, however; it is are related to the average number of deaths or the number of hospital admissions per 10.000

inhabitants in a particular part of town. Thus it is not information at an individual level we are dealing with, but information at the level of geographical units. Indicators at this aggregated level can be corrected (standardised) for factors such as the age distribution of the population in the relevant areas, but the object of research is the community, not the individual. The advantages of collecting data at neighbourhood level are:

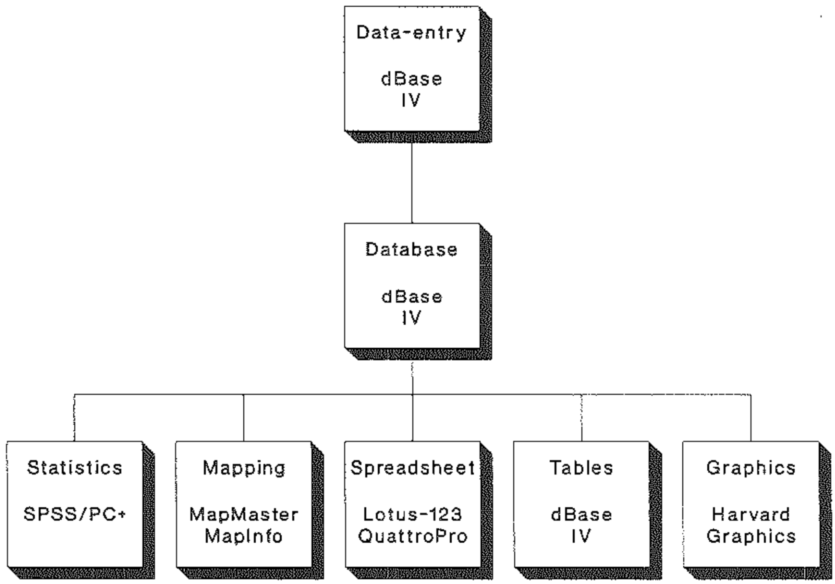
- much information is already being recorded at this level in Rotterdam;
- many health related factors are geographically linked (e.g. traffic, noise, soil pollution);
- districts and neighbourhoods are regarded by local authorities as a sound basis for developing (health) policies;
- districts and neighbourhoods are often (but not always) recognisable geographical units, which may encourage participation of the local population.

Furthermore, data registered in the different neighbourhoods is defined in the same way, which increases their comparability.
Of course, a collection of information of this kind has its limitations:

- the results are bound up to the neighbourhood investigated, which means that no statements at an individual level can be made. (the neighbourhood is the object of research, not the individual);
- physical health is not only influenced by local factors: the labour situation may be an environmental factor that is often situated outside the neighbourhood;
- environmental factors within a neighbourhood are not always distributed homogeneously.

The structure of the information system
For collecting this type of information a database management system was set up consisting of a central database connected with a number of utility programs. Figure 4.1.1 is a schematic representation of the construction of the information system.
All data are stored in the central database and can be accessed in various ways with the help of a range of software. The information stored includes geographical features and relevant data of the particular district or neighbourhood. The software used for the central database is dBase IV, which allows also figures to be collated (by neighbourhood, or per year, for example). Large scale statistical analyses can be accomplished with SPSS/PC+ and the program MapMaster makes it possible to create maps with data from the central database, to present information geographically.

Figure 4.1.1. Structure of the database management system REBUS



Review of the data collected

Dimensions of the health situation
The importance of these variables is primarily the availability of parameters on health status at neighbourhood level. In order to make sensible epidemiological statements about risk factors, these variables will be frequently used as dependent variables. REBUS includes, amongst others, mortality rates, the prevalence of certain infectious diseases, perception of health, a list of health complaints, psycho-social problems and assessment of the help needed by the patient. The sources used include local health surveys conducted by the department itself, figures of the Netherlands Central Bureau of Statistics (mortality) and other documents provided by the Public Health Service (for instance the prevalence of infectious diseases).

The presence and use of health care
Besides (perceived) health and need for assistance, the availability of facilities, the use people make of them and their opinion of the care they receive, is also important. Sources are local health surveys and data from official agencies.

Lifestyles
Lifestyles may be of direct influence on health. Data on the abuse of alcohol, tobacco, illicit drugs, sedatives, sleeping pills and other medicines, not to mention dietary habits and the amount of exercise taken, is collected. Sources are local health surveys and data from official agencies (such as the police, the health services, etcetera).

Social environment
Data on the social environment includes a number of important factors, such as educational level, occupation, income, unemployment, marital status, political participation and mobility. Sources are local health surveys and information from local authority research departments.

Physical surroundings
All factors in the neighbourhood that may influence health are of importance. The system contains many indicators concerning people's living conditions: level of services and accessibility, information on housing (the age and number of houses, types of houses), information on urban renewal and property development, public parks and gardens, industry, traffic and transport, and ecological data related to the pollution of soil, water and air, and noise. Sources are various local government offices.

Results

In this paragraph some general results will be presented for the health situation as well as for determinants of health (lifestyle, social environment, physical environment). First however, some demographic data will be presented.

Demography
Rotterdam has about 600.000 inhabitants. The age distribution of the population of Rotterdam is clearly different from that of the rest of The Netherlands. In Rotterdam, there is a relatively larger population of older people. More than 17% of the population is older than 65 years. This is almost 5% higher than the national average. The percentage of very old people in Rotterdam (4.4%) is also higher than that in the rest of The Netherlands (2.9%). The picture is precisely the reverse for the younger age groups. Rotterdam now has a lower percentage of young people than the rest of The Netherlands. The most recent population prognosis for Rotterdam (van Zundert, 1989) predicts however, that the trend towards a larger older population will stop and that more young people will live in the city. The percentage of younger people in Rotterdam is increasing. At the turn of the century, it is predicted that the percentages of both older and younger people will be higher than those in the rest of The Netherlands.
Nationally, roughly 4.5% of the population belongs to an ethnic minority, in Rotterdam, this is 18%. Turks (25%), Moroccans (15%) and Surinamese (35%) make up the largest part of this population (van Zundert, 1989). The age

distribution of this population includes a higher percentage of very young persons in relation to the national population. Roughly 64% of the persons belonging to an ethnic minority, as opposed to 40% of the persons in the population of The Netherlands as a whole, are younger than 30 years. The proportion of ethnic minorities in the Rotterdam population will increase to about 25% at the turn of the century. The distribution of ethnic minorities in the city of Rotterdam is given in figure 4.1.2.

Health

Mortality rates are strongly influenced by differences in age distribution of the populations under consideration. These differences are corrected for through standardisation with regard to age distribution. After standardisation, the mortality rates for men in Rotterdam are significantly higher than those for the Dutch population as a whole. For women, these rates are in the area of the mean for The Netherlands. A similar picture is obtained for the two most important causes of death, that is, coronary and vascular diseases, and cancer (van Oers and Teeuwen, 1990). These two groups of diseases account for about 70% of the total mortality.

When mortality rates are analyzed per neighbourhood, there appear to be differences between neighbourhoods for both males and females (van Oers, 1987; van Oers and Teeuwen, 1990). The results of this analysis are given in the figures 4.1.3 and 4.1.4. These results are given in the form of schematic maps of Rotterdam. In figure 4.1.3, the shaded areas (based on division of the city into 83 neighbourhoods, as done by the Netherlands Central Bureau of Statistics) indicate the distribution of the standardised mortality ratio (SMR) for men, the city average being given as 100. An SMR of less than 90 indicates a relatively low mortality rate and a SMR of more than 110 indicates a relatively high mortality rate.

In a number of cases, the differences between neighbourhoods can be attributed to the presence of a nursing home in the neighbourhood. This is not true for a number of older downtown neighbourhoods. Here, a high mortality is found even in the absence of a nursing home.

Statistics about infectious diseases exist per neighbourhood for tuberculosis and hepatitis A. The presence of tuberculosis and hepatitis A is caused to an important degree by import from non-Western countries. This importation occurs via three groups of people: tourists returning from non-Western countries, seafarers, and migrants returning from visits to their families. A relatively larger number of these illnesses is seen in neighbourhoods in which a higher percentage of migrants live.

Figure 4.1.2. Percentage foreigners per neighbourhood

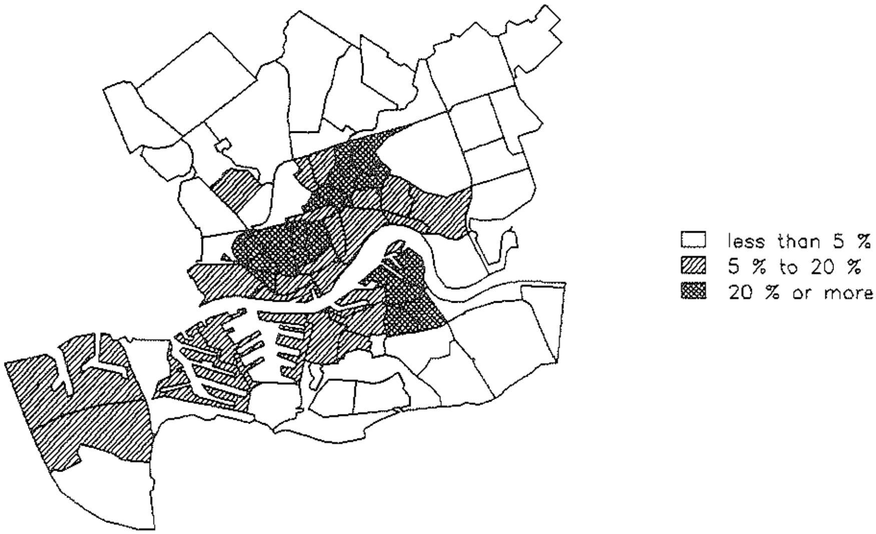
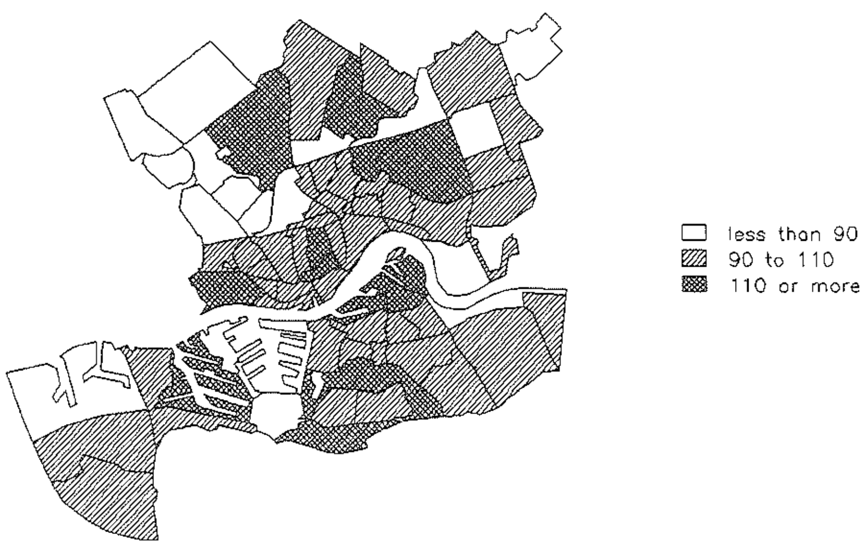


Figure 4.1.3. Standardized mortality ratio (SMR) for males



In a survey carried out in Rotterdam, no differences between neighbourhoods were found with regard to the use of such services as visits to the general practitioner or specialist, or admission to the hospital (Reelick, 1988). There were, however, differences found in whether persons had considered obtaining help with psychological problems. The older downtown areas of Rotterdam in particular had high scores on this item.
Another theme included in the survey was how people perceived their own health. It was found that most people in Rotterdam who were questioned considered that they were in good health (72%). There were no differences between neighbourhoods on this item. Rotterdam scored lower on this item than The Netherlands on the average (nationally, 81% consider themselves to be in good health).

Lifestyle
People's lifestyles have a great influence on their health. A number of goals that have been formulated in the context of the Healthy Cities Project are related to lifestyle and the encouragement of healthy behaviour. The term lifestyle includes such items as the use of alcohol and tobacco, nutrition, sport, behaviour in traffic and violent behaviour. Lifestyle is also related to socioeconomic status and other personal factors.
A survey showed that four out of five people living in Rotterdam drink alcohol. The majority drinks in moderation. In such cases, drinking cannot be considered to be a health threatening behaviour. This is the case, however, when drinking is combined with taking certain medicines or driving. There are more health risks when drinking is excessive. The number of excessive and very excessive drinkers constitutes roughly 9% of the respondents and appears to vary per neighbourhood (Reelick, 1988), as can be seen in figure 4.1.5.
In contrast to the use of alcohol, smoking can be damaging when done even in a small degree. Lung cancer, bronchitis, asthma, emphysema, and coronary and vascular diseases are all related to smoking. The percentage smokers in each neighbourhood of Rotterdam is shown in figure 4.1.6. As in the case for alcohol use, the use of tobacco varies by neighbourhood. It is notable that the same neighbourhoods in which many people have considered obtaining psychiatric assistance are also those in which many people drink and smoke excessively. The fact that many young single people live in these neighbourhoods may play a role in this.

Social environment
A possible cause of the unequal distribution of health lies in the social environment, including such factors as socioeconomic status. Various national and international studies show that a lower health status is related to a lower socioeconomic status. Factors playing a role are education, occupation, income, worksituation, and living conditions (Garretsen and Raat, 1989). Unemployment is one of the variables recorded in the REBUS project. In 1987, there was 22% male unemployment and 19% female unemployment in Rotterdam. There are considerable differences between neighbourhoods. The older central city

neighbourhoods have the worst statistics in this regard. The unemployment problem is considerably less severe in the suburbs of Rotterdam (GBOS, 1987) (figure 4.1.7).
Further research has shown that those Rotterdam neighbourhoods with a mean lower socioeconomic status have a higher mortality than neighbourhoods with a higher socioeconomic status (van Oers and Teeuwen, 1990). The percentage unemployment, the percentage of persons receiving benefit and the percentage 17 and 18 years old receiving education were used as indicators of socioeconomic status in this analysis. After correction for residents of nursing homes, the relationship was about the same for males and females.

Physical environment
Physical as well as the social environmental factors mentioned above can influence health. Physical environmental factors include quality of housing, facilities in the neighbourhood, traffic and environment. A clear indicator of housing quality is difficult to give, but factors like the construction year, the available living area, and the presence of a shower or bath play an important role. The percentage of houses without bath or shower is given per neighbourhood in figure 4.1.8. The older neighbourhoods on both the north and south bank of Rotterdam have large numbers of houses without bath or shower. The percentages in these neighbourhoods exceed 30%.
Traffic is an important factor with regard to quality of living and safety. It is not only the number of traffic accidents but also the noise and air pollution and the taking up of (in many cases) scarce space that cause problems. Rotterdam has a good record with regard to the number of traffic accidents in relation to other large cities.
The quality of the environment is a subject of great importance for many people and, partially in relation to health, deserves a great deal of attention. A part of the environmental problem is not bound to neighbourhood, urban or even national boundaries. Other parts, such as noise and soil pollution are strongly bound to a single location so that a collection of data at a local level does make sense. In 1987, nearly 5000 environmental complaints were registered in Rotterdam. More than 53% of these complaints were concerned with smell and more than 30% with noise nuisance. In figure 4.1.9, the number of noise complaints per 10.000 inhabitants per neighbourhood is shown. It is obvious that large numbers of these complaints were registered in neighbourhoods near the harbour and industrial areas. It is notable that there were also high complaint percentages on the northern edge of the city (near Zestienhoven, the airport of Rotterdam) and in a number of the central city neighbourhoods.

Figure 4.1.4. Standardized mortality ratio (SMR) for females

Figure 4.1.5. Excessive alcohol use per district

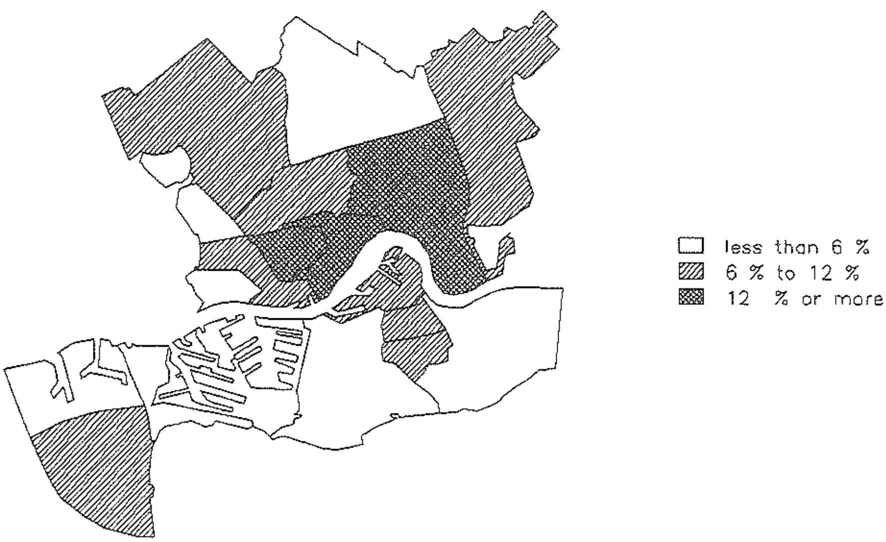
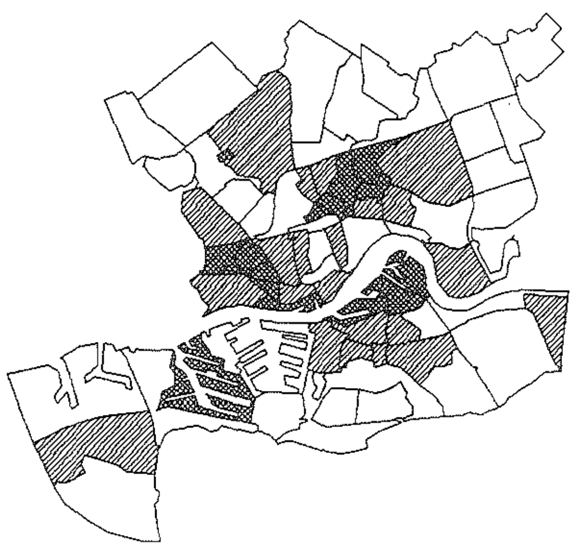


Figure 4.1.6. Percentage smokers per neighbourhood

less than 38 %
38 % to 43 %
43 % or more

Figure 4.1.7. Percentage unemployment per neighbourhood



less than 15 %
15 % to 30 %
30 % or more

Figure 4.1.8. Percentage dwellings without shower or bath per neighbourhood

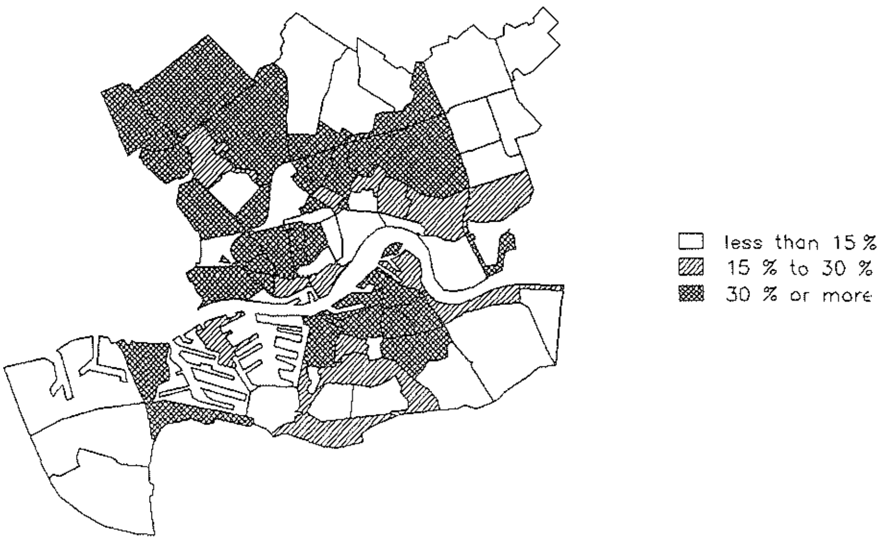
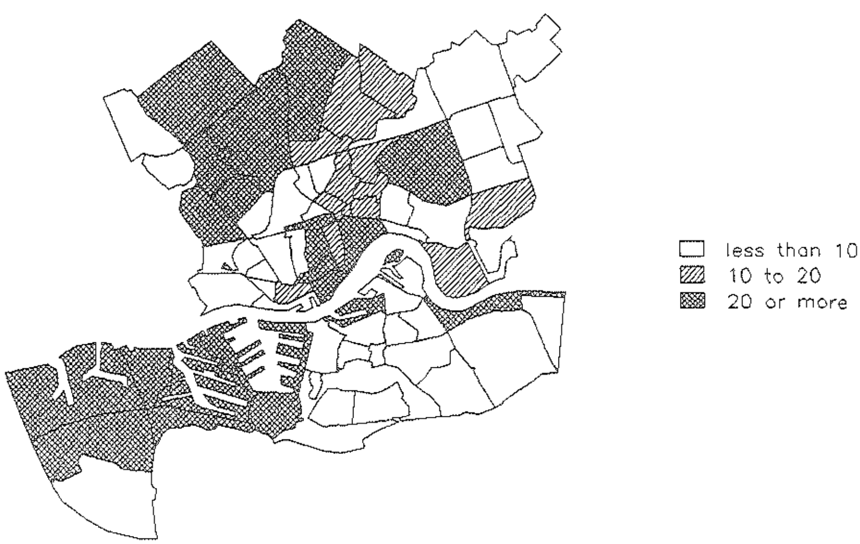


Figure 4.1.9. Number of noise complaints per 10.000 inhabitants



Conclusion

Health situation

From the above presented material it is clear that Rotterdam differs greatly from the average values in The Netherlands with regard to the population structure. These differences naturally have an effect on the health situation. Rotterdam has more older residents and more ethnic minorities. Stereotypical ideas of the problems of old people or the problems of the ethnic minorities must, however, emphatically be avoided. Several of the many processes involved in health have been discussed above. The statistics show that there are considerable differences between neighbourhoods. The differences in mortality can partially be explained by the presence of nursing homes, but socioeconomic status plays an important role. There are also differences between neighbourhoods with respect to many other factors, as, for example, the degree to which people have considered getting help with psychosocial problems High percentages on this factor are found particularly in those neighbourhoods where single young people live.
It is precisely because of the breadth of the information collected by REBUS that a detailed picture of the health of the residents of Rotterdam and the factors influencing it can be obtained. On the basis of this information recommendations can be made to improve the health in a planned way.

The information system as a policy instrument

The data amassed can be put to various uses, one of which is giving an impression of the general character of a community in relation to the living conditions and state of health. Sometimes a general description is required, but it is also possible that attention is focused only on one particular aspect: e.g. the nature and extent of alcoholism in a community in relation to the different types of drinking establishments in the area. Emphasis may be placed either on numerical data or on qualitative information.
The indicator function is also very important: the information system may indicate whether there are health threats that hitherto have been unknown. Instead of waiting and seeing, or simply responding to the actions of uneasy local inhabitants, problems are actively looked for.
Another possible use of REBUS is to analyze the relationship between the state of health of the population and the various characteristics of the neighbourhood they live in. In this case, the unit of research is the community, not the individual.

The effect on public health and welfare can be examined for specific environmental factors as traffic, the availability of recreation facilities or the quality of housing. Urban geography is another possible approach, allowing differences to be established and examined between inner-city and peripheral neighbourhoods, the northern and southern banks of the River Meuse, of ancient and modern areas of town. The effects of specific environmental factors on public health and welfare can be explored. The provision of facilities in a community is very

much bound up with the relationship between the extent of the care facilities there and the degree of health and wellbeing.
The results of such searches will be passed on to one or more of the following authorities, as appropriate:

- other departments of the local health authority, specially in connection with actions by other executive departments if the results relate to lifestyle;
- other local governmental services and councillors. The system provides a basis for intersectoral policy;
- central government in cases when a local governments' powers are exhausted or exceeded, for example in the case of variations in the quality of public health due to socioeconomic factors.

Policy makers and managers find it useful to have health data arranged according to urban area, since it is generally easier to give form to policies at a local level than it is to aim them at risk groups that are often rather inaccessible. REBUS not only addresses local authorities but also a number of other interested organisations: hospitals, auxiliary nursing organisations, general practitioners, and the national health service. A health service that is open to market forces needs information about supply and demand on that market. REBUS will be able to supply that need. Interest in this type of information has also been shown by other local authority departments, such as the police, public housing, town and country planning and traffic planning. By making information from REBUS available to a wider public, the local health authority hopes to stimulate intersectoral policy making.

Community involvement
The community oriented approach of the information system offers the chance to encourage community involvement and community participation. Epidemiological information might well be the catalyst that activates people's interest in public health objectives. Most research deals with individuals, whose behaviour is to some extent health threatening; REBUS deals with groups of people living in one and the same area. Basically, such neighbourhood information is highly suitable for stimulating groups in the population, especially when neighbourhoods are compared with each other.

If REBUS is really get to work in the fields mentioned above, it must become better known in the urban communities. This involves the health education department of the Municipal Health Service. What also needs to be worked out further, is a good definition of 'participation'. Central government cannot account for all the improvements desired, but it can encourage groups, societies and perhaps even small 'business-units' to do as much as possible. REBUS is a way of passing information from the local government of Rotterdam to the people of Rotterdam who are prepared to commit themselves to improve their city.

4.2 Quantitative indicators for a healthy city: The Rotterdam Local Health Information System*

Introduction

In 1977 the 30th World Health Assembly formulated a new general target for the WHO and its member states. This target implied that by the year 2000 all citizens of the world should have attained "a level of health which will permit them to lead a socially and economically productive life". This was followed in 1984 by the adoption of the European Regional Committee of 38 specific regional targets (WHO, 1985). At the same time the European Regional Office initiated the so-called "Healthy Cities Project", which aims to make a contribution to health promotion in urban areas. One of the 38 targets aforementioned is that of conducting research for health (WHO, 1987). This research should provide knowledge about the health status and factors influencing the health status of the population concerned. Community diagnosis based on different data resources (epidemiological research, census data, traffic accident data, etcetera) will play an especially important role (Hancock, 1987; Conrad, 1988). As in several other European countries, a number of cities in the Netherlands show interest in the Healthy Cities Project. At the moment 17 cities are united in a Dutch "Network of Healthy Cities". One of these is the city of Rotterdam.
In Rotterdam the Healthy Cities Project is part of a bigger project called "Social Renewal" (van den Bogaard et al, 1989; Commission "Social Renewal, 1988). The purpose of this project is to improve the living condition among the disadvantaged. Public Health is considered to be of major importance in this project. In the project efforts are made to lessen the rate of unemployment, to improve health services and disease prevention and to stimulate research to obtain more information on health and on factors related to health. A fundamental part of this research is the development of a local health information system. This system is set up by the section Epidemiology of the Municipal Health Service for Rotterdam area. In this system information is gathered on health status, the health care system, lifestyles and the social and physical environment. Using the information system it is possible to obtain insight into the health situation of Rotterdam and in the several districts into which the city is divided. In this way the local government can be advised on measures to improve the health situation of the disadvantaged.

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The REBUS project

REBUS (Rotterdam Local Health Information System) is meant to be a continuous health information system. This means that as far as possible and realistic, the database will be updated annually. REBUS has two main targets:

- the monitoring of health status and factors related to health of the citizens of Rotterdam at district or neighbourhood level;
- aiding the development of a local health policy that reduces differences in health status (van Oers et al, 1988).

In the first stage of the project, the information collected is mainly quantitative, but in a later stage qualitative information will also be gathered. The qualitative stage is still under development. In this paper we will restrict ourselves to quantitative data collection.
Rotterdam is divided into districts, which are subdivided into neighbourhoods. Data collection will take place at neighbourhood and district level. Advantages of this method of data collecting are: (1) many health related factors are related to a district or neighbourhood (e.g. traffic, noise, soil pollution), (2) much health care in the Netherlands is organised on a district of neighbourhood level, and (3) a neighbourhood forms in many cases a recognisable geographical and social unit which can promote community participation.
In REBUS the following data are collected:

Data on health status
This means mortality and morbidity figures. Mortality figures are obtained from the National and the Municipal Bureaus of Statistics. Morbidity figures are currently collected by means of health surveys. From these surveys data on subjective health, mental health, use of health care services and specific health complaints are gathered. Methods to collect data from general practitioners, mental health institutions, hospitals etcetera are being developed.

Data on health risk factors
"Health risk factors" are not only concerned with lifestyle factors as smoking, alcohol consumption and sports. Aspects of the physical environment as housing quality, pollution and amount of traffic are also implicated. Data on lifestyles are collected by means of health surveys; health risk factors from the physical environment are collected from regional and municipal authorities.

Socioeconomic and demographic data
Socioeconomic and demographic data which are collected are sex, marital status, education level, age, unemployment and occupational level. Some of these data are collected by means of health surveys, others are collected from the National and Municipal Bureaus of Statistics.

These data are collected to obtain an overall picture of the health state of the inhabitants of the several districts and neighbourhoods of Rotterdam and of the factors which are related to their health. In order to give a more specific picture of REBUS some data on health status are represented here. Mortality figures and an example of morbidity figures in the form of data on mental health are shown. In these examples the data will be represented at district level.

Two examples of data on health status

Mortality figures
Data on mortality by cause of death are collected by the National Bureau of Statistics. These data are available for the whole Rotterdam area, but not at the level of district or neighbourhood. They are used to compare overall mortality and cause specific mortality for Rotterdam and for the Netherlands as a whole. Data on total mortality also are collected by the Municipal Bureau of Statistics, and are available at neighbourhood level. These data are used for the analysis of total mortality at neighbourhood level. Mortality figures are of course influenced to a large extent by the age distribution of the population under study. Thus when analysing mortality figures it is necessary to correct for the differences in age distribution between the index-population (eg, the population of a district) and the reference-population (eg, the population of Rotterdam). Standardisation is a commonly used method, and a distinction must be made between direct and indirect standardisation. Direct standardisation, using the age-specific mortality of the indexpopulation, results in a Comparative Mortality Figure (CMF). Indirect standardisation, using the age-specific mortality of the reference-population, results in a Standardised Mortality Ratio (SMR). The standardised mortality ratio is subject to less random error than the CMF and it can be calculated without knowledge of age-specific mortality figures of the index population. On the other hand standardised mortality ratios of different index populations can not be compared with each other, but only to the reference-population. Large differences between standardised mortality ratio and CMF are seldom found in practice (Rothman, 1986).
Direct standardisation, resulting in a comparative mortality figure, is used for a comparison of Rotterdam with the Netherlands. Because no age-specific mortality data are available at district level, calculation of mortality figures at a district level in Rotterdam is done by using the indirect method, resulting in a standardised mortality ratio. Calculations are made over the period 1983–1987, for males and females. A CMF/SMR-value below 100 indicates a lower mortality, a CMF/SMR-value above 100 indicates a higher mortality than the mean value for the reference population.
After standardisation the mortality for males was shown to be higher than the average in the Netherlands (CMF-males=111,2). For females the mortality was more or less the same level as in The Netherlands (CMF-females=98,2).
Standardised mortality ratio values were calculated for each district in Rotterdam using the total of deaths in 1983–1987. In this way, random effects because of a low number of deaths are avoided as far as possible. The geographical distribution of the values is shown in figure 4.2.1. In a number of cases high

values were found in districts where one or more nursing homes are located. These nursing homes have a predominantly female population and the female standardised mortality ratios values in these districts are above 105. As can be seen in figure 4.2.1, other factors besides the presence of nursing homes, can contribute to increased mortality in certain districts. Some socioeconomic and demographic characteristics of the districts with an increased mortality are shown in table 4.2.1.
From this figures it can be calculated that those districts showing high percentages of unemployed and poorly educated people also show high mortality rates.

Morbidity figures: data on mental health status
Another example of health data collected in REBUS are data on mental health. Information on this is collected using health surveys. Health Interview Surveys have been carried out in the United States for some time, examples being the RAND Corporation Health Insurance Experiment (Ware et al, 1979) and the Health Interview Survey (DHEW, 1979). An overview of health (interview) surveys can be found in the report "Feeling the Nation's Pulse" (Kars-Marshall, 1983). In The Netherlands a health interview survey is held every year (CBS, 1988). In Rotterdam local health surveys were begun in 1983 (Garretsen and Wierdsma, 1984) and mailed questionnaires rather than interviews are used.
From 1987 onwards health surveys have been held yearly in Rotterdam (Reelick, 1988). These surveys are part of a larger survey in which several municipal departments in Rotterdam take part. Every department sends in questions about subjects which are relevant to them. The epidemiology section of the Municipal Health Service for Rotterdam area is one of the participants in this large survey, with questions on subjects as subjective health, somatic complaints, visits to the general practitioner, seeking help for mental problems etcetera.
The questionnaire is sent to a random sample of 3.000 citizens in the age group of 16 to 70 which have the Dutch nationality (from 1988 the age range has been extended to 16 - 75 years). The response on the 1987 survey was 63% (n=1891) and is representative of the Rotterdam population, with respect to age, sex and socioeconomic status.
Mental health was measured by the 'Affect Balance Scale' which was developed by Bradburn in 1969 (Bradburn, 1969) and translated and adapted for the Dutch population by Ormel (Ormel, 1980). It is a short (8-item) but valid and reliable instrument to obtain a global indication on the prevalence of mental health problems in a population. The scale measures two concepts, 'pleasant feelings' and 'unpleasant feelings'. Only the second concept was analyzed because the 4 items which measured this concept turned out to be the most valid. As an indication of the prevalence of mental health problems a cut off point was established, based on other research in The Netherlands in which the scale was used. To get an indication of how to interpret the differences between districts a stepwise logistic regression analysis with four independent variables (districts, age, sex, and marital status) was carried out. On the basis of this analysis differences between districts due to differences in age, sex and marital status

could be corrected by means of direct standardisation (Holt and Smith, 1979; Rosenbaum, 1987). In figure 4.2.2 the prevalence of people who score above the cut off point in the 17 districts is shown. These are the results before correction by direct standardisation. However the differences between the districts remain significant after standardisation. Some socioeconomic and demographic characteristics of the districts with a rather high prevalence of mental health problems are given in table 4.2.1. From these characteristics it may be assumed that these districts are characterised by rather high percentages of unemployment (with one exception, district A) and high percentages of single (not married, divorced, or widowed) people. This last result may be an indication of problems of loneliness. After weighing for differences on age, sex and marital status (direct standardisation) the percentage of people with psychosocial problems lowered in the districts A and B. This means that in these districts marital status may play a role in the genesis of psychosocial problems. In the other districts unemployment may play an important role.

Table 4.2.1 Socioeconomic and demographic data of some Rotterdam districts

	District A	*District B*	*District G*	*District K*	*Total Rotterdam*
Inhabitants					
0 - 19 years	*2102*	*10269*	*10003*	*7098*	*127294*
20 - 34 years	*5644*	*13880*	*12154*	*6775*	*151244*
35 - 64 years	*5580*	*12485*	*12855*	*7742*	*196769*
65 years or older	*2681*	*3730*	*5790*	*2423*	*98993*
Marital status					
Married	*34%*	*32%*	*35%*	*36%*	*42%*
Single	*49%*	*54%*	*48%*	*49%*	*42%*
Divorced	*10%*	*10%*	*9%*	*9%*	*7%*
Widowed	*7%*	*5%*	*7%*	*5%*	*8%*
Education low	*50%*	*65%*	*77%*	*78%*	*71%*
Education high	*50%*	*35%*	*23%*	*22%*	*29%*
Unemployed	*15%*	*30%*	*32%*	*39%*	*20%*

Discussion

Because REBUS is a system in which data on health status, data on health risk factors and socioeconomic data are collected, it is relatively easy to locate districts with health problems and it is also relatively easy to identify factors which may be related to these health problems. This information could be important for local health policy. The information obtained from the REBUS project will make it possible in the future to see if and in what way specific health policy is desirable for a certain district. Even at present, and in spite of the fact that the REBUS data are rather crude and global, they already have an influence on the local health policy.
An example is given by districts G and K in the figures 4.2.1 and 4.2.2. The mortality rates and the high percentage of people with psychosocial (and other health) problems in district K led to discussions with citizens and local politicians. These discussions played an important role in choosing this district as one of the target areas for the "Social Renewal Project" mentioned above. This means that in this district a concentrated effort is made to improve the social and health condition of the inhabitants. In district G the health professionals and the inhabitants themselves developed plans in discussion with the representatives of the Municipal Health Service on the basis of the results mentioned in figure 4.2.1 and 4.2.2. These plans are directed towards an improvement of ambulatory mental health services and towards discussing the institution of preventive programs to influence lifestyle factors such as smoking and alcohol consumption. These examples show that even now data from REBUS can influence local health policy.
However, the coming years will be especially important in the plan to increase the influence of REBUS on local health policy. On the one hand more specific research is needed, for instance research on factors which may explain the high percentage of people with mental health problems in certain districts. On the other hand more attention should be paid to the political and social relevance of REBUS data. To ensure this, several project groups are formed, working on specific neighbourhoods or districts. In these project groups researchers, representatives of several municipal departments and people working in health care participate. In this way it is hoped to make REBUS scientifically and politically as relevant as possible.

All in all, the prospects are good that the REBUS project will able to give a good picture of the state of health of citizens in Rotterdam, to gain insight into the differences in health between different districts and finally to learn something about the factors which influence health and differences in health. However, to reach these targets, a number of problems must be overcome. Three main problems arise when collecting data from several municipal and regional institutions.
First, not all the institutions involved use the same geographical division of districts and neighbourhoods. Therefore in a number of cases some way of data conversion has to be devised before the data are suitable for REBUS. Second,

data are at present collected from existing sources, and hence the best useful indicators are not always obtained. Third, not all institutions use compatible hardware and/or software, which leads to data transportation problems. Furthermore the sources of information for morbidity are limited and will remain so in the near future. The most important sources at present are health surveys in which only a few health topics can be handled. These data are only collected for a particular age group (latterly 16 to 75). Another limitation is that the two most important immigrant groups (Turks and Moroccans) are not part of the sample.

Interpreting the results, a few things should be kept in mind. The results are on neighbourhood or district level, so statements about individuals cannot be made. Furthermore, not all health related factors are related to a neighbourhood (eg, labour conditions) or are homogenously distributed over a neighbourhood. Also, the problem of small numbers might appear when areas like districts or neighbourhoods are compared, because of small population figures. The aggregation of data over a longer time interval may alleviate this problem somewhat. Finally some caution is required in the interpretation of results from health surveys as a measure of health as such. There is of course a strong correlation between perceived health and health diagnosed by a general practitioner or specialist, but there is not a one to one relation between the two. So in the future it will be essential to work towards an expansion of the different sources of data on health. Data from general practitioners and from mental health organisations are specially important in this respect. Furthermore the data from the health surveys must necessarily be broadened. Only in these ways will the optimal use of REBUS be possible.

Figure 4.2.1. Standardized mortality ratio (SMR) for males and females per district

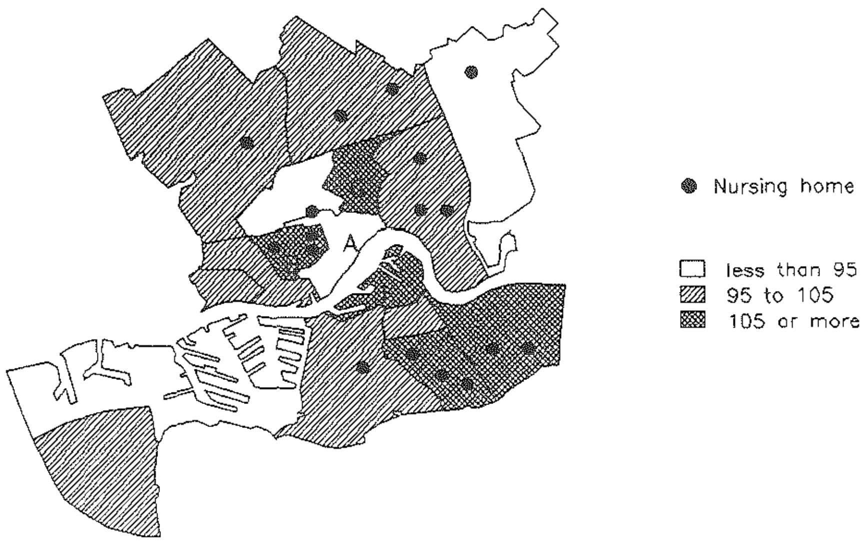
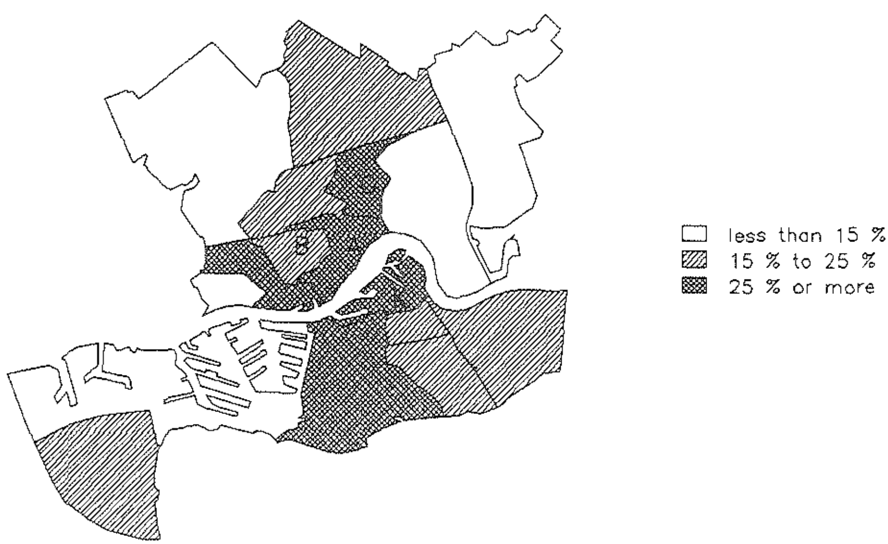


Figure 4.2.2. Prevalence of mental health problems per district



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Chapter 5

Applications of the Rotterdam Local Health Information System

5.1 How healthy is the Rotterdam population?*

Introduction

Rotterdam is working on the future. Under the motto "The New Rotterdam" the City Council has planned a new course in many areas. The Council has also decided to develop a new strategy in the field of social renewal. Public health is one of the areas which should be included in the process of social renewal. The publication of the memorandum "The New Rotterdam: a Healthy City" marks one of the first concrete manifestations of social renewal in Rotterdam (van den Bogaard et al, 1989).

Present developments in the health care policy for Rotterdam are guided to a large extent by the Healthy Cities Project of the World Health Organisation. This project focuses on large urban regions in Europe since it is expected that in the year 2000 75% of the European population will live in large cities. The idea is to approach the problem of improving health conditions in these cities in a planned way. This will be undertaken from the ecological point of view, focusing not only on health but also on various factors that determine health such as living conditions, lifestyle and health care. Rotterdam considers the Healthy Cities Project to be a pillar of its health policy for the future. The major points of this new policy are to decrease existing inequalities in health and to improve the quality of life in Rotterdam (van den Bogaard et al, 1989).
One of the activities being carried out by the Municipal Health Service for Rotterdam area to support this policy is the Rotterdam Local Health Information System (REBUS). The purpose of REBUS is to catalogue health and health–related factors in Rotterdam at the neighbourhood level. In this manner, a broad

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insight into health conditions and the factors that influence these condition can be obtained. Data are collected on physical surroundings (e.g. traffic, environment, quality of housing), social environment (e.g. socioeconomic status, unemployment, marital status), lifestyle (e.g. smoking, alcohol consumption, nutrition) and health care. Both quantitative and qualitative data are collected. This is a continuous process, i.e. as far as possible and worthwhile, the data in the database will be updated annually. In 1988 the first REBUS data collection for the year 1987 was completed (van Oers et al, 1988). Only quantitative data was included since the collection of qualitative information is still in the experimental stage. Investigations are in progress to determine the most effective method for the collection of qualitative information.
On the basis of the first set of data it can be stated that there are marked differences between neighbourhoods or districts in Rotterdam in mortality, morbidity and health, lifestyle, social environment and physical environment. The most important differences will be discussed briefly below.

Demography

Rotterdam has about 600,000 inhabitants. The age distribution of the Rotterdam population is clearly different from that in the Netherlands. Rotterdam has a relatively large elderly population, more than 17% are over 65 years of age. This is almost 5% more than in Amsterdam and Utrecht (14% and 16%, respectively) but lower than in The Hague (19%). The percentage very old inhabitants in Rotterdam (4.4%) also exceeds the national percentage (2.9%). For the younger age categories, the pattern is just the opposite. At present the percentage young people in Rotterdam is lower than the mean for the Netherlands. However the most recent population prognosis for Rotterdam (van Zundert, 1989) predicts that ageing of the population will stop and that "de-ageing" will begin. In addition the percentage young people in Rotterdam will increase. By the end of the century, the population of Rotterdam will include a higher percentage of young people but also a higher percentage of elderly than the mean Dutch population.
At the national level, about 4.5% of the population belong to an ethnic minority group. In Rotterdam almost 18% of the population is part of an ethnic minority. People from Turkey (25%), Morocco (15%) and Surinam (35%) form the largest groups (van Zundert, 1989). In comparison with the total population, these minorities represent a very young population. About 65% of the ethnic minority groups are younger than 30 years of age versus only 40% of the total population. Around the end of the century, ethnic minority groups will represent about 25% of the population in Rotterdam.

Health

The health of a population can be described by means of health indicators. A review of this data was published by Garretsen and Raat (1989). Mortality data have long been considered an important source of information but data on disease, use of health care facilities and the subjective health go a long way toward completing the picture of health. Within the framework of the REBUS project an attempt has been made to collect data on all of the above-mentioned aspects at the neighbourhood level. Several examples will be given below.
Mortality data are markedly influenced by differences in age distribution of the populations under consideration. By means of standardisation of the age distribution, correction for these differences can be applied. In comparison with the Netherlands as a whole, mortality in Rotterdam after standardisation is significantly higher for men and about the same for women (table 5.1.1). The pattern is similar when the two most important causes of death -cardiovascular diseases and cancer- are studied (van Oers and Teeuwen, 1990). These two causes of death are responsible for about 70% of all deaths.
When mortality data are analyzed according to neighbourhood, it appears that differences in mortality occur within Rotterdam for both men and women (van Oers, 1987; van Oers and Teeuwen, 1990). The results of this analysis are depicted in figures 5.1.1 and 5.1.2. In a number of cases, but not all, the differences found can be explained by the presence of a nursing home in the neighbourhood. In a number of other cases the differences in mortality found are not as easily explained; presumably such factors as socioeconomic status, physical environment and lifestyle play a role.
In addition to total mortality, also the distribution of deaths due to cancer and to cardiovascular diseases was investigated within the city of Rotterdam. For reasons of privacy these data are not reported at the neighbourhood level but always represent a combination of several neighbourhoods. As in the case of total mortality, the mortality due to cardiovascular diseases and cancer was increased in a number of neighbourhoods without a nursing home, which might otherwise have explained the results obtained (van Oers and Teeuwen, 1990). In figures 5.1.3 and 5.1.4 the geographic distribution of deaths due to cancer is shown. A clear-cut pattern cannot be found here. Data on infectious diseases also provide an insight into health conditions. Information is available about tuberculosis and hepatitis-A at the neighbourhood level. The occurrence of tuberculosis and hepatitis-A can be ascribed to a large extent to import from non-western countries. The diseases are imported predominantly by three groups: tourists to non-western countries, seamen and migrants returning from visits to their families. A relatively larger number of cases of these infectious diseases are found in those neighbourhoods with a higher percentage of migrant workers.
With respect to the use of health care facilities it can be stated that as far as visiting the general practitioner, consulting a specialist and hospital admissions are concerned, a survey carried out in Rotterdam revealed that there are no differences between neighbourhoods (Reelick, 1988). There was however a

difference between neighbourhoods in thinking about seeking help for psychosocial problems. The older centre city neighbourhoods scored especially high in the above-mentioned survey. The fact that young single men and women often populate these neighbourhoods may possibly play a role in this respect.
The subjective health was another theme explored in the survey. In this connection it appeared that most of the respondents have a good subjective health (72%); differences between neighbourhoods could not be demonstrated. In comparison with the national mean, the score for Rotterdam was lower than the national figure (81%) and also lower than Amsterdam (78%) and The Hague (76%) (Reelick, 1988).

Lifestyle

The lifestyle of people has an important influence on their health. A number of aims that were defined within the framework of the Healthy Cities Project also involve lifestyle and the promotion of healthy behaviour. Lifestyle includes such aspects as smoking, alcohol consumption, nutrition, sport and exercise, behaviour on the road, aggressive behaviour, etc. And lifestyle is directly related to such aspects as socioeconomic status and other individual-related factors.
The survey showed that 4 out of 5 Rotterdam inhabitants (between 16 and 70 years of age) drink alcohol, most of them in moderation. In such cases there is not a problem of health-threatening behaviour. But this certainly is the case when drinking coincides with taking medicine or before participating in traffic. When drinking is excessive, more risks occur. The number of heavy to highly excessive drinkers represented about 9% of the respondents and appears to vary per neighbourhood (Reelick, 1988).
In contrast to alcohol consumption, it can be stated that smoking even small quantities can be bad for one's health since it can lead to such conditions as lung cancer, bronchitis, lung emphysema and cardiovascular diseases. The number of smokers per neighbourhood in Rotterdam is shown in figure 5.1.5. As in the case of alcohol, smoking also seems to vary per neighbourhood.

Social environment

A possible cause of inequalities in health is the social environment, which includes the socioeconomic status. Several national and international studies have demonstrated that those who have poor health often also have a lower socioeconomic status. Factors that may play a role in this respect are education, occupation, income, working conditions and living conditions (Garretsen and Raat, 1989).
Unemployment is one of the variables which is included in the REBUS project. In 1987 unemployment in Rotterdam was 22% for the male and 19% for the female working population. A study of the distribution throughout the city shows considerable differences between neighbourhoods, excessive values being found

for the older centre city neighbourhoods in particular. The problem of unemployment is much less important in the outskirts of the city (GBOS, 1987).
Further studies have revealed that in Rotterdam mortality is higher in neighbourhoods with a lower average socioeconomic status than in neighbourhoods with a higher socioeconomic status (van Oers and Teeuwen, 1990).
As indicators of socioeconomic status, unemployment percentages, the number of individuals eligible for compensation and the number of 17 to 18-year-olds receiving education can be used. The relationship, after correction for the presence of nursing homes, appeared to be about the same for males and females.

Table 5.1.1 Standardised total mortality (SMR) in Rotterdam for all ages and for 0 to 64-year-olds using the Netherlands as reference

	male		*female*	
	SMR all ages	*SMR 0 - 64*	*SMR all ages*	*SMR 0 - 64*
1978	*103.3*	*104.4*	*98.7*	*107.0*
1979	*108.5*	*112.4*	*100.1*	*109.0*
1980	*106.3*	*109.9*	*101.5*	*110.6*
1981	*106.2*	*109.3*	*99.0*	*100.6*
1982	*105.5*	*105.2*	*102.8*	*117.0*
1983	*104.2*	*104.2*	*99.9*	*108.6*
1984	*107.7*	*123.1*	*95.2*	*111.3*
1985	*109.5*	*118.2*	*97.0*	*105.0*
1986	*102.1*	*109.2*	*99.3*	*108.1*
1987	*106.0*	*110.8*	*97.9*	*124.5*

Physical environment

Like the above-mentioned factors of the social environment, the physical environment can also influence health. The physical surroundings refer to the quality of housing, facilities in the neighbourhood, traffic conditions and environment. A single indicator for quality of housing is difficult to define, but the year of construction of the building, the available living space or the presence of bath or shower play an important role. In figure 5.1.6 the percentage houses without a bath or shower is shown per neighbourhood. In the majority of the neighbourhoods built after 1940, almost all of the houses have a bath or shower.

Figure 5.1.1. Standardized mortality ratio (SMR) for males

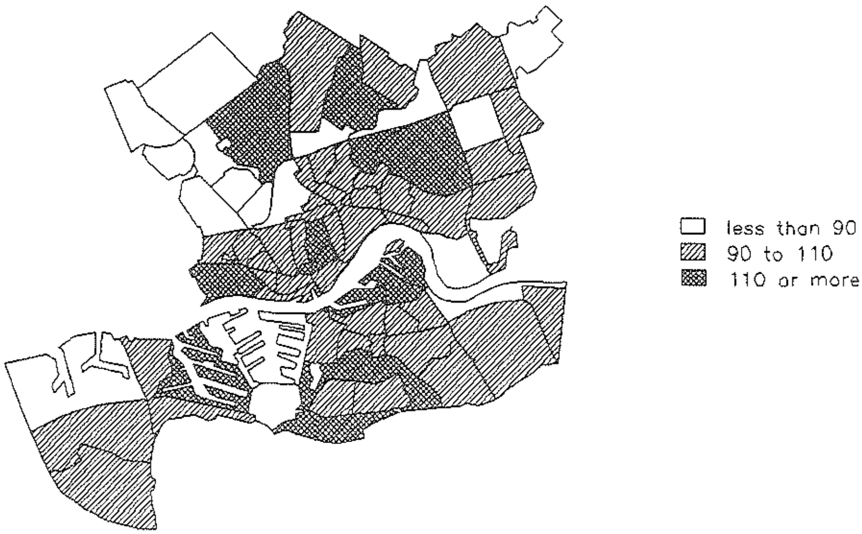


Figure 5.1.2. Standardized mortality ratio (SMR) for females

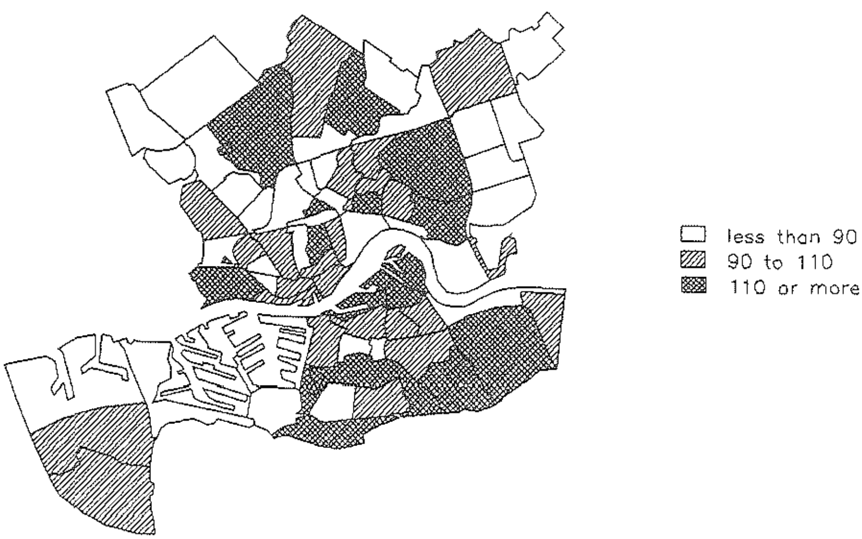


Figure 5.1.3. Standardized mortality ratio (SMR) males; cause-of-death cancer

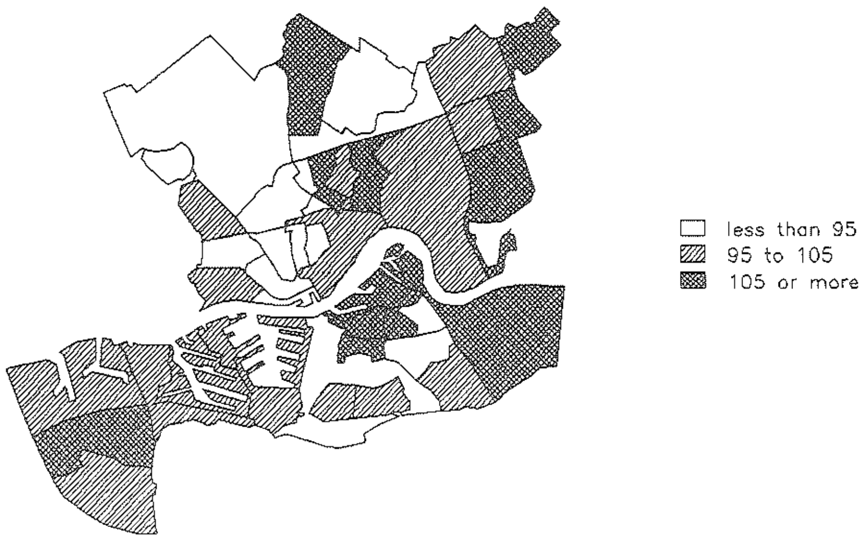


Figure 5.1.4. Standardized mortality ratio (SMR) females; cause-of-death cancer

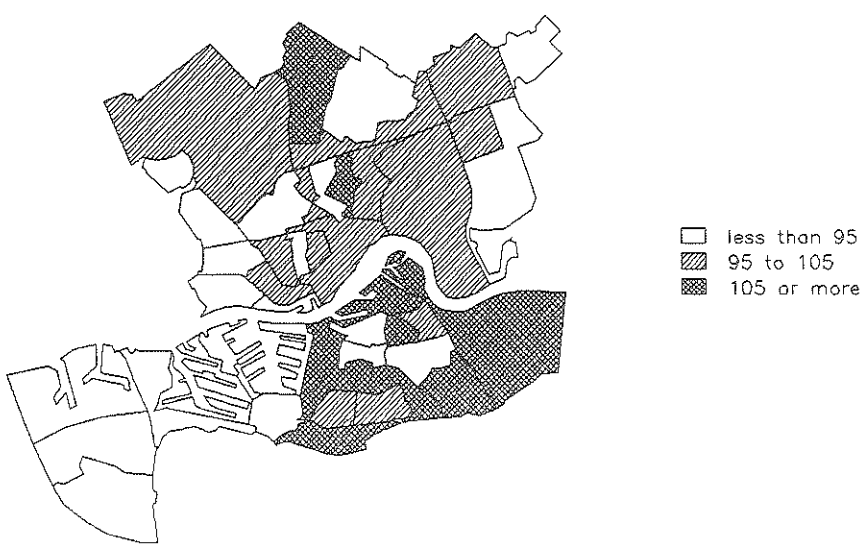


Figure 5.1.5. Percentage smokers per neighbourhood

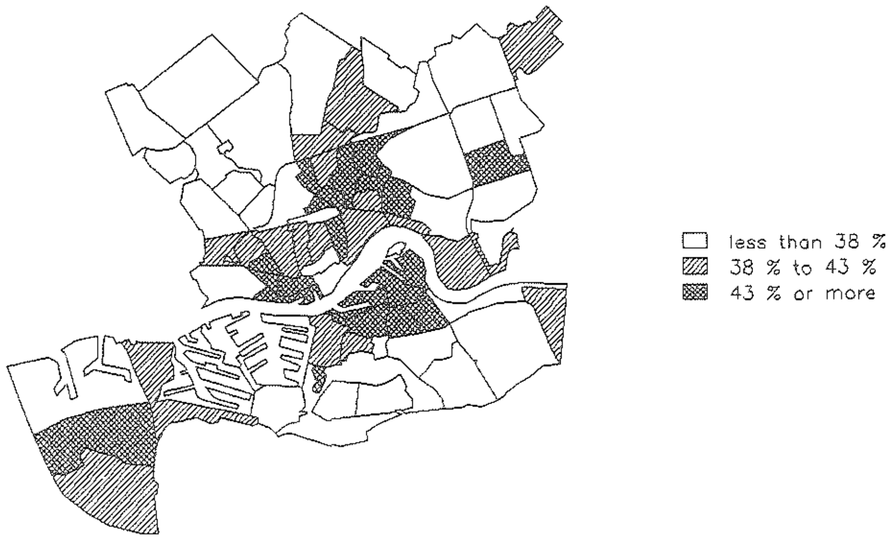
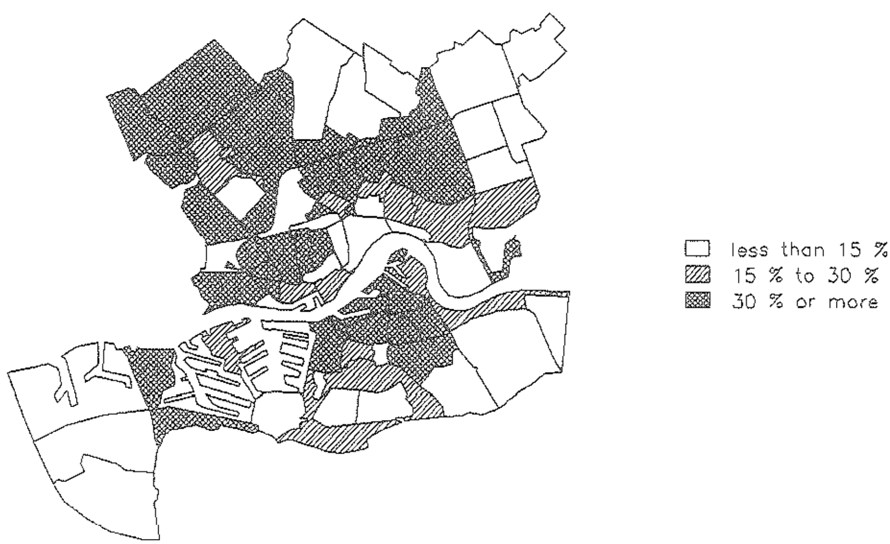


Figure 5.1.6. Percentage dwellings without shower or bath per neighbourhood



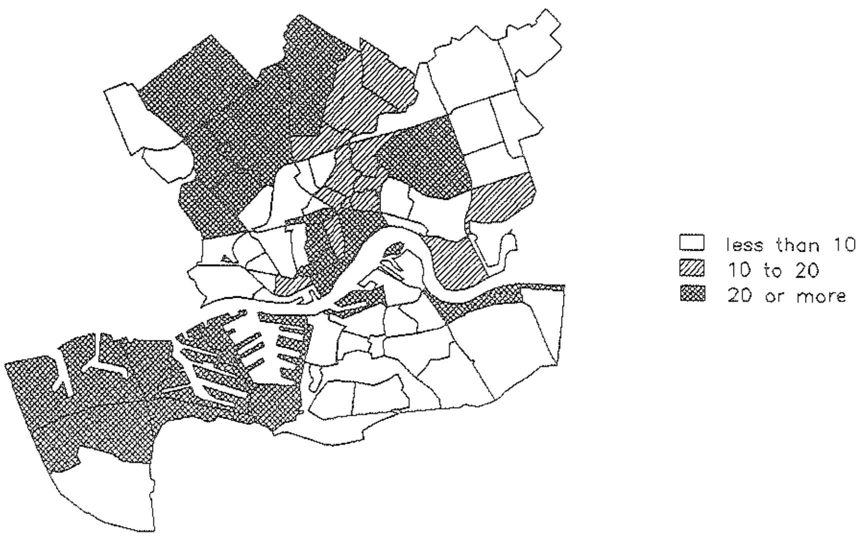
The older neighbourhoods, both in Rotterdam-North as well as in Rotterdam-South, still have a large number of homes without a bath or shower: in some cases as many as 30% of the homes.
Traffic conditions are an important factor as far as the liveability and safety of a neighbourhood are concerned. A higher intensity of traffic leads not only to more traffic accidents but also to an increased noise burden, air pollution and the demand for more (often scarce) land. In comparison with other large cities in the Netherlands, however, Rotterdam has a favourable record as far as the number of traffic fatalities is concerned.
The quality of the environment is a subject of major importance for many people and deserves, partly because of its relation to health, considerable attention. Part of the environmental problems are not related to neighbourhoods, cities or even countries. Another part however is markedly dependent on location so that the collection of data at the neighbourhood level can be quite worthwhile. In addition to data on the quality of the environment, environmental complaints of the inhabitants were also recorded. In 1987 more than 500 environmental complaints were registered in Rotterdam.
More than 53% concerned complaints of stench, more than 30% concerned noise. In figure 5.1.7 the number of complaints about noise per 10,000 inhabitants per neighbourhood is shown. Fairly obvious are the numerous complaints in neighbourhoods close to the harbours and industrial complexes. Striking is the high percentage of complaints registered along the northern edge of the city (Zestienhoven Airport) and in a number of centre city neighbourhoods.

Conclusions

From the above it is clear that Rotterdam differs markedly from the Netherlands as a whole in population distribution. A similar situation exists more or less in the other three large cities. These differences in population of course affect health patterns. Rotterdam has more elderly inhabitants and more members of ethnic minority groups; however the oversimplified picture of "the problems of the elderly" or "the problems of ethnic minority groups" must without a doubt be avoided. The question "How healthy is the Rotterdam population?" cannot therefore be answered with a simple statement or number.
Several of the many aspects of health have been discussed above. The figures reveal that there are considerable differences between neighbourhoods. As far as mortality is concerned, these differences can in part be explained by the presence of nursing homes; on the other hand the socioeconomic status can also play a role.
Neighbourhood differences were also found for many other indicators, for example thinking about seeking help for psychiatric problems. Elevated percentage were found particularly for neighbourhoods with many single young people. As a result of the broad field covered by the data collected for the REBUS project, a detailed picture of health conditions in Rotterdam and the factors that

influence health can be obtained. On the basis of this information as well as other sources, policy recommendations for a schematic approach to the improvement of health can be made.

Figure 5.1.7. Number of noise complaints per 10.000 inhabitants



5.2 Socioeconomic status and differences in mortality between Rotterdam neighbourhoods*

Introduction

In 1977, the WHO formulated a new general goal for member countries. It stated that the entire world population should have achieved such a level of health by the year 2000, that every person would be able to lead a socially and economically productive life. Health therefore is considered to be a condition of total physical, mental and social well-being and not simply the absence of disease or handicaps. Subsequently the European Regional Committee of the WHO defined 38 specific targets directed toward realisation of the above-mentioned goal. In addition, the so-called "Healthy Cities Project" was initiated. The aim of this project is to contribute to improvement of health conditions in large cities (WHO, 1985). Research in this field is important because it can provide good insight into both health conditions in large cities and the factors that influence these conditions. Specifically, the construction of health profiles based on highly diverse sources of data is important (Hancock, 1987).
Within the framework of the "Healthy Cities Project", reduction of inequalities in health is an essential aspect. Mortality data have always played an important role as an indicator of health conditions.
The difference in mortality between neighbourhoods in Rotterdam was already investigated earlier (Slooff and Klingenberg, 1984; van Oers, 1987). In other cities too, both national and international, a difference in mortality between neighbourhoods has been demonstrated (Lau-IJzerman et al, 1980; van der Maas et al, 1987; Renvoize et al, 1988). In the Amsterdam Comparative Neighbourhood Study, it was also found that the order of the neighbourhoods according to socioeconomic status exhibited little variation in the course of a number of years. It is not known, however, whether the differences between "good" neighbourhoods and "bad" neighbourhoods have increased or decreased in recent years.
The relationship between socioeconomic status and mortality has also been investigated in a large number of studies in the Netherlands as well as other countries. Mackenbach and van der Maas (1987) have reviewed the most important findings in this field. Recent studies in the Netherlands have been summarised by Mackenbach and Stronks (1988).
In the Rotterdam neighbourhood study, the question of whether there is a higher mortality in neighbourhoods with a lower average socioeconomic status (SES)

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* *Oers, J.A.M. van, Teeuwen, J.H.M. Socioeconomic status and differences in mortality between Rotterdam neighbourhoods. Tijdschrift Sociale Gezondheidszorg 69, 55-60, 1991*

was investigated. A second question of the study was whether socioeconomic differences in mortality in Rotterdam have increased or decreased in the last ten years.

Materials and methods

Mortality data

The data on total mortality per neighbourhood were obtained from the Municipal Bureau of Statistics (Gemeentelijk Bureau voor Onderzoek en Statistiek, 1978–1987).

Mortality data are markedly influenced by the age distribution of the population under investigation. Before analysis it is often necessary to eliminate the disturbing influence of differences in this age distribution so that it will be possible to compare various regions with one another. Standardisation is the method normally used for this purpose. In this study, the method of indirect standardisation, which yields a standardised mortality ratio (SMR), was used (Rothman, 1986).

Socioeconomic status

Indicators on socioeconomic status (SES) focus predominantly on the triangle education–occupation–income. The choice of indicators of SES for analysis per neighbourhood is highly dependent upon the availability of data. In Rotterdam the Municipal Bureau of Statistics has collected and published data on SES per neighbourhood.

For an investigation of the relationship between mortality and socioeconomic status, it would seem worthwhile to limit the choice of indicators of SES to those that can immediately be interpreted as a measure of SES (thus in the triangle education–occupation–income). Other indicators, such as percentage migrants, can of course exhibit a close correlation with SES per neighbourhood but do not as a result contribute to the validity of the SES indicator. Therefore, for this study, the following four indicators were chosen: percentage unemployed, percentage receiving benefit, percentage 17 and 18–year–olds receiving education and income level. The precise definition of and sources for the indicators used are listed in table 5.2.1.

The relation between mortality and socioeconomic status

For an evaluation of the relationship between mortality and socioeconomic status per neighbourhood, ecological analysis (Rothman, 1986) was the study method used. In an ecological study of SES and mortality, the relationship is analyzed in aggregates, usually geographical units. A well–known example of an investigation with a city neighbourhood as the unit of analysis is the Amsterdam Comparative Neighbourhood Study (Lau–IJzerman et al, 1980) and the follow–up study (van der Maas et al, 1987).

One might ask to what extent the form of the relationship between exposure and disease that is observed after aggregation is the same as that before aggregation.

This is not always the case, a phenomenon known as "cross-level bias" or "ecological fallacy". In general, an analysis at the level of geographical units will be subject to cross-level bias due, for example, to migration trends or the disruptive effect of unemployment in a neighbourhood as a whole.
In addition, the effect of social interactions within the family or the form of cohabitation will also play a role. Thus the chance of disease can be determined by the individual's own determinants as well as the determinants of the partner, or ageing.
In addition to cross-level bias, there are also other problems that can be encountered in ecological studies. Confounding factors at the aggregate level are not the same as those at the individual level; information about confounders at the aggregate level is often not available. As a result of aggregation, the correlation coefficient will in general increase. Determinant variables often show very close mutual correlations (multicollinearity) making isolation of the individual contribution of one variable very difficult.
On the other hand, variables such as the percentage unemployment or average income are often easier to determine and are more reliable on the neighbourhood level than the individual level since the latter often depends, for instance, on the results of questionnaires. Rothman (1986) states that ecological studies are especially useful in the descriptive and explorative sense, i.e. for the recognition of differences between populations which can then be used to design subsequent investigations. In this case too, the description of the differences in and the relationships between the variables at the neighbourhood level (irrespective of their eventual equivalents at their individual level) is a goal in itself.

Method
The relationship between mortality and SES was investigated by means of a linear regression model. In the regression model it is possible to include one or more SES indicators. In our model the values at the start of the study period were introduced as far as possible; the values later in the period were used to investigate the stability of the SES indicators.
When several SES indicators are used, the above-mentioned problem of multicollinearity can be encountered. This problem was solved by means of a principal component analysis of the four selected SES indicators. For this purpose a linear combination of independent variables is formed which explains the greatest possible part of the total variance. Subsequently regression analysis of mortality with respect to the first principal component is carried out (Chatfield and Collins, 1980).
Another complication is the presence of nursing homes in the neighbourhood. Since the health status of patients in a nursing home is lower than that of individuals of the same age group who are not in a nursing home, the mortality risk for this group is higher. As a result the SMR-values for neighbourhoods with a nursing home are higher. In addition the inhabitants of a nursing home often do not originate from the neighbourhood where the home is located. Since a nursing home population consists predominantly of females, especially a distortion of the SMR's for females can occur. It is difficult to find a completely

satisfactory solution for this problem because the age-specific mortality and population data for nursing homes are not known.
The nursing home statistics of the National Hospital Board (NZI, 1978-1987) do indicate the annual number of deaths in nursing homes. These figures pertain not only to patients whose home address is that of the nursing home but also to those with a different home address. In the first case, the death is included in the total figure for the neighbourhood in which the nursing home is located; in the latter case it is not. On the basis of these National Hospital Board figures a correction term has been determined. The idea behind this correction term is that nursing home mortality is a fixed but unknown fraction of the observed mortality. Correction is needed if the number of nursing home deaths in a neighbourhood is different from what would be expected if nursing home deaths were evenly divided over all neighbourhoods.
Neighbourhood populations vary in size. By means of weighted regression analysis using weights that are proportional to the size of the population, an efficient regression analysis can be carried out. An alternative approach is to eliminate neighbourhoods with small populations from the analysis and give all remaining neighbourhoods the same weight. For this purpose, a somewhat arbitrary cut-off point must be established. A disadvantage of this second method is the decreased statistical efficiency. However, since the neighbourhoods differ quite markedly in the number of inhabitants, weighted analysis can lead to a pronounced influence of some neighbourhoods on the regression line.
Explorative analysis revealed that even after weighting, the results were greatly distorted due to the inclusion of several neighbourhoods with less than 2000 inhabitants. This might be attributable to the fact that both the SMR-values and the independent variables for these neighbourhoods were inaccurate. For this reason it was decided that neighbourhoods with less than 2000 inhabitants would not be included in the analysis; 47 neighbourhoods remained for analysis.
For analysis of the trend in mortality, the trend for each neighbourhood was determined separately using simple regression analysis of the SMR with respect to time. This estimated trend was plotted against the first principal SES component.

Results

Mortality data

Because the number of deaths per year per neighbourhood is small, the figures for a 10-year period were used. In total the calculations cover the period 1978-1987. In the figures 5.2.1 and 5.2.2 the distribution of the SMR per neighbourhood is shown, for males and females. The majority of the neighbourhoods with an SMR higher than 110 are neighbourhoods which include nursing homes. Since most of the nursing home population is female, this effect is more apparent for females than for males. Some neighbourhoods that do not have nursing homes still have a mortality ratio that is higher than the mean for

Rotterdam. These neighbourhoods lie predominantly in the older parts of the centre of the city. The majority of the neighbourhoods in the outskirts of the city have an SMR that is close to or less than the mean.
In the subsequent analysis 47 neighbourhoods were included. These 47 neighbourhoods had more than 2000 inhabitants in the period 1978–1987 and represent more than 93% of the total number of person–years in Rotterdam in that period.

Table 5.2.1 Review of the SES indicators used in the analysis

var–iable	*description of SES–indicator*	*reference*
W78	*estimated percentage unemployment among dependent male employees per April 1978*	*Das & Doorn (1980)*
W82	*idem per December 1982*	*Oomens & Das (1984)*
W86	*idem per May 1986*	*GBOS (1987)*
U79	*individuals living at home and receiving benefit as a percentage of the relevant population aged 16 years and older per January 1979*	*Das & Doorn (1980)*
U83	*individuals living at home and receiving benefit as a percentage of the relevant population aged 20 years and older per Oktober 1983*	*Oomens & Das (1984)*
U86	*idem per Oktober 1986*	*Das & Oomens (1987)*
O79	*percentage 17 and 18–year–olds receiving education per January 1979*	*Das & Doorn (1980)*
O83	*idem per January 1983*	*Oomens & Das (1984)*
O86	*idem per February 1986*	*Oomens & Das (1987)*
I82	*average spendable income per employed individual for 1982 (in thousands of Dutch guilders)*	*GBOS (1986)*

The SES data
The correlation with respect to time for each of the selected indicators of socioeconomic status was determined. The correlations were high, varying from 0.66 to 0.91.
The percentage unemployment and the percentage receiving benefit, in particular, were very stable as far as the relative order of the neighbourhoods

was concerned. This is especially remarkable for the percentage unemployment in view of the marked increase in absolute numbers of unemployed. The stability of the variable "percentage of 17 and 18-year-olds receiving education" was slightly lower. In general however the SES indicators appear to be stable enough to be able to assume that the SES at the neighbourhood level was constant in the period 1978-1987 and thus to concentrate the analysis on (the course of) mortality in relation to the socioeconomic status in 1978-1979. In the analysis, use was made of the indicators "unemployment 1978" (W78), "percentage receiving benefit 1979" (U79), "percentage 17 and 18-year-olds receiving education 1979" (O79) and "spendable income 1982" (I82).
Multivariate analysis of the four indicators used in the subsequent analysis was carried out. The first principal component explains 81% of the variation. Regression analysis was then carried out using the above-mentioned first principal component as SES indicator.

The relationship between trends in mortality and SES
The analysis revealed that there is no relationship between the trend in mortality in a neighbourhood and the SES level of that neighbourhood. This means that there appears to be no difference in the course of the SMR in time between neighbourhoods with a low and a high SES.
For the purpose of illustration, the trend in SMR estimated for each neighbourhood separately for males (on the basis of simple regression analysis of the SMR in time for all neighbourhoods separately) is plotted against the score for the SES principal component (a low value for the SES principal component corresponds with a high SES); see figure 5.2.3. And indeed, a pattern cannot be discerned. These results seem to indicate that in the period 1978-1987 the differences in standardised mortality between neighbourhoods with a low and a high SES remained the same.

The relationship between mortality and SES
The results described above justify a limitation of the further analysis to the standardised mortality for the entire period 1978-1987. A first impression of the relationship between standardised mortality and socioeconomic status can be obtained from the correlation coefficients for SMR (SMRM for males and SMRF for females) and the SES indicators (table 5.2.2). The correlations for females are lower than those for males due to the greater influence of nursing home mortality.
In the description of the method, it was mentioned that regression analysis can provide more worthwhile information than the consideration of correlations. For this purpose the first principal component of the SES indicators was used again. Table 5.2.3 shows that correction for nursing home mortality markedly enhances the relationship between SMR and SES, especially for females.
The coefficients for the correlation between SMRM and SMRF and the principal component of SES are similar. This suggests that the relationship between SES and mortality for females does not differ markedly from that found for males.

In figure 5.2.4 the values of the SMRM and the SES principal component are plotted and the regression line obtained on the basis of table 5.2.3 (thus after correction for nursing homes) is shown. The estimated SMR varies between 114.0 for the lowest SES score and 82.2 for the highest SES score. The estimated relationship of the standardised mortality ratio for neighbourhoods with the highest and the lowest SES score is therefore 1.39. In figure 5.2.5 the results for females are shown. Here the estimated relationship for the mortality ratio is 1.36.

Table 5.2.2 Correlations between SMR's for the period 1978–1987 and SES indicators

	SMRM	*SMRV*	*W78*	*U79*	*O79*	*I82*
SMRM: SMR for males	–					
SMRV: SMR for females	*0.69*	–				
W78: unemployment	*0.57*	*0.25*	–			
U79: individuals receiving benefit	*0.51*	*0.26*	*0.79*	–		
O79: education 17/18-year-	*-0.39*	*-0.22*	*-0.66*	*0.80*	–	
I82: income	*-0.49*	*-0.11*	*-0.65*	*-0.84*	*0.75*	–

Conclusions and discussion

In neighbourhoods with a lower average socioeconomic status mortality is higher than in neighbourhoods with a higher socioeconomic status. This finding is in accordance with reports in the literature on both ecological and non-ecological studies. The relationship between SES and mortality appeared to be approximately the same for males and females, after correction for nursing home mortality. Comparison with the Amsterdam Comparative Neighbourhood Study is somewhat difficult, due to differences in the choice of both geographical units and the method of analysis. The partial correlation found in Rotterdam between SES and mortality was 0.70 for males and 0.55 for females. In the Amsterdam Comparative Neighbourhood Study the correlation between mortality and SES was 0.56. In the Amsterdam study a correction for nursing home mortality was not applied; however since the neighbourhoods chosen were larger, the disruptive influence of nursing home mortality was lower. In addition, data on duration of residence was available for the Amsterdam study. The ratio between the neighbourhoods with the highest and lowest SES scores is about the same in

Rotterdam and Amsterdam. It can be concluded that the results of the two studies are comparable.
Trends in SES-related differences in mortality could not be demonstrated. The neighbourhoods were found to be fairly constant in order according to SES over the 10-year period. Furthermore no differences in the trend in SMR were found between the neighbourhoods with the highest and lowest SES in 1978. This implies that changes in neighbourhoods with a high SES were not different from the changes in neighbourhoods with a low SES; the differences between the neighbourhoods remained on the same order of magnitude. In this connection it must be noted that information for the trend analysis was rather scarce. In addition a period of 10 years is too short to reveal long-term effects. The lack of any evidence for a relationship at the neighbourhood level between SES and trend in SMR implies that one must take great care when (superficially) interpreting observed trends in mortality for individual neighbourhoods. For this, longer periods are required.
It can be stated without any doubt that this study has demonstrated a relationship between mortality and SES at the neighbourhood level; no conclusions on the underlying causal mechanisms can be drawn. In addition to the factors age, sex and nursing homes, differentiation according to such aspects as marital status and ethnic group could be considered. Differentiation according to marital status might be useful. The question is however whether the neighbourhoods differ in this respect; another problem is whether marital status at the time of death or 10-20 years earlier is more appropriate. Differentiation according to ethnic group is less worthwhile in this study because the focus is on a description of the relationship between mortality and SES at the neighbourhood level and not on the underlying causal mechanisms.
It is clear that differences in mortality exist (as a measure of health) between neighbourhoods in Rotterdam and are related to socioeconomic inequality. There are several neighbourhoods in Rotterdam (specifically in the old centers of Rotterdam-North as well as Rotterdam-South) which are characterised by both socioeconomic problems and health problems (expressed in mortality rates). This unequal distribution of health is considered an important aspect by the Rotterdam committee "Social Renewal" within the framework of "The New Rotterdam". As a consequence the Municipal Health Service has developed activities and policy proposals within the framework of the "Healthy Cities Project" whereby considerable attention has been directed toward neighbourhood-oriented work. It is precisely in the above-mentioned neighbourhoods with socioeconomic problems and health problems that a scala of neighbourhood-directed activities will be developed.

Figure 5.2.1. Standardized mortality ratio (SMR) for males, 1978-1987

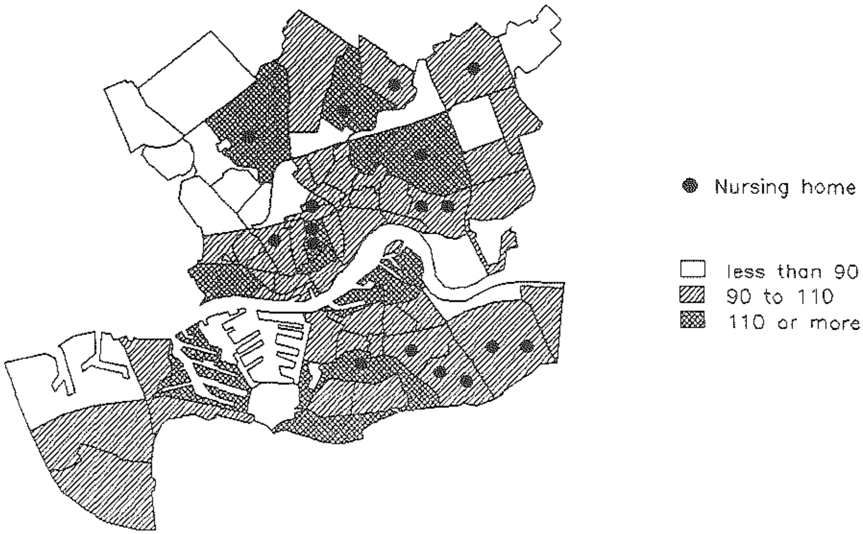


Figure 5.2.2. Standardized mortality ratio (SMR) for females, 1978-1987

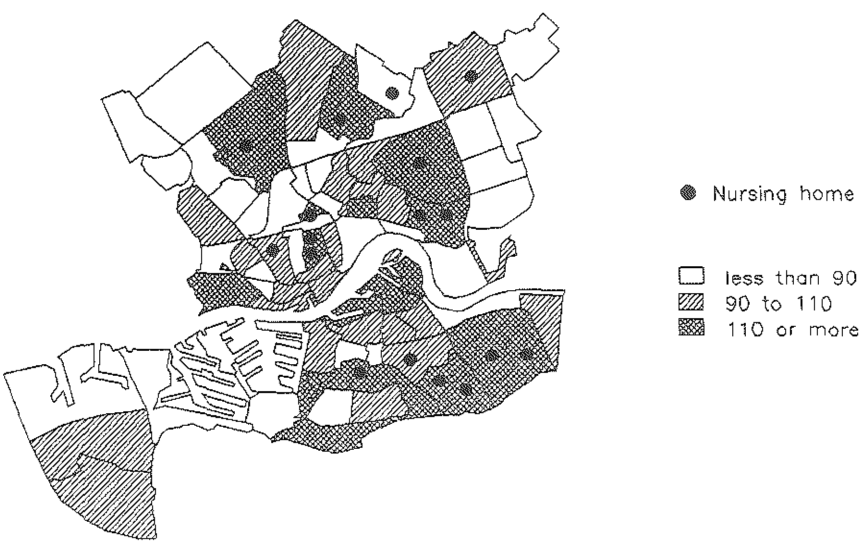
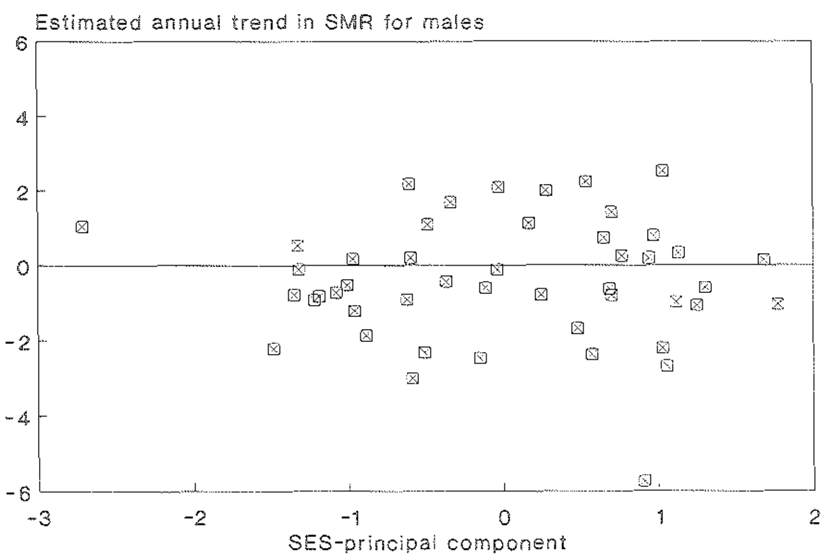


Table 5.2.3 Results of regression analysis

Variable	*Coefficient*	*95 % CI*	*t-value*	*Correlation*	*Partial correlation*
Male					
Constant	*101.4*	*99.2-103.6*	*5.50*		
SES principal component	*7.1*	*4.9-9.3*	*6.44*	*0.60*	*0.70*
Nursing home mortality	*5.8*	*2.9-8.6*	*4.08*	*0.30*	*0.52*
Female					
Constant	*99.3*	*96.3-102.3*	*67.46*		
SES principal component	*6.5*	*3.5-9.5*	*4.36*	*0.26*	*0.55*
Nursing home mortality	*14.9*	*11.4-18.5*	*8.41*	*0.70*	*0.79*

Figure 5.2.3. Trend in SMR for males per neighbourhood versus SES



(N=47)

Figure 5.2.4. SMR for males versus the socioeconomic status per neighbourhood

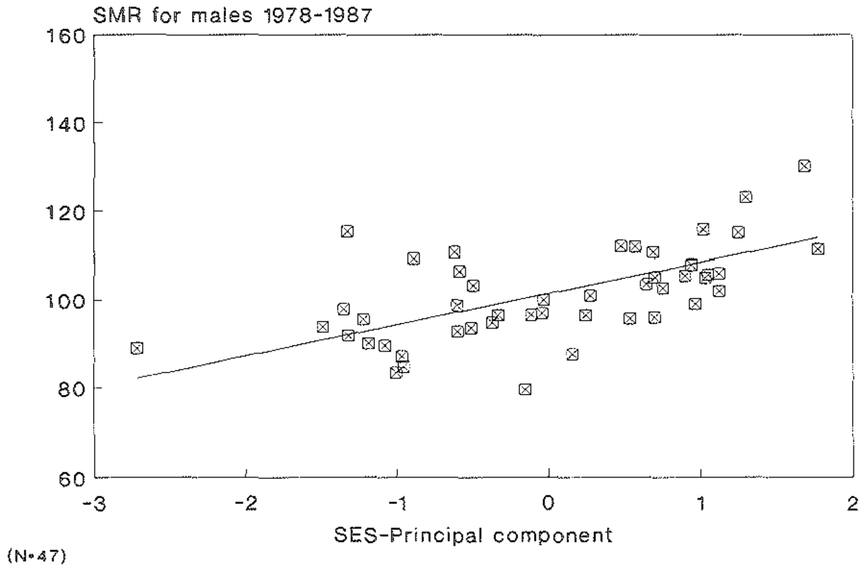
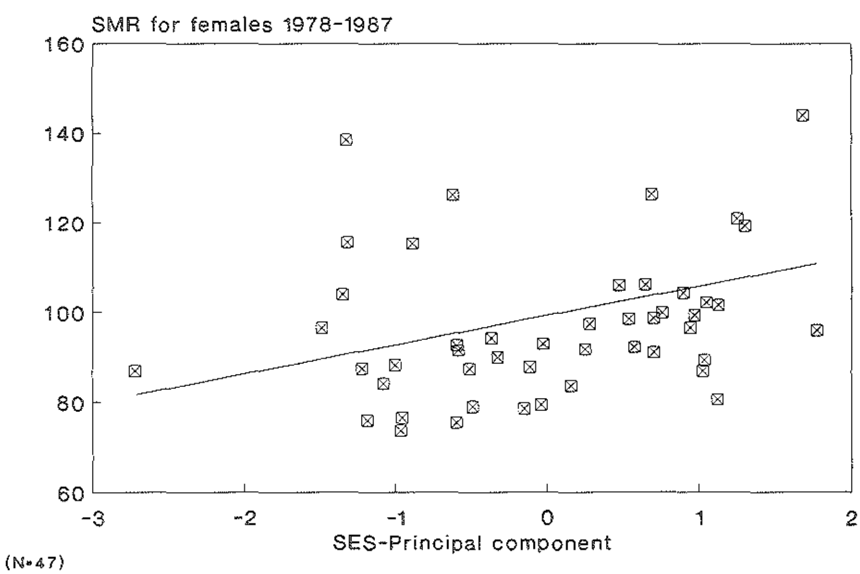


Figure 5.2.5. SMR for females versus the socioeconomic status per neighbourhood



5.3 Socioeconomic status and the use of district nursing in Rotterdam*

Introduction

The use of district nursing differs from one neighbourhood to the next. Several factors play a role here, such as the age distribution of a neighbourhood, the number of migrants in a neighbourhood and the presence of nursing homes. These aspects were already taken into account at the time of the allocation of personnel and funds for the various districts. For example, migrant children in the 0 to 4–year–old age group are counted twice when the number of children in this age group is established; the number of nursing home beds is subtracted from the number of inhabitants in the 80 and over age group because district nurses do not work in nursing homes. Various studies have provided clear evidence that inequalities in health are related to socioeconomic status. In general those with a lower socioeconomic status are also less healthy. Mackenbach and van der Maas (1987) and Mackenbach and Stronks (1988) reviewed the most important findings of studies in this field. In the most recent review (Mackenbach, 1991) Dutch studies performed in the past few years are summarised. In this review it is shown that socioeconomic differences in health have been demonstrated, for instance, for the prevalence of established health complaints, perceived health and mortality. In addition it is shown that in a number of cases a relationship has also been found between socioeconomic status and the use of health care facilities. Thus the frequency of visits to the general practitioner is higher among the lower socioeconomic groups, but this difference disappears when the difference in health is taken into account. There are however considerable differences in the nature of the visit to the general practitioner between socioeconomic groups.

In Rotterdam, too, socioeconomic differences have been demonstrated, for example, in mortality, established complaints and visits to the general practitioner (Reelick, 1988; van Oers et al, 1990; van Oers & Teeuwen, 1991). The relationship between socioeconomic status and the use of district nurses has not yet been studied in Rotterdam.

In this paper the relationship between the socioeconomic status of a neighbourhood and the use of district nurses is described. For this purpose both the number of patients and the number of home visits were investigated. Although such relationships do not demonstrate causality, they do provide insight into the

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need for further studies and can be used for further differentiation of the allocation of personnel and funds for the various districts.

Materials and methods

The data for this study were collected within the framework of the Rotterdam Local Health Informationsystem (REBUS) (van Oers et al, 1988; Garretsen et al, 1991). This database contains information at the neighbourhood level about health and health–related factors such as lifestyle, social environment, physical environment and health care. These data were collected from the registries and databases of a large number of service organisations and institutions. As a rule the data are supplemented annually.

The data available in this database about district nursing were obtained from the registration and information bank for district nursing of the Cooperative of Rotterdam Health Service Organisations (SSRK) (Rotterdamse Kruisverenigingen, 1990). Information on the number of patients per neighbourhood and the number of home visits per neighbourhood was collected. Office consultations, telephone calls and visits to specific clinics were not included. Both the number of patients and the number of home visits were divided according to age into four categories: 0–4 years, 5–54 years, 55–79 years and 80 years and older. In addition the data were subdivided according to the purpose of the home visit: active nursing, guidance, prevention, intake and indirect care. No information was available on the mean duration of the contacts. All values were converted to a value per number of inhabitants. For this purpose the presence of nursing homes was taken into account by subtracting the number of nursing home beds from the number of inhabitants 80 years and older. The figures refer to the year 1989.

As an indicator for the socioeconomic status of a neighbourhood the so–called "lag scores" for a neighbourhood was used, which were calculated by the Municipal Bureau for Statistics (Das and Oomens, 1987). Various aspects of the lag in a neighbourhood, such as unemployment, income, age of the buildings and participation in education, were taken into account. The most recent estimates with respect to lag refer to the year 1987.

District nursing in Rotterdam is organised into so–called basic units, 17 in total. These basic units are subdivided into neighbourhoods, 80 in total. For this analysis only those neighbourhoods with more than 2000 inhabitants in 1989 were included. This cut–off point was also used in a comparable study at the neighbourhood level (van Oers and Teeuwen, 1991). This is necessary to avoid large fluctuations in the figures due to large random effects. As a result neighbourhoods with insufficient numbers of patients and home visits were excluded from further analysis. In total 52 neighbourhoods remained representing 95% of the Rotterdam population.

Per basic unit, the care offered to the neighbourhoods is the same. A direct comparison of the neighbourhoods within one basic unit to evaluate the relationship between the use of district nurses and socioeconomic status is possible in

principle but because of the small number of neighbourhoods within one single basic unit, it will have little practical value. If all basic units are combined together, then such a comparison cannot be carried out directly because the average socioeconomic level of each basic unit is different; a correction for this must be applied. In addition, there are differences between neighbourhoods in age distribution which play an important role in the need for care. Therefore the number of patients and the number of home visits must also be corrected for differences in age distribution. These corrections were carried out in two steps.
The first step consisted of correction for the difference in age distribution and difference in average socioeconomic status. For this purpose the method of indirect standardisation was used (Rothman, 1986); the population of a basic unit was used as the reference population for the neighbourhoods within the basic unit. The standardisation yielded a standardised patient ratio and a standardised home visit ratio for each neighbourhood. The standardised ratio's thus obtained all had the same mean (by definition the mean is 1).
The second step involved the correction for differences in distribution. This correction was obtained by converting the ratio's into so-called "z-scores". The values thus obtained had a mean of 0 and a standard deviation of 1.
The corrected ratio's were then correlated with the data on socioeconomic status using Pearson's correlation coefficient. To obtain a better impression of the mutual relationships, a simple regression analysis was carried out using the standardised home visits as the dependent variable and the socioeconomic status as the independent variable. All calculations were performed with the software package SPSS/PC+ (Norusis, 1990).

Results

In total in 1989 in Rotterdam 17,000 people were cared for by district nurses. About one-half of the cases involved 0 to 4-year-old. The number of home visits in 1989 was almost 400,000, by far the majority of these patients were over 55 years of age. The exact numbers per age category are listed in table 5.3.1. Figures 5.3.1 and 5.3.2 show the number of patients and the number of home visits per 1000 inhabitants per neighbourhood. It is clear that there are differences between neighbourhoods in both the number of patients and the number of home visits.
The analysis of correlations focused on the number of patients and home visits in the five above-mentioned categories of purpose of the home visit. In addition an analysis of all categories together except prevention was also carried out. This was done because prevention is fairly independent of demand and because this aspect would receive the lowest priority in the event of an increased workload.
The correlations-analysis revealed that there is not a significant relationship between the number of patients and the socioeconomic status of a neighbourhood ($r = -0.07$; $p = 0.31$; $n = 52$). A significant relationship was demonstrated between the socioeconomic status of a neighbourhood and the number of home

visits. The correlation between the socioeconomic status and home visits in the five categories of purpose together was –0.35 (p 0.05; n = 52); the correlation between socioeconomic status and home visits in all categories except prevention was –0.35 (p 0.05; n = 52).
To gain a better insight into the relationships, simple regression analysis was carried out whereby the socioeconomic status was the descriptive variable and the number of home visits the dependent variable. The results of this analysis are listed in table 5.3.2.

Table 5.3.1 Number of patients and home visits for district nursing in Rotterdam in 1989

	0 - 4	*5 - 54*	*55 - 79*	*80 +*	*total*
Number of patients	*8722*	*768*	*4244*	*3363*	*17097*
Number of home visits	*16069*	*21549*	*178805*	*173460*	*389883*

Table 5.3.2 Results of regression analysis

	Coefficient	*Standard deviation*	*p-value*
All categories			
Lag score	*-0.306*	*0.117*	*0.012*
Constant	*-0.065*	*0.113*	*0.570*
All categories except prevention			
Lag score	*-0.305*	*0.117*	*0.012*
Constant	*-0.065*	*0.113*	*0.571*

Discussion

In this study a relationship between the number of patients cared for by district nurses and the socioeconomic status of a neighbourhood could not be demonstrated. This implies that just as many patients request the help of district nurses in neighbourhoods with a low socioeconomic status as in neighbourhoods with a high socioeconomic status. However there was a relationship between the number of home visits and the socioeconomic status of a neighbourhood. In neighbourhoods with a low socioeconomic status the patients had more contacts with the district nurses than in neighbourhoods with a higher socioeconomic

status. This can be interpreted in various manners. It is possible that in neighbourhoods with a lower socioeconomic status, the disease patterns are more severe so that care is needed for longer periods. Another explanation is that the inhabitants of neighbourhoods with a lower socioeconomic status cannot fall back on voluntary home care until a later stage or that such volunteers are not even available so that more and prolonged care via district nurses is necessary.
This could in turn be related to urban renewal projects which often are radical so that the informal system of mutual help is disrupted for prolonged periods. A further explanation could be the expectation that in neighbourhoods with a high socioeconomic status use is made sooner and/or more frequently of private health care, organised and non-organised.
Finally it is also possible that in neighbourhoods with a lower socioeconomic status, living conditions are worse and homes in general are difficult or impossible to adapt.

An important note with respect to the above-mentioned conclusions is that the establishment of the size of a basic unit is already based on twice the actual number of migrant children. The neighbourhoods with numerous migrants are however in many cases also the neighbourhoods with a lower socioeconomic status. Indirectly therefore there is already a (partial) correction for the difference in socioeconomic status at the time of allocation.
Further studies may indicate whether there are differences in the various types of care, as given by the five categories of purpose, or differences in the duration of the visits. The results are in any case sufficient reason to consider a further refinement of the allocation of personnel and funds to the various neighbourhoods. In addition to corrections for age, nursing homes and migrants, a correction for socioeconomic status could also be applied.

Figure 5.3.1. Number of patients under care per 1000 inhabitants

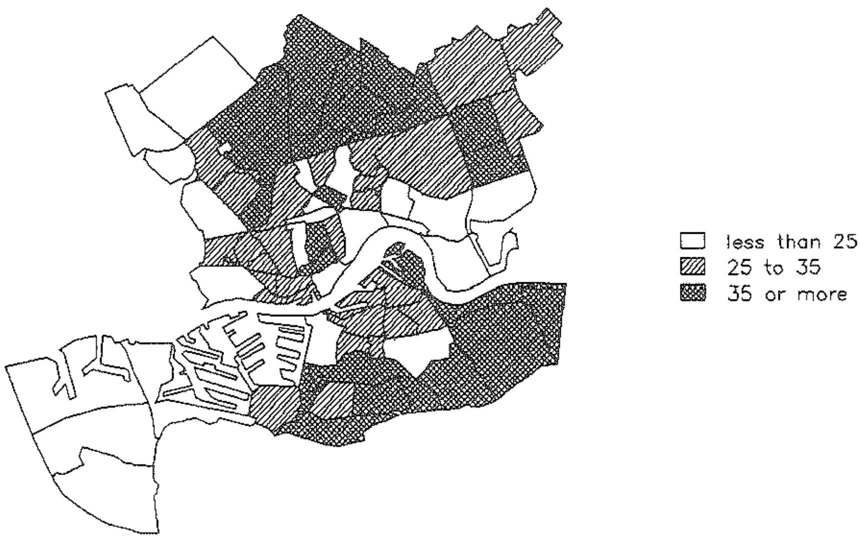
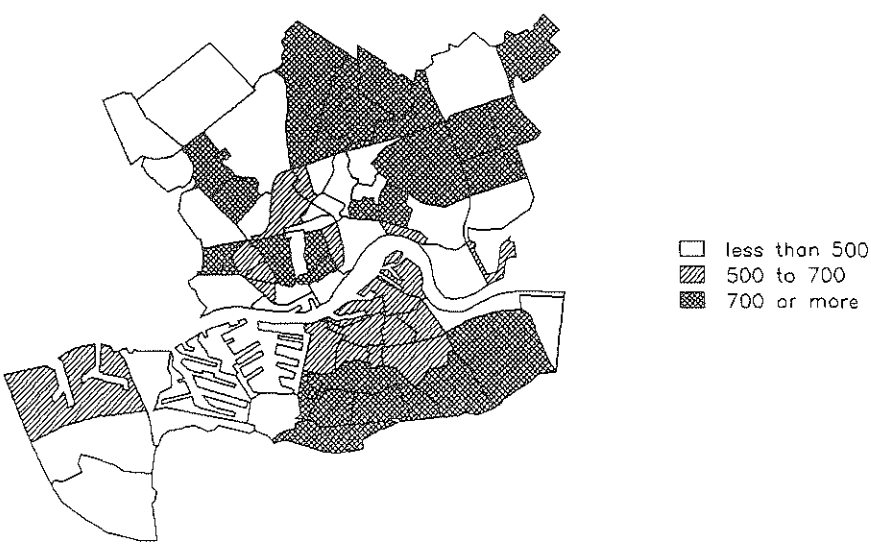


Figure 5.3.2. Number of district nurse home visits per 1000 inhabitants



5.4 The geographic relationship between alcohol-use, bars, liquorshops and traffic injuries in Rotterdam*

Introduction

Within the scope of the World Health Organisation (WHO) action program "Health for all by the Year 2000", the European Regional Committee of the WHO defined 38 specific targets for its region (WHO, 1985). The development of research strategies supported by the use of information-systems, is one of these targets. The decrease in alcohol-use and alcohol related problems (such as traffic accidents) are mentioned as two other targets.
In 1985 the Regional Office of the WHO in Europe initiated the Healthy Cities Project, as its contribution to the Health For All program. The Healthy Cities Project focuses especially on the cities in Europe, as it is believed that in the year 2000, 75% of the European population will live in urban areas. This attempt to improve the health conditions in the cities is based on an ecological approach with consideration for the social and physical environment, lifestyles, health care and biological factors influencing health (Hancock, 1987).
To gain insight into the health situation, and in health related factors in the city of Rotterdam, The Netherlands, a health information system has been developed (Garretsen et al, 1991; van Oers and Reelick, 1992). In this information system, data on health, lifestyle, health care, social and physical environment are collected at neighbourhood level on a yearly basis. In the next paragraph, the design of the information-system is given, together with a review of the data collected. The data in the information-system is linked to geographical units, i.e. neighbourhoods. The object of interest is the neighbourhood, not the individual.

In this study data are presented on the geographic distribution of alcohol-use, liquor shops, bars, and traffic accidents in Rotterdam neighbourhoods, and on their spatial associations. These data are provided by the Rotterdam Local Health Information System. Due to the type of data, this study has an explorative character and although the presented associations do not indicate causal relationships, they give rise to further investigations. Knowledge of such relations can be important for further development of a multi-sectoral local health policy.
In earlier studies in Rotterdam it was already shown that differences in alcohol use exist between neighbourhoods (Reelick, 1988; Reelick and Teeuwen, 1989; Reelick and Lamers, 1991). Also, relationships were shown between alcohol-use and socioeconomic status at the individual level. Identification of neighbour-

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* *Oers, J.A.M. van, Garretsen, H.F.L. The geographic relationship between alcoholuse, bars, liquorshops and traffic-injuries in Rotterdam. Journal for Studies on Alcohol, in press*

hoods with a high prevalence of alcohol users has led to focusing special preventive efforts on these neighbourhoods.
In a number of studies the influence of alcohol consumption on traffic safety was shown. Evans (1990) showed that about 47% of traffic fatalities is attributable to alcohol. A study of Zador (1991) showed that with blood-alcohol concentrations in the range of 0.05 - 0.09 percent, the likelihood of a crash was at least nine times higher that at zero blood-alcohol concentrations. Moskowitz (1989) reviewed research on the relationship between alcohol-use and density of alcohol outlets. He concluded that a positive relation exists, but the design of the reviewed studies could not make clear whether greater consumption was due to more outlets, or vice versa. The relationship between traffic fatalities and alcohol outlets has been researched scarcely. Colon and Cutter (1983) found a negative relation between traffic fatalities and density of alcohol outlets, but in his review-article Moskowitz suggests that this may be due to multicollinearity (Moskowitz, 1989).

The Rotterdam Local Health Information System

Data for the study described in this paper come from the Rotterdam Local Health Information System (REBUS). This information-system was set up by the Municipal Health Service (Garretsen et al, 1991; van Oers and Reelick, 1992). The central aims of the REBUS-project are to map out the health situation and health related factors in the city of Rotterdam at district and neighbourhood level and to contribute to the development of a local health policy for reducing the noted differences in the health situation of the population.
REBUS is designed as a continuous health information system for the city of Rotterdam, which means that as far as possible and useful data are updated on an annual basis, to make longitudinal comparisons possible.
The information system contains data on health itself and also on health related issues from other sectors. Information is collected from various sources that can be roughly categorised as follows: (1) statistical information, such as mortality rates and figures from social institutions, and material covering health related areas like housing, employment, education, leisure time activities, provision of health care, etcetera.; (2) data collected from the population itself (health surveys); (3) documentary information gathered from the local newspapers and limited-circulation leaflets; and (4) ideas and views of informants and key members of the community as expressed in personal interviews, group discussions or in questionnaires (Van Oers, 1989; Garretsen et al, 1991).

In short, the system is a collection of quantitative data (numerical material from various statistics and health surveys) linked with qualitative information (with emphasis on content, underlying information derived from documentation, key informants, etc.). Qualitative information makes it possible to account for, illustrate and, if necessary, supplement purely statistical findings.

For the quantitative data a relational database was set up. All data are stored in a central database and can be accessed in various ways with the help of a range of software (dBase IV, SPSS/PC+, Mapmaster, Symphony, Harvard Business Graphics).

Review of data collected

The health status of the population is determined by several main groups of variables i.e. genetic and biological determinants, lifestyles, physical environmental factors, social environmental factors and health care. A broad definition of "health" will be applied, as specified by the WHO: "health is a condition of complete physical, mental and social wellbeing". REBUS contains data both on the health status and on most of the groups mentioned (data on genetic and biological determinants are not available). The following types of data are included:

Dimensions of the health situation
The information system includes among others mortality data, the prevalence of a number of infectious diseases, data on perceived health, health complaints, psychosocial problems and assessments of the help needed by the patient. The data are obtained from the Netherlands Central Bureau of Statistics (mortality rates), from health surveys conducted by the department itself, and other documents provided by the Municipal Health service (for instance the prevalence of infectious diseases).

The presence and use of health care
Important is the availability of healthcare-facilities, the use people make of them and their opinion of the care they receive. Sources are health surveys and local authorities.

Social environment
Factors determining the social environment are educational level, occupation, income, unemployment level, marital status, political participation, mobility, etcetera. Sources are health surveys and local authority research departments.

Physical environment
The information system contains indicators concerning living condition i.e., level of services and accessibility, information on housing (the age and number of houses, types of houses and their amenity), information on urban renewal and property development, public parks and gardens, industry, traffic and transport, and ecological data related to the pollution of soil, water and air, and noise. Sources are health surveys, various local and regional authorities.

Lifestyles
Lifestyles may have a direct influence on health. Lifestyle factors that can influence health are the use of alcohol, tobacco, illicit drugs, sedatives, sleeping pills and other medicines, not to mention dietary habits and the amount of exercise taken. Sources are health surveys and data from local authorities.

Several variables with regard to alcohol are included in the information system, which are of interest in the underlying study.
Data on alcohol use are collected by means of an annual survey, performed by the Municipal Health Service. Every year a questionnaire is sent to a random sample of 2500 citizens in the age group of 16 to 75 years. The response is typically about 70 % and forms a good representation of the Rotterdam population with respect to age, sex and socioeconomic status. Alcohol use is measured with one question, which was validated in earlier research (Garretsen, 1983). Data are originally collected at the individual level but are aggregated on a neighbourhood level by means of a postal code when entered in the information system. Data from 1987 to 1989 are utilised in this study.
The Municipal Service for Urban Development supplies yearly data on the number of bars and liquorshops, retrieved from the Municipal Administration of Real Estate. In this analysis density data over the period 1987 to 1989 are used, calculated as the number of bars an liquorshops per 10.000 inhabitants per neighbourhood.
The Municipal Traffic Service collects information on traffic accidents in Rotterdam. All traffic accidents with injuries are registered, but an unknown part of traffic accidents without injuries (the accidents that are not reported to the police) is not registered. The number of traffic accidents are supplied to REBUS annually. Data are provided on number of accidents with injured people, number of accidents without injured people and total number of injuries. No specific information is available on alcohol-related accidents. In earlier research it was shown that about 47% of all traffic fatalities is attributable to alcohol (Evans, 1990), which means that in this study relationships between traffic accidents and alcohol-related indicators will be confounded by non-alcohol-related traffic accidents. In this analysis the rate of traffic injuries is used, based on 1988 data, calculated as the number of traffic injuries per 10,000 inhabitants per neighbourhood.
Population figures, figures on marital status and unemployment rates, are supplied to the information system by the Municipal Bureau of Statistics. Data from the period 1987 to 1989 are utilised in this study.

Analysis

Rotterdam has about 600.000 inhabitants, divided among 83 neighbourhoods. All neighbourhoods are shown on the maps in the figures, but in this analysis neighbourhoods with less than 2000 inhabitants were excluded. This cut-off point was also used in comparable studies at the neighbourhood level (van Oers

and Teeuwen, 1991; van Oers and Koning-van den Berg van Saparoea, 1992). This exclusion of small neighbourhoods is necessary to avoid large fluctuation in the data due to large random effects. The remaining 55 neighbourhoods represent 97% of the total population.
Alternatively, combining small neighbourhoods with adjacent larger ones does not lead to a satisfactory solution. Because most neighbourhoods have more than one adjacent neighbourhood, this will lead to an arbitrary combination of neighbourhoods. Moreover, adjacent neighbourhoods can differ significantly from each other, not only with respect to the presented variables but in their complete physical and social structure.
The density of bars and liquorshops, and the rate of traffic injuries showed a very asymmetric distribution. For a correlation analysis at least a symmetrical distribution of the data is necessary. Based on the interquartile range, a number of outliers and extremes in the higher regions were detected. A square-root transformation, according to Tukey (1977) solved this problem, leading to symmetrical distributions for density of bars and the rate of traffic injuries. After transformation only one neighbourhood remained as an outlier and was removed from the dataset. In the case of liquorshops, the neighbourhoods without any liquorshops at the one hand and neighbourhoods with one or more liquorshops on the other represent two different groups. Both groups showed about equal variation in alcohol use, traffic injury rate and density of bars. Because it was clear that the data represented two different distributions, the neighbourhoods without any liquorshop were removed from the dataset and the analysis was performed only on neighbourhoods with one or more liquorshops.
After square-root transformation, Pearson correlation coefficients were calculated. All calculations were performed with the software-package SPSS/PC+ (Norusis, 1990)

Results

In table 5.4.1 some essential data are presented for Rotterdam. It can be concluded from the table that the selection of neighbourhoods with more than 2000 inhabitants does not affect the values significantly, justifying further analysis with the selected neighbourhoods.
Differences exist between neighbourhoods for all presented variables. The map of the percentage alcohol users (figure 5.4.1) shows clustering in a number of neighbourhoods, especially in neighbourhoods on the north bank of the river. The density of bars and liquor shops (figure 5.4.2 and 5.4.3) also show clustering in neighbourhoods on the north bank, although the clustering is not all the same as for the neighbourhoods with high a percentage of alcohol users. The traffic injuries (figure 5.4.4) are irregularly distributed over all neighbourhoods.
The correlation analysis showed a significant correlation between the percentage of alcohol users and the rate of traffic injuries (r= 0.41) and between the percentage alcohol users and the density of liquor shops (r= 0.29). No significant correlation was found between the density of bars and percentage alcohol users.

Significant correlations were found between the traffic injury rate and the density of bars (r = 0.48) and liquor shops (r= 0.69). No significant correlations were found between the percentage alcohol users on the one hand and percentage men in age group 20 – 39 years, percentage divorced and unemployment rate, on the other.
The most important correlation coefficients are summarised in table 5.4.2. In the figures 5.4.5 and 5.4.6 the relationships between traffic injuries rate and alcohol use and density of bars are shown.

Table 5.4.1 Data for Rotterdam, before and after selection of neighbourhoods

	value before selection	*value after selection*	*percentage remaining*
Mean population 1987–1989	*576.556*	*557.356*	*96,7 %*
Divorced (%)	*7,5 %*	*7,6 %*	–
Unemployed (%)	*22,0 %*	*22,0 %*	–
Respondents in health survey	*4.936*	*4.780*	*96,8 %*
Alcohol users (%)	*75,0 %*	*75,1 %*	–
Number of traffic injuries	*2.256*	*1.804*	*80,0 %*
Number of bars	*882*	*740*	*83,9 %*
Number of liquor shops	*94*	*88*	*93,6 %*

Discussion

The observed correlations between the percentage of alcohol users, traffic injuries, and density of bars and liquor shops can not all be explained in a simple way. The relationships between the percentage of alcohol users, rate of traffic injuries and density of bars seem to be obvious, although it must be kept in mind that only about 50% of the traffic injuries are supposed to be alcohol–related. This means that in the analysis the alcohol–related traffic injuries are confounded with non–alcohol–related traffic injuries. The positive relation between alcohol use and traffic injuries rate was found in other research (Moskowitz, 1989), but a positive relation between number of bars and traffic injuries was not found earlier.
The relationship between the percentage of alcohol users and density of liquor shops seems less logic but can be explained. In neighbourhoods with relatively more liquor shops it is possible that the percentage alcohol users can increase. Also, it seems logical that in neighbourhoods with a greater demand (that is to say a higher percentage of alcohol users) more liquor shops will move in.

Moreover, in this analysis we did not account for alcohol sales by supermarkets and filling stations.
For the above mentioned relationships between alcohol users and traffic injuries, traffic injuries and density of bars as well as the relationship between alcohol users and liquor shops, one must bear in mind that underlying variables like percentage divorced, unemployment rate and age distribution of the neighbourhoods can play an important role, although none of these showed a significant relation with the percentage of alcohol users (at the neighbourhood level).
The relationship between bars and liquor shops can perhaps point in the direction of economic activity of a neighbourhood. The relationship between density of liquor shops and traffic injuries can not be accounted for here, although one or more underlying variables (e.g. percentage alcohol users) are most likely playing a role.
Further research will be necessary to broaden the knowledge in this field. Especially more detailed information about alcohol-related traffic accidents should become available. At the moment under Dutch law, a blood alcohol test is not obligatory, hence the real percentage of alcohol-related accidents is hard to determine. In practice, this problem can be overcome in some way by using night time traffic accidents as a proxy for alcohol related accidents. Furthermore, it is necessary to have more information on traffic volume as it is better to base the traffic injury rates of the neighbourhoods not on the population but on the traffic volume. To gain more insight into the role of public transportation it would be interesting to compare the number of traffic injuries among the different groups of traffic participants.

In the context of alcohol use, traffic injuries, bars and liquor shops, preventive measures have been suggested by Mosher (1983) and O'Donnel (1985). For the prevention of alcohol-impaired driving, three basic components play a role: (1) educational programs for servers of alcoholic beverages; (2) laws and regulations; and (3) the environment of bars, especially in relation to the availability of public transport facilities.
In Rotterdam at the moment attention is given to the first two components. Educational programs have been developed and a municipal working group is studying the possibility of alcohol reduction policies at the local level. Potential policies are the reduction or prohibition of public alcohol advertising and the restriction of alcohol outlets. The third component mentioned above, the environment of the bars and the availability of public transportation, has not received great attention yet. Within the scope of probable alcohol reduction policies in Rotterdam, more attention has to be given to this component in the near future. In this way, environmental strategies can supplement the current individual-based alcohol-prevention programs.

Table 5.4.2 Correlation between alcohol-use, traffic injuries, bars and liquorshops per neighbourhood

	Alcohol users	*Traffic injuries*	*Bars*	*Liquor shops*
Alcohol users *(percentage* *alcohol users)*	1 - -			
Traffic injuries *(no. per* *10.000 inhabitants)*	$r = 0.41$ $n = 54$ $p < 0.001$	1 - -		
Bars *(no. per* *10.000 inhabitants)*	$r = 0.04$ $n = 53$ $p = 0.387$	$r = 0.48$ $n = 53$ $r < 0.001$	1 - -	
Liquor shops *(no. per* *10.000 inhabitants)*	$r = 0.29$ $n = 44$ $p = 0.029$	$r = 0.69$ $n = 44$ $p < 0.001$	$r = 0.43$ $n = 44$ $p < 0.001$	1 - -

Figure 5.4.1. Percentage alcohol-users per neighbourhood

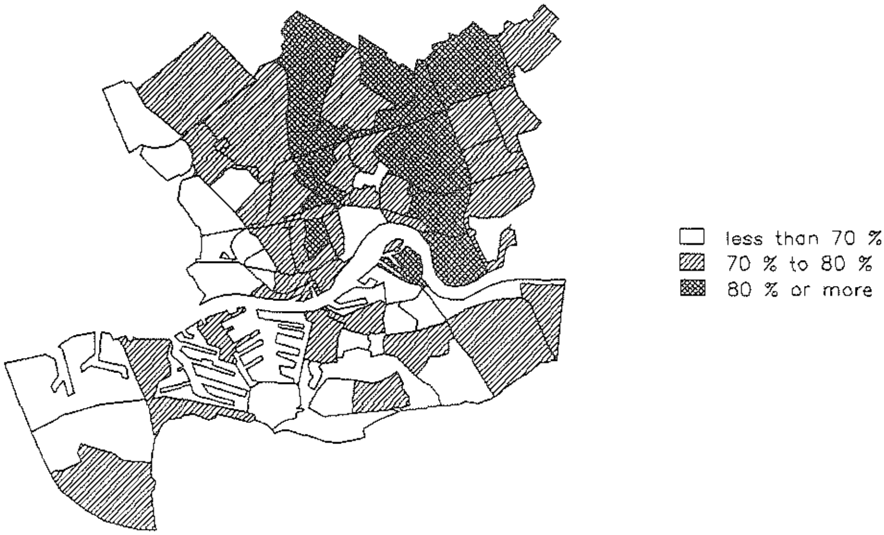


Figure 5.4.2. Number of bars per 10.000 inhabitants per neighbourhood.

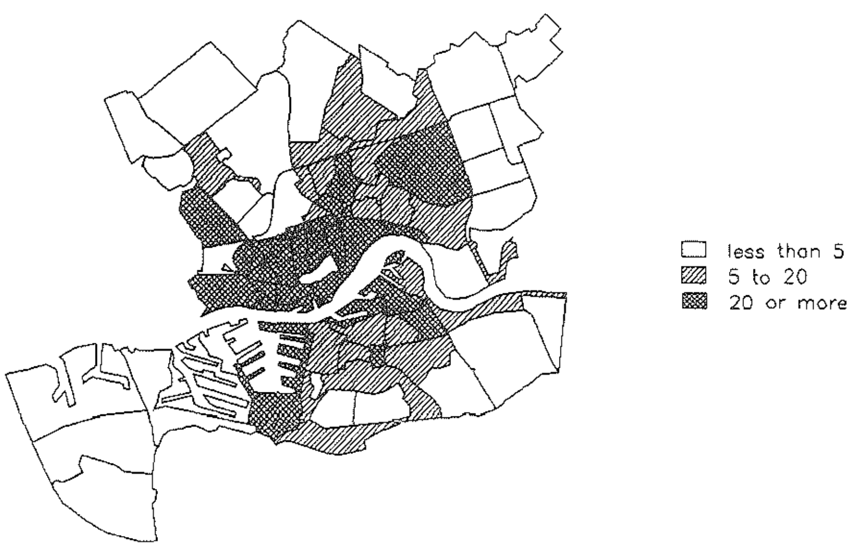


Figure 5.4.3. Number of liquorshops per 10.000 inhabitants per neighbourhood.

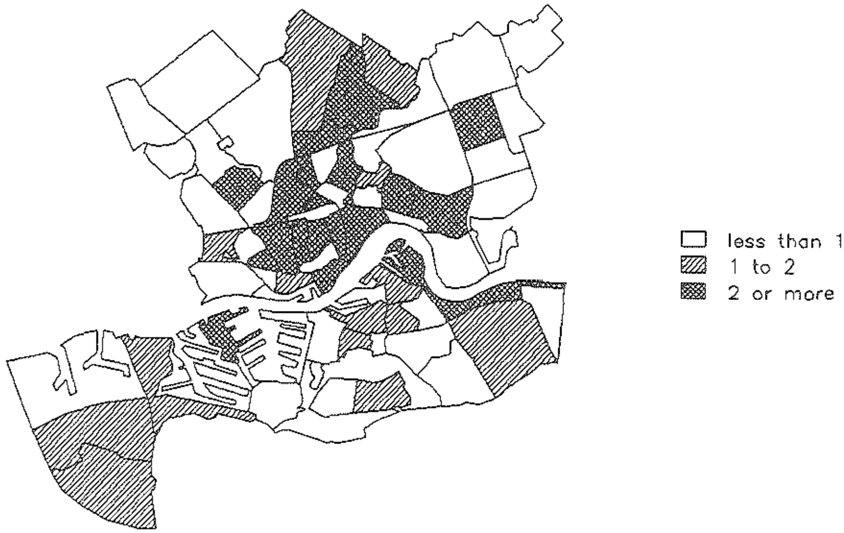


Figure 5.4.4. Number of traffic injuries per 10.000 inhabitants.

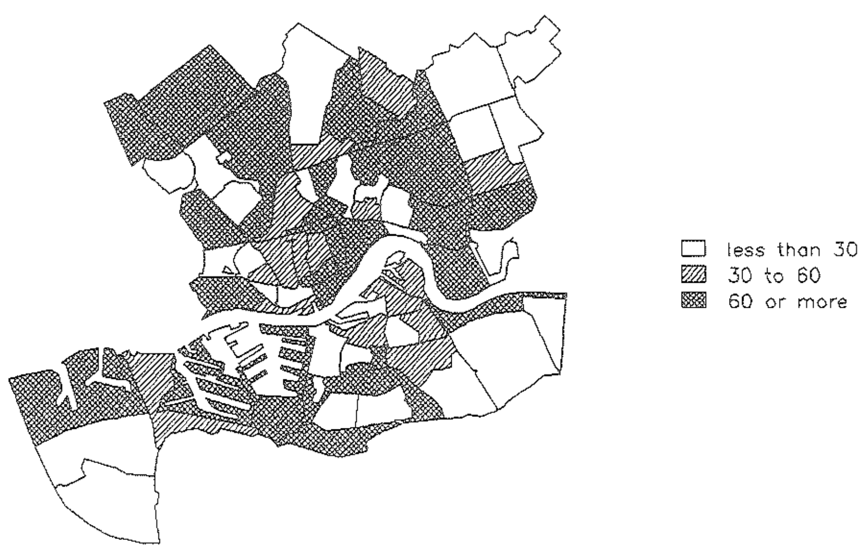


Figure 5.4.5. Traffic injuries rate
related to percentage alcoholusers

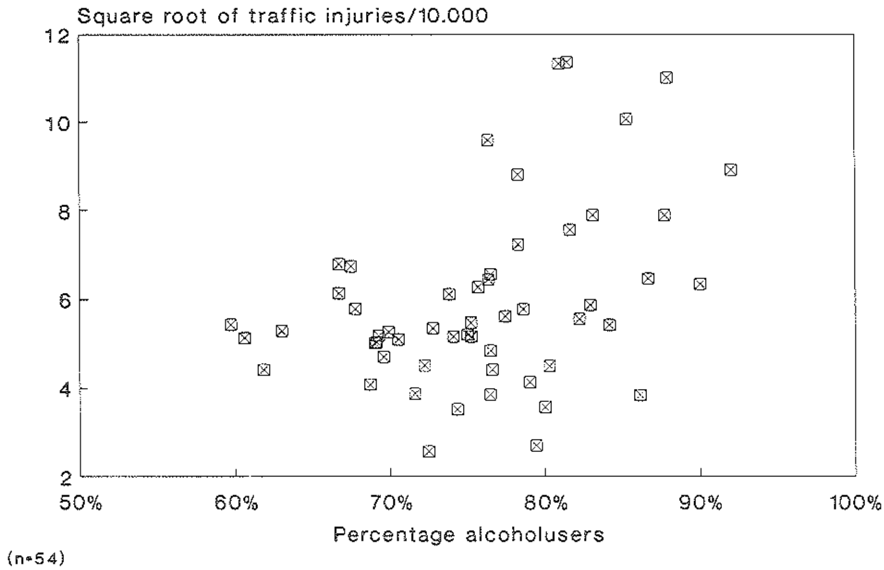
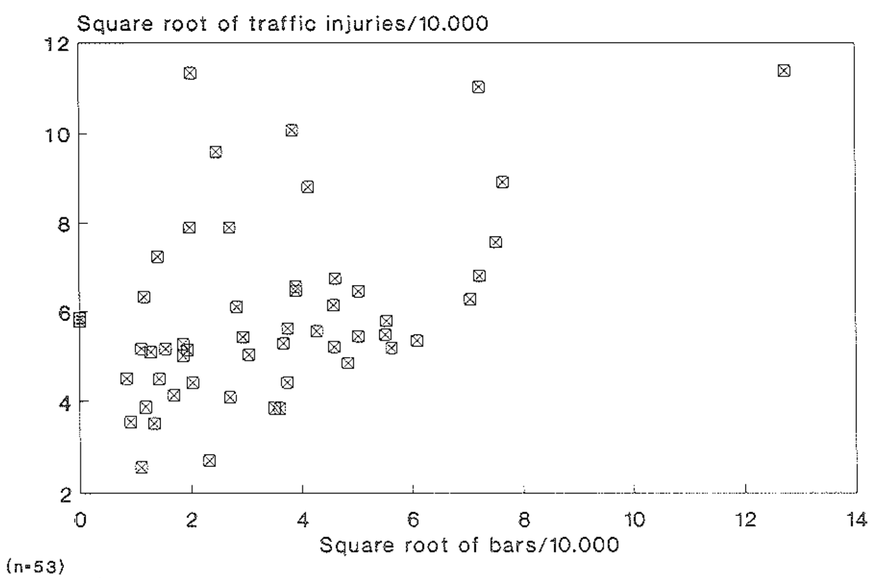


Figure 5.4.6. Traffic injuries rate
related to density of bars



5.5 Cervical cancer screening: role of socioeconomic status, marital status, ethnicity and general practitioner density*

Introduction

Attendance is an important factor contributing to the health effect of screening programs in general. In this paper data are presented on the geographic distribution of attendance to the cervical cancer screening program and the results of the smear-test in Rotterdam neighbourhoods, and on their spatial associations with data on socioeconomic status, marital status, ethnicity and general practitioner density. For policy purposes it can be important to know if there are differences in attendance between the Rotterdam neighbourhoods, and which factors probably give rise to these differences. A study on the attendance to the cervical cancer screening program in Florence, Italy showed that non-attenders can be divided into true refusers and women not attending for other reasons (e.g. migration or hysterectomy) (Ciatto et al, 1991). In this case-control study a significant association between socioeconomic status, marital status and attendance was found. Little is known about the attendance of migrant groups to screening programs, although it is supposed that attendance rates are lower in these groups. The role of general practitioner density in attendance in urban areas is greatly unknown.
Most, if not all of the studies, which have reported the above mentioned findings are case-control studies. In this study however, the findings are population based and not the result of a case-control study, where the question of representativeness of the controls arises. Furthermore, the relationship between socioeconomic status, marital status, ethnicity and general practitioner density on the one hand and attendance to screening on the other has not yet been studied at the neighbourhood level in Rotterdam, nor in other big cities in The Netherlands.
Due to the type of data, the described study has an explorative character and although the presented associations do not indicate causal relationships, they give rise to further investigations. Knowledge of such relations can be important for further development of a local health policy.

In the Netherlands a considerable cervical cancer screening program was undertaken during the period 1976-1984 in three regions: Nijmegen, Utrecht and

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Rotterdam. Women aged 35–54 were invited for a smear test at a three year interval. On the basis of this program the Evaluation Committee concluded that a centrally organised screening program could be implemented successfully in the entire Netherlands (Evaluation Committee, 1989). Such a nationwide screening program was already started during the course of the experimental program, but was "restyled" afterwards. In 1988 the "restyled" cervical cancer screening program was started in the Rotterdam region. In this new setup the target population remained the same: women aged 35–54. They are invited once in three years to attend the screening program. Invitations to the women are divided equally over the three year-period and the age-groups. The Municipal Health Service Rotterdam area functions as the coordinating institute (van der Poel and Raat, 1990). The cervical smear is taken by the patients own general practitioner, in contrast to the experimental program in the three regions.
In the experimental program in the three regions mentioned above, the attendance percentage was quite high, 60% to 70% (Evaluation Committee, 1988, 1989). In the "restyled" screening program the attendance percentage in the Rotterdam region varies from 47% for the city of Rotterdam to 57% for the surrounding municipalities.

Materials and methods

Materials
Data for the study described in this paper are provided by the Rotterdam Local Health Information System (REBUS). This information-system was setup by the Municipal Health Service (Garretsen et al, 1991, van Oers and Reelick, 1992). The central aims of REBUS are to gain insight into the health situation and health related factors in Rotterdam at neighbourhood level, and to contribute to the development of a local health policy for reducing noted differences in the health situation of the population.
REBUS is designed as a continuous information-system on health, which means that as far as possible and useful data are updated annually, as to make longitudinal comparisons possible.
A broad definition of health will be applied, as specified by the WHO: "Health is a condition of complete physical, mental and social wellbeing". The health status of the population is determined by several main groups of factors. In REBUS data on health status and of presence and use of health care facilities, social environment (e.g. education, income, occupation), physical environment (e.g. housing, traffic, urban renewal) and lifestyle (e.g. alcohol-use, tobacco-use) are included.
All data are stored in a central database and can be accessed in various ways by means of a range of standard software (dBase IV, SPSS/PC+, MapMaster, Symphony, Harvard Graphics).

Several variables with regard to screening on cervical cancer are included in the information-system, which are of interest in the underlying study.

Data on attendance to the cervical cancer screening program are provided by the Municipal Health Service for Rotterdam area, department of Epidemiology, being the coordinating institute of the screening program in the Rotterdam region. Aggregated at neighbourhood level the number of invited women and number of attended women are included yearly in REBUS. In this study the percentage of women attending the screening program per neighbourhood is used (attendance percentage in 1990 = number of women attending in 1990 / number of women invited in 1990). Data are used over the year 1990, both for the number of invited and for the number of attending women. In this way the women invited in 1990 but attending in 1991 are excluded, and women invited in 1989 but attending in 1990 are included in the study. The overall effect will be that these false inclusions and exclusions compensate each other.
The results of the smear-test are provided by the Foundation Cooperative Pathologists in Rotterdam and the Leiden Cytology and Pathology Laboratory. These data are also aggregated at neighbourhood level, divided into the standard Papanicolaou-classes (PAP-classes), and added to REBUS each year. For the purpose of this study two different definitions for positive smears were used.

> *In the screening practice a smear-test result of PAP 3B, PAP 4 and PAP 5 (severe dysplasia or worse) is always followed by a histological examination within a month, at the gynaecological practice. The first group of women with positive smear is thus defined as all women having a smear-test result of PAP 3B, PAP 4 or PAP 5. Women with a smear-test result of PAP 3A in the screening program are requested for a second smear at the general practitioners', within three months. The second group of women with positive smear is thus defined as all women having a smear-test result of PAP 3A, PAP 3B, PAP 4 or PAP 5.*

The percentage positive per neighbourhood was calculated (percentage positive = number of positive women in 1990 / number of women attending in 1990).
Population figures, figures on marital status, ethnicity and the indicator for socioeconomic status are provided by the Municipal Centre for Statistics. Population figures date from 1990. The indicator for socioeconomic status is composed from several variables by means of a principal component analysis (Chatfield and Collins, 1980; Leijs and Das, 1991). Variables such as educational level, unemployment, income, percentage migrants, percentage receiving benefits are used to form a single indicator for the socioeconomic status of a neighbourhood. A negative value indicates a low socioeconomic status, a positive value indicates a high socioeconomic status. The socioeconomic indicator is determined and published every four years. In this study data for 1991 are used.
The number of general practitioners per neighbourhood are compiled by the local organisation for general practitioners, and supplied each year to the information-system. In this analysis density figures are calculated as the number of general practitioners per 1.000 inhabitants per neighbourhood. Data are used over the year 1990.

Methods

Rotterdam has 572.000 inhabitants, divided among 83 neighbourhoods. All neighbourhoods are shown on the map in the figures. Neighbourhoods consisting of 2000 inhabitants or less are excluded from the analysis. This cut–off point was also used in comparable studies at neighbourhood level (van Oers and Teeuwen, 1991; van Oers and Koning–van den Berg van Saparoea, 1992). This exclusion is necessary to avoid large fluctuations in the data due to large random effects. In total 50 neighbourhoods remained in the analysis, representing 94% of the Rotterdam population.

The data on ethnicity and marital status show a very asymmetrical distribution. For a parametric correlation analysis at least a symmetrical distribution of the data is necessary. Based on the interquartile range, which is the difference between the 25th and the 75th percentile, a number of outliers and extremes (more than 1.5 and 3 interquartile ranges distant from the 75th percentile respectively) in the higher regions were detected. A square–root transformation, according to Tukey (Tukey, 1977) solved this problem, leading to symmetrical distributions for all variables. After transformation Pearson correlation coefficients were calculated. All calculations were performed using the software package SPSS/PC+ (Norusis, 1990).

Results

About 18% of the Rotterdam population belongs to the ethnic minorities, 12.5% having a foreign nationality. The three major groups of ethnic minorities are the Turkish (25%), Moroccan (15%) and the Surinam and Antillian (43%) inhabitants, the latter group almost exclusive having the Dutch nationality (van Zundert, 1989). In table 5.5.1 some essential data are presented for Rotterdam. This table shows that the selection of neighbourhoods with more than 2000 inhabitants does not effect the used variables in a great sense, justifying further calculations with the selected neighbourhoods.

Between neighbourhoods large difference in attending the screening program exists. Table 5.5.2 shows a mean attendance of 48.9 % in 1990 for the 50 selected neighbourhoods, varying from 24.6 % to 58.6 %. Figure 5.5.1 shows the city of Rotterdam with the attendance percentage per neighbourhood. The percentage women with positive smear tests (both with and without PAP 3A) also varies per neighbourhood. The mean value of the percentage positive (including PAP 3A) is 1.7 % positive, varying from 0 % to 5.5 % per neighbourhood (see table 5.5.2, figure 5.5.2).

The correlation analysis showed a significant correlation between the socioeconomic status of a neighbourhood, the percentage migrants, marital status and the attendance to screening. A high socioeconomic level of a neighbourhood correlates with a high percentage women attending the screening program. In figure 5.5.3 this correlation is visualised. A high percentage of migrants correlates with a low attendance percentage. In addition, a low socioeconomic status of a neighbourhood correlates with a high percentage of migrants. A high percentage married women and a high percentage widowed women correlates with a high attendance percentage. On the contrary a high percentage singles and divorced women correlates with a low attendance percentage. No significant correlation was found between the general practitioners density and the attendance percentage. The results of this correlation analysis are summarised in table 5.5.3.

Table 5.5.1 Essential figures for Rotterdam overall and for selected neighbourhoods

	overall Rotterdam	*after selection*	*percentage remaining*
number of neighbourhoods	*83*	*50*	–
inhabitants 1990	*582242*	*545251*	*93.6*
migrants	*72579*	*70141*	*96.6*
mean age	*38.9 year*	*37.7 year*	–
single	*254979*	*239285*	*93.8*
married	*237465*	*221348*	*93.2*
divorced	*44801*	*42399*	*94.6*
widowed	*44997*	*42219*	*93.8*
general practitioners	*258*	*248*	*96.1*
invited for cervical cancer screening	*24973*	*23303*	*93.3*
attending the screening program	*11870*	*11390*	*96.0*
attendance percentage	*47.5%*	*48.9%*	–
positive result smear test (PAP 3B, PAP 4, PAP 5)	*48*	*45*	*93.8*
percentage positive smear test (PAP 3B, PAP 4, PAP 5)	*0.4%*	*0.4%*	–
positive result smear test (PAP 3A, PAP 3B, PAP 4, PAP 5)	*197*	*190*	*96.4*
percentage positive smear test (PAP 3A, PAP 3B, PAP 4, PAP 5)	*1.7%*	*1.7%*	–

Although not very strong, a significant correlation was found between both the socioeconomic status and percentage migrants and the percentage with a positive smear test (PAP 3A, PAP 3B, PAP 4, PAP 5) in a neighbourhood. No significant correlation was found between marital status and general practitioner density at the one hand and positive smear test at the other. When the PAP 3A category is excluded, no significant correlation is found, probably due to small numbers. The results of this correlation analysis are presented in table 5.5.4.

Table 5.5.2 Review of data used in the analysis. Values given per neighbourhood, the mean based on the selected 50 neighbourhoods

	Mean	*Minimum*	*Maximum*	*Transformation*
inhabitants	*10905*	*3129*	*29256*	
migrants	*12.9%*	*1.3%*	*40.9%*	*square root*
mean age	*37.7*	*29.6*	*47.9*	
single	*43.9%*	*31.0%*	*57.0%*	*square root*
married	*40.6%*	*29.6%*	*51.8%*	*square root*
divorced	*7.8%*	*3.2%*	*13.4%*	*square root*
widowed	*7.7%*	*3.3%*	*14.0%*	*square root*
general practitioners density	*0.45*	*0.06*	*1.57*	*square root*
socioeconomic status	*0*	*-1.71*	*1.83*	
attendance percentage	*48.9%*	*24.6%*	*58.6%*	
percentage positive smear test (PAP 3B, PAP 4, PAP 5)	*0.4%*	*0%*	*2.0%*	
percentage positive smear test (PAP 3A, PAP 3B, PAP 4, PAP 5)	*1.7%*	*0%*	*5.5%*	

Figure 5.5.1. Attendance to cervical cancer screening per neighbourhood

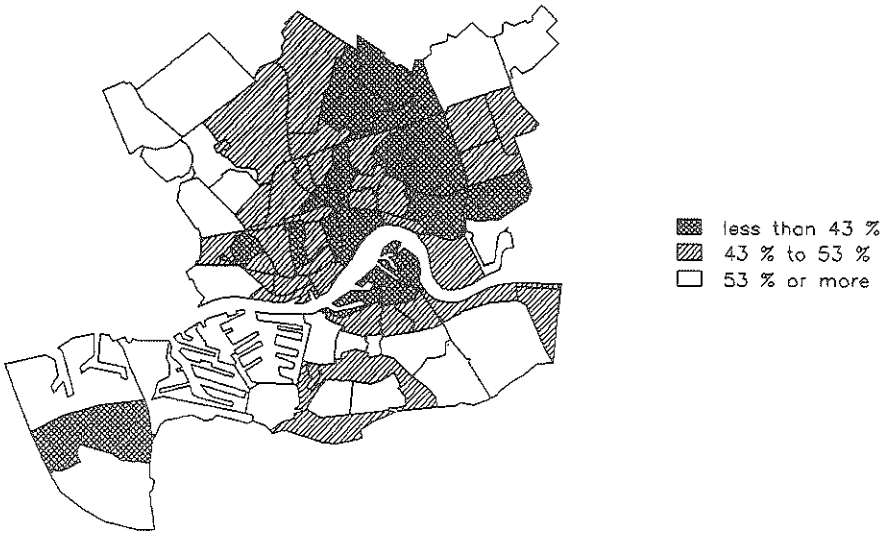


Figure 5.5.2. Percentage positive smear-test per neighbourhood

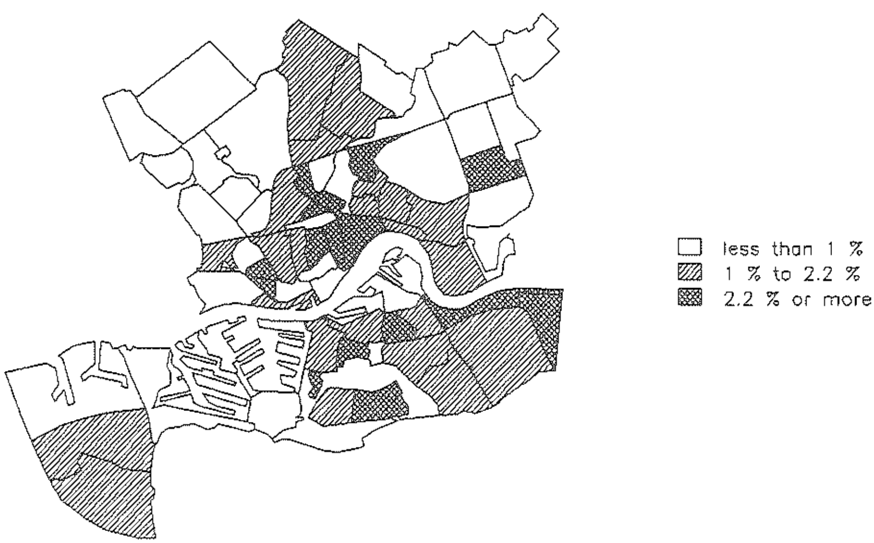


Table 5.5.3 Correlation between respectively socioeconomic status, marital status, percentage migrants, general practitioner density and attendance to cervical cancer screening

	correlation coefficient	*significance*	*N*
socioeconomic status	*0.53*	$p < 0.001$	*50*
percentage migrants	*-0.54*	$p < 0.001$	*50*
percentage single	*-0.61*	$p < 0.001$	*50*
percentage married	*0.60*	$p < 0.001$	*50*
percentage divorced	*-0.39*	$p < 0.001$	*50*
percentage widowed	*0.47*	$p < 0.001$	*50*
general practitioner density	*-0.22*	*n.s.*	*50*

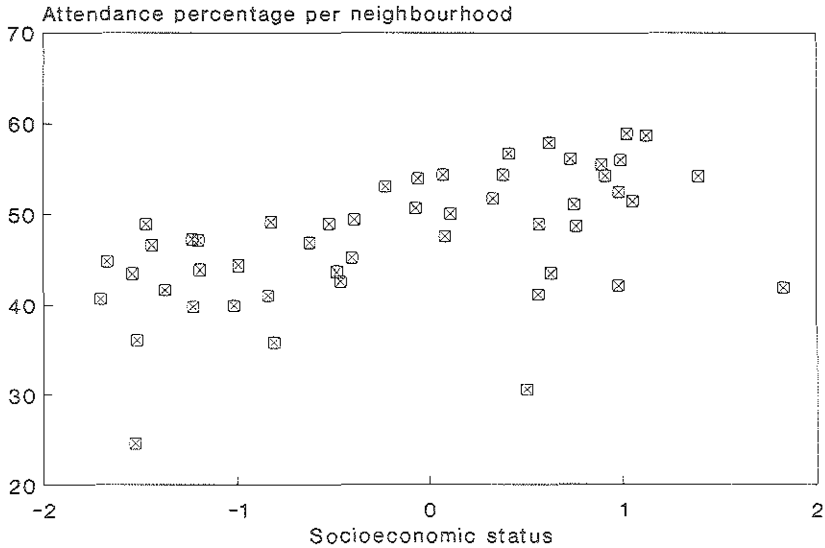
Table 5.5.4 Correlation between respectively socioeconomic status, marital status, percentage migrants, general practitioner density and positive smear test (PAP 3A, PAP 3B, PAP 4, PAP 5)

	correlation coefficient	*significance*	*N*
socioeconomic status	*-0.27*	$p < 0.05$	*50*
percentage migrants	*0.30*	$p < 0.05$	*50*
percentage single	*0.22*	*n.s.*	*50*
percentage married	*-0.20*	*n.s.*	*50*
percentage divorced	*0.13*	*n.s.*	*50*
percentage widowed	*-0.16*	*n.s.*	*50*
general practitioner density	*-0.03*	*n.s.*	*50*

Discussion

The results from the study enable us to identify the neighbourhoods showing low attendance percentages in the screening program for cervical cancer. Besides, common factors playing a role in low attendance rates were identified: socioeconomic status, percentage migrants and marital status. One must however bear in mind that the attendance can be distorted because of factors like migration or previous hysterectomy.

Figure 5.5.3. Relation between SES and attendance to cervical cancer screening



Screening year 1990

The relation between socioeconomic status and attendance was shown earlier at an individual level, based on a random sample of 94 refusers and 94 attenders (Ciatto et al, 1991). However, in this study only two educational levels were used as the sole indicator of socioeconomic status. A Dutch study showed the same relation between attendance and socioeconomic status. In this study the way of health insurance was used as the indicator of socioeconomic status: private health insurance for high socioeconomic groups, sick-fund insurance for low socioeconomic groups (Verberk, 1988).
The percentage migrants living in a neighbourhood is closely related to the socioeconomic level of that neighbourhood. The significant relation that was found between the percentage migrants and attendance seems to be logical in this way. It must be kept in mind however, that the migrant groups are approached more emphatically for attendance to the cervical cancer screening program than the non-migrant groups. It seems that, in spite of this special approach, the barrier to attending is still higher for migrant groups.

The relation between marital status and attendance was reported before in a Belgian study Hal et al, 1987) and in the earlier mentioned Italian study, both at the individual level.
No relation was found between general practitioner density and attendance. Obviously, the observed differences in general practitioner density between the neighbourhoods does not affect the attendance.
Future activities aiming at improvement of attendance of the cervical cancer screening program can be focused on those neighbourhoods being identified as having low attendance percentages, or to the lower socioeconomic groups. For example special promotion campaigns can be organised, focused on neighbourhoods with low attendance percentages. In addition special attention for migrants will be necessary, for improving the attendance of these groups to the screening program. One possibility may be active case-finding by the general practitioner. Further research is directed at what factors at the individual level play a role in not attending the screening program, and how the attendance can be improved.
A weak significant relation was found between socioeconomic status and percentage women with a positive smear test (including PAP 3A). This finding is in accordance with literature in the field of socioeconomic health differences (Logan, 1982). The absence of this relation when the number of positive smear test is restricted to PAP 3B, PAP 4 and PAP 5 is probably due to the low occurrence of positive smear tests in this group.

5.6 Presenting health information at the local level. REBUS VISION: a software package to define a community diagnosis

Introduction

Policy makers, service providers, health educators and citizens ask for readily available information to assess, monitor and evaluate the health of the population (Reynolds and Chambers, 1992). Increased emphasis on health promotion has led to the need for clear and digestible health information. Local responsibility for planning and priority setting in the field of health policy makes it necessary that policy makers have full access to results of local health research to improve decision making. However, researchers do not always know exactly what kind of health information policy makers need. Moreover, parts of the scientific information is published in specific journals, not reaching potential local users. All in all, it can be stated that the health information produced by local health research has to be made better available for health policy makers, without overloading them with large amounts of unnecessary information. For this reason, the computer program REBUS VISION was developed, which will be described below.

Objectives of REBUS VISION

To meet the needs of policy makers the Municipal Health Service developed a computer program to make the information collected in the Rotterdam Local Health Information System better available for policy makers. With this software package users can look up their own neighbourhood and district and can create their own community profile. It enables policy makers to take a close look at the available data by themselves and to make their own choice. They had to be able to do this without having prior knowledge of the structure of the Rotterdam Local Health Information System and without having to study extensive manuals of the software. The application should be set up in such a way that one could use it in an intuitive way.

The main objectives of REBUS VISION were threefold. First, the application is intended to give users the opportunity to inspect the collected data in order to monitor the health situation of the local population. Not only information about health should be obtainable, but also about health care, lifestyle and the environment. In the second place, it was felt that the users themselves should decide which issues are relevant to them. The users should decide about what indicators they want information and about which neighbourhoods they want to have that information. In the third place the program should make comparisons possible between neighbourhoods, districts and the total municipality. In this way it is possible for policy makers to identify areas with specific health problems. This knowledge could support them in defining policies aimed at these problems,, and could give rise to the formulation of additional research questions.

Furthermore, the program should be very user-friendly, easy to learn and by its appearance more or less an invitation to use. Graphs and maps have proved to be very useful to communicate quantitative information. Accessible information on graphics design and examples of quality graphs that were intended to convey information efficiently may be found in Tufte (1983) and Meilach (1986). It was therefore decided to use graphical methods in an extensive way in presenting the information.

Description of REBUS VISION

As mentioned above, REBUS VISION is based on information collected in the Rotterdam Local Health Information System. REBUS VISION is meant to be the connection between this health information system and the daily work situation. In the program the collected information is divided into five groups: demographic structure (age and ethnicity), socioeconomic structure (households, living situation, education and deprivation), physical environment (housing, provisions, traffic, criminality), lifestyle (tobacco, alcohol, harddrugs, tranquilisers) and health and health care provisions (mortality, morbidity, perceived health, health care).

Neighbourhoods and districts can be chosen by the user by means of the map of Rotterdam appearing on the screen, or otherwise can be picked from a table. Besides neighbourhoods and districts any combination of neighbourhoods can be selected and saved.
A neighbourhood can be compared with the mean of the district to which it belongs and with the mean of Rotterdam as a whole. Neighbourhoods can also be compared with each other. This comparison is made visible through bar charts which are displayed on the screen. Furthermore, a map of Rotterdam divided into its neighbourhoods can be shown, in which the information is displayed in categories.
It is important to provide the right amount of background information to enable proper evaluation of the presented information possible. In REBUS VISION this background information is available throughout the program and consists of information about original data source, year of collection of the data, number of respondents, a description of the indicator and reference to relevant literature.

The program REBUS VISION was brought about by means of evolutionary development. In short time a modular prototype was developed, assuring ongoing interaction between developers and potential users. In later stages of the project new functions and modifications of existing functions could be realised relatively easy. This process of permanent feed back from potential users showed to be a very useful method for developing a practical tool like REBUS VISION.
Recent software developments made clear that the use of high resolution colour display and a mouse form an important contribution to the attractiveness and user-friendliness of an application. However, this should not imply that extreme demands have to be put on the required computer configuration, as the application should be made available and usable as wide as possible. To make the program available for a wide range of users, the hardware platform used is the IBM-compatible PC working under MS-DOS version 3.3 or higher, with 640 Kbyte of internal memory of which REBUS VISION uses 530 Kbyte. A harddisk is not necessary, but improves the performance of the application substantially. A choice was made for a standard 16 colour VGA-resolution screen. In the application the colour-palette can be adjusted, making the program compatible with monochrome VGA-displays. The program is fully mouse-driven, although all functions are also available by using key combinations. The barcharts and maps of Rotterdam produced on the screen can be printed on a variety of dotmatrix printers, laserprinters and colour inkjetprinters.
Most of the attractiveness and usefulness of REBUS VISION cannot be described on paper, but will become clear when using the program. Therefore, a copy of the program is enclosed on diskette.

Conclusions

It can be concluded that REBUS VISION is a software package that gives access to a large amount of information about health and health-related issues in an attractive way, without the user feeling drowned with information. The user is confronted only with the information asked for. The attractive way of searching for and looking at the information stimulates policy makers to work with the software package. In this way a greater awareness of specific health problems in the neighbourhoods is achieved, and insight is given into the relative importance of specific health problems. The link between health information and policy formulation is strengthened and policy makers are better provided to formulate new research questions.
Because the software package contains information on a wide selection of issues, attention for health is achieved within other sectors than the health care sector and everyone concerned has the same data at his or her order.

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Chapter 6

Conclusions and discussion

6.1 Introduction

The general purpose of this study was to develop an instrument to make geographical epidemiological information available to and suitable for policy makers. Three questions were derived from this general purpose.

1. Is it possible to set up a geographic information system, to obtain insight into the health situation in neighbourhoods?
2. Can such a geographic information system be used for performing epidemiological research?
3. Can such a geographic information system be used for developing and supporting local health policy?

The conclusions will be discussed in the three following paragraphs. It should be noted that a clear difference between research and policy support is difficult to make. In this study health policy support means research that is directly applicable in the given local circumstances.

6.2 Designing a local health information system

In this study it was concluded that it is possible to design a geographic information system, which can be used to obtain insight into the health situation in the neighbourhoods, using existing data sources. For the city of Rotterdam a system was developed comprising the essential elements of a geographic information system: data acquisition, data organisation, manipulation and analysis, and report generation. The system could be built up with standard software for the PC, working with MS-DOS.

By far the most important and time consuming part of the development of the system is data acquisition at the neighbourhood level. It turned out that in Rotterdam a large quantity of data relevant to health is collected at neighbourhood level in existing registrations. A factor of major importance is that these registrations are managed by one single municipality. Registrations at a higher level of aggregation can give rise to several problems, for example the national registration of mortality by cause-of-death does not include a postal code, making it impossible to use the registration at neighbourhood level. All registrations used included all Rotterdam neighbourhoods, which means that the data definition was identical for all neighbourhoods. In almost all cases it was possible to aggregate the collected data to the same geographical level, the neighbourhood. Because existing registrations were used the continuity of the data availability over the years was secured for the greater part of the data. Still, in a small number of cases the registration was changed or, in one case, abolished.

As a secondary user of the data, it is only possible in a few cases to influence what data is to be collected and in what way. An exception to this is the data collected within the Municipal Health Service itself. In most cases however, it was not the most ideal indicators which were collected.

It is striking that the portability (from one computer to the other) of the data is very small. A number of registrations are still not automated, and the larger part of the automated registrations has low portability because of hardware and software restrictions. Only data from a few registrations can be appended directly to REBUS.

The data is collected at neighbourhood level. This puts certain restrictions on the data collection. It is not a registration of the individual, therefore no individual relations between the variables can be investigated. However, the advantage of the collection at neighbourhood level is that the database is kept relatively small.

The geographic information system is set up in standard software, suited to MS-DOS computers. It does contain limited possibilities for spatial manipulation. Spatial aggregation, recoding and overlay techniques are standard techniques which are available to some extent. For the development and support of health policy at the neighbourhood level it is not directly necessary to have more analytical power available. Because of the way the database is set up, the analytical possibilities are restricted. The geographic information system will be specifically suited to explorative, ecological studies with the neighbourhood as unit of analysis, although surveys have to be combined over several years to obtain enough respondents for analysis at neighbourhood level. Because of the small numbers and privacy problems, analytical problems occur sometimes. To be able to use the geographical information in the database in an optimal way for research purposes, it is however necessary to have more possibilities for spatial analysis available.

6.3 Using a local health information system for epidemiological research

The second question in this study concerned whether a geographic information system can be used for epidemiological research. This was shown to be the case. Examples of local health research are given from three different points of view. In the first place an example (chapter 5.2) is given of how existing socioeconomic health differences can be visualised for the local politicians. The second example (chapter 5.3 and 5.5) shows how the local health care management can be supported by using the information system. The third example (chapter 5.4) highlights the possibilities for strengthening intersectoral cooperation by means of research.

The first research example was detailed chapter 5.2. The purpose of this study was to investigate the socioeconomic health differences between neighbourhoods. Reduction of inequalities in health is an essential aspect within the framework of the Healthy Cities Project. It was concluded from this study that in Rotterdam in neighbourhoods with a lower socioeconomic status, mortality is higher than in neighbourhoods with a higher socioeconomic status. There are several neighbourhoods in Rotterdam which are characterised by both socioeconomic problems and health problems. This unequal distribution of health has led to greater awareness of policy makers for these deprived areas. Policy proposals and activities were developed with considerable attention focused on neighbourhood-oriented work.

Examples of the second point of view are detailed in chapters 5.3 and 5.5. The health care system is one of the health influencing factors within the Healthy Cities Project deserving renewed attention. The presented examples show how the local health care system can use the information collected in a geographic information system.
In chapter 5.3 a study on socioeconomic status and the use of district nursing is described. In this study no relationship was found between the socioeconomic status of a neighbourhood and the number of patients cared for by district nurses. There was however a relationship between the number of home visits and socioeconomic status of a neighbourhood. In neighbourhoods with a low socioeconomic status the patients had more contacts with the district nurse than in neighbourhoods with a higher socioeconomic status. Although such relationships do not demonstrate causality, they do provide insight into the need for further studies. The results are in any case sufficient reason to consider a correction for socioeconomic status in the allocation of personnel and funds to the various neighbourhoods.

In chapter 5.5 a study on attendance to cervical cancer screening is given. The purpose of this study was to identify neighbourhoods showing low attendance rates and to identify common factors playing a role in these low attendance rates. This study showed that socioeconomic status, marital status and percentage migrants in the neighbourhood play a significant role in the attendance to the screening program. No relation was found between general practitioner density and attendance rate. The results can lead in the future to focusing activities on improving attendance in those neighbourhoods identified as having low attendance rates (e.g. special promotion campaigns). In addition special attention might be necessary for migrants, for improving attendance to the screening program of these groups.

An example of the third point of view shows how the information system can be used to support intersectoral research and in this way trigger the development of health policy outside the health sector itself. The decrease in alcohol–use and alcohol related problems (such as traffic accidents) are mentioned in two targets of the Healthy Cities Project. In chapter 5.4 a study on the geographic relationship between alcohol–use, bars, liquorshops and traffic injuries is explored. Knowledge of such relations can be important for further development of a multi–sectoral local health policy. The analysis showed a significant correlation between the percentage alcohol–users and the rate of traffic injuries and between the percentage alcohol–users and density of liquorshops. No significant correlation was found between the density of bars and percentage alcohol–users. Significant correlations were found between the rate of traffic injuries and the density of bars and liquorshops. It will be evident that the analysis has an explorative character. Further research will be necessary to broaden the knowledge in this field so that environmental strategies can supplement the current individual–based alcohol–prevention programs.

6.4 Using a local health information system for health policy support

The third question in this study was whether a geographic information system can be used for developing and supporting local health policy. In this study it was shown that a geographic information system can support local health policy by making existing epidemiological research better available to policy makers. It is difficult to prove that one single tool actually plays a supportive role in the policy process, because the policy process itself is rather untransparant (de Jong, 1986). Still there are a developments in Rotterdam, where the utilisation of the collected information in REBUS has played a significant role.
The collected information is used in different ways and at different levels in the city to support local health policy. In general it can be stated that REBUS has created a degree of standardisation in health information, thus facilitating interaction between researchers and policy makers. The information acts as a common reference for the different forces in the field of health. It has contributed to a better notion of health and health related issues and to putting health on the political agenda.
At the city level local health policy may need a general description of the health situation. Information is needed to monitor the health situation of the total population through the years and to give insight into differences in health between the neighbourhoods. The information from REBUS can be used to produce a general community diagnosis of the population. An example of such a community diagnosis is given in chapter 5.1. On a regular basis these reports are published for the local government (van Oers et al, 1988, 1991, 1993). The information makes it possible to compare neighbourhoods in an objective way,

based on a large number of indicators. REBUS forms an important source of information for the Healthy Cities Project. Amongst others, information from REBUS about the health situation in deprived neighbourhoods supported the selection of neighbourhoods receiving special support from the Healthy Cities Project (de Vries et al, 1990; van den Bogaard et al, 1991).

Also at the neighbourhood and district level the information from REBUS is used to support health policy, although in a somewhat different way. In the first place the information can be used to describe the health situation in a neighbourhood in a detailed, both quantitative and qualitative way. Examples of such descriptions of the health situation are given in Van Gilst et al (1990a, 1990b) and Van Dueren den Hollander et al (1990). On the basis of these health descriptions specific health action plans for the neighbourhoods can be made.
Furthermore at the neighbourhood level the information is used to start and to support activities. Examples of these activities are described in De Jonge et al (1990) and De Vries (1992) concerning activities in the neighbourhood Feyenoord and Van Gilst et al (1993) concerning activities in the neighbourhood Het Oude Westen. Because REBUS acts as a catalyst at neighbourhood level, health issues are receiving much more attention in these neighbourhoods. REBUS produces information that leads to improvement in the communication between special interest groups and the local government. It contributes to the advancement of expertise of the workers in the neighbourhood and it enhances the involvement of the inhabitants.
Besides the above mentioned policy support aimed at specific groups, the software package REBUS VISION described in chapter 5.6 gives information relevant to all groups. In principle it is the same information, but presented in a way best suited to the specific user. The user is only confronted with the information requested. REBUS VISION gives access to large amounts of information about health and health-related issues in an attractive way, without the user feeling a sense of being drowned with information.

From the above-mentioned it can be concluded that the three central questions in this study are answered in the affirmative. Despite the many restrictions, the study showed that a geographic information system can be a useful tool in epidemiological research and health policy support at the local level.

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Summary

Background and purpose of the study

This book deals with the development and use of a geographic information system for local public health policy. Health differences between populations in different geographical areas, large (countries) or small (city–neighbourhoods) have always been a challenge to epidemiologists and policy makers. To epidemiologists, these differences can give insight into the health effects of certain exposures, for policy makers these differences can give rise to well–targeted interventions.

Making epidemiological knowledge available to and suitable for policy makers is a major task of the Municipal Health Service. A description of the health situation by means of a community diagnosis can accommodate the requirements of the local politicians. However, it is necessary that a community diagnosis is provided not only for the total municipality, but also for separate districts and neighbourhoods. For this purpose the Municipal Health Service in Rotterdam started the development of a geographic information system. Three questions form a central part in this study:

1. Is it possible to set up a geographic information system, in order to obtain insight into the health situation in neighbourhoods?
2. Can such a geographic information system be used for epidemiological research?
3. Can such a geographic information system be used for developing and supporting local health policy?

In the first part of the study attention is focused on recent developments in health policy, the concept of a community diagnosis and the potentials of geographic information systems for local health policy. In the second part of the study the theory is worked out for the situation in Rotterdam.

Health research and local health policy

Development of a local health policy is an essential part of the WHO Healthy Cities Project. Also the Dutch government underlines in the Nota 2000 the urgency for regional and local government to develop a health policy adjusted to the regional and local circumstances. For the development and support of a local health policy the Municipal Health Service is the major authority.

For a local health policy four essential conditions have to be met. *Political commitment* is a basic necessity for the development and implementation of a new health policy. The health sector will not be able to solve all health–related

problems, so *intersectoral cooperation* is necessary to tackle the encountered problems. People must be aware of their own responsibility concerning health, which can be achieved by *active participation* in the development and evaluation of health policy and the search for health promoting solutions. Health policy needs to be supported with *information about the health situation*.
Districts and neighbourhoods are regarded by local authorities as a sound basis for developing (health) policies and are often recognisable geographical units, which may encourage participation of the local population. To give an extensive description of the health situation, it is necessary that data from different policy sectors can be linked together. This leads to the creation of a so-called community diagnosis. The purpose of a community diagnosis is (1) to describe and monitor the general state of health of the community, (2) to function as a warning system, that can identify specific health problems and (3) to improve the possibilities for the evaluation of local health policy and health care.
Once valid information is obtained, it must be made accessible to others. Graphical information can be presented in an attractive way, quickly and selectively, drawing attention to what is important. Spatial distributions and patterns can be readily appreciated and analyzed. A geographic information system collecting information on health and health related factors at the neighbourhood level seems to be a promising tool in this context.

Geographic information systems at a local level

A geographic information system may be thought of as a specialised form of database system. Four specific subsystems or processes can be distinguished: data acquisition, data organisation, data analysis and report generation. The type of information to be produced with a geographic information system is dependent on the kind of user.
Researchers preparing policy studies have to be able to conduct research, based on information collected in the geographic information system. The task of policy decision makers is to evaluate policy options, and information supplied by research is one of the factors on which it is based. The growing awareness of geographically determined problems and the increasing complexity and amount of spatial data means that there is an increasing need for a decision supporting environment for these users. A necessary condition is that the information supplied to the decision makers and the rules for evaluating alternatives should be uncomplicated, unambiguous and easy to understand to ensure that policy makers use it in an optimal way.
Interested citizens, pressure groups, special interest groups and various social (locally oriented) organisations are characterised by a need to be kept informed continually about issues involving demographic structure, physical and social environment and health. It is believed that there is a large potential demand for information systems in which the most important up-to-date information on these topics is made available. For this group of users geographic information systems can contribute to the democratisation of decision-making.

Geographic information systems in the field of health research and public health policy have in general three main functions: (1) monitoring and evaluation, (2) policy formulation and planning and (3) research. Health policy is conducted at different governmental levels. Although each level might deal with the same public health issues, a considerable difference in policy making can be found between these levels. In essence, this is a consequence of the different scale of observation, related to the size of the area of responsibility.
The WHO is concerned with policy making on a global scale, studying global trends and promoting new policy programs. Geographic information systems are used at this level to clarify differences between member states in aspects of the health situation. These insights can be used to support new global or continental strategies on health.
At the national level information is needed about the national health situation and health care provision at a regional level. In The Netherlands Regional Health Profiles for each of the 65 public health regions have been compiled. The purpose of these profiles is to provide health information to local politicians for directing intervention and research programs in their own region.
Local public health services are concerned with health care planning, health promotion and epidemiological research in their own region. Local authorities have several reasons for demanding information at a low level, such as the neighbourhood level. Using a geographic information system makes it relatively easy to locate areas with health problems and to identify factors which may be related to these health problems. A local geographic information system not only addresses local authorities but also a number of other interested organisations: hospitals, district nursing organisations, general practitioners, and other workers in the field.

Development of the Rotterdam Local Health Information System

The Rotterdam Local Health Information System (REBUS) is designed as a continuous information system for the health situation in Rotterdam at neighbourhood level. The central aims of the information system are (1) monitoring the health situation and related factors in the city of Rotterdam at district and neighbourhood level and (2) contributing to the development of a local health policy to reduce the noted differences in the health situation of the population.
The information collected in REBUS is information at the level of geographical units, the object of research is the community, not the individual. For collecting this type of information a database management system was set up consisting of a central database connected with a number of utility programs. All data is stored in the central database and can be accessed in various ways with the help of a range of software. The information stored includes geographical features and relevant data on the particular district or neighbourhood.
Data is collected on health status, lifestyle, social and physical environment and the health care system. Data is retrieved from the existing sources of the Central

and Municipal Bureau of Statistics, health care services, regional and municipal institutions and by means of regularly performed local health surveys. The database is updated every year.

Potentials of the Rotterdam Local Health Information System

The Rotterdam Local Health Information System can be used for conducting health research and for supporting local health policy, of which the following examples are presented.

Socioeconomic status and mortality differences between neighbourhoods
Research was carried out on differences in mortality between Rotterdam neighbourhoods and the relationship between these differences and socioeconomic status. This investigation revealed that mortality is higher in neighbourhoods with a lower average socioeconomic status than in neighbourhoods with a higher socioeconomic status. After correction for nursing home mortality, this relationship was found to be approximately the same for males and females. In addition, it appeared that for the period 1978–1987 neighbourhoods with a low socioeconomic status did not show a different trend in mortality than neighbourhoods with a high socioeconomic status. It can be concluded that several neighbourhoods in Rotterdam are characterised by both socioeconomic and health problems. These socioeconomic inequalities in health are an important issue in current health policy in Rotterdam.

Socioeconomic status and the use of district nursing
The relationship between the socioeconomic status of a neighbourhood and the use of district nursing was investigated. Corrections for the age distribution of the population, the number of patients in nursing homes and the limited availability of health care facilities were made. This study revealed that there is no relationship between the number of patients in a neighbourhood and the socioeconomic level of that neighbourhood. There was however a significant relationship between the number of home visits made by the district nurse and the socioeconomic status of a neighbourhood. Patients in neighbourhoods with a low socioeconomic status had more home visits from the district nurses than patients in neighbourhoods with a high socioeconomic status. Although such a relationship is not causal, it can lead to differentiation in the allocation of personnel and funds for district nursing.

Attendance to cervical cancer screening
Attendance is an important factor contributing to the effectiveness of screening for cervical cancer. Research has been performed on the geographic distribution of attendance to the cervical cancer screening program, the results of the smear-test in Rotterdam neighbourhoods and on their spatial associations with socioeconomic status, marital status, ethnicity and general practitioner density.

Between the 50 selected neighbourhoods a large difference in attending the screening program exists, varying from 24.6 % to 58.6 %. Correlation analysis showed that a high socioeconomic level of a neighbourhood and a low percentage migrants correlates with a high attendance percentage. No significant correlation was found between the general practitioners density and the attendance percentage. A weak correlation was found between both the socioeconomic status and percentage migrants and the percentage with a positive smear test in a neighbourhood.
The results make it possible to identify neighbourhoods showing low attendance percentages in the screening program. Future activities aiming at improving the attendance of the screening program can be focused on specific neighbourhoods or on the lower socioeconomic groups.

Relationships between alcohol-use, bars, liquorshops and traffic accidents
This study was directed at the relationship between the percentage alcohol-users, numbers of bars, liquorshops and traffic injuries. Significant correlations were found between the percentage alcohol-users and traffic injuries per neighbourhood, the number of bars and traffic injuries per neighbourhood and the percentage alcohol-users and number of liquorshops per neighbourhood. Although confounding of the data occurs, the observed relations can be easily understood. Knowledge of the geographic relation between alcohol-use, traffic injuries and number of bars can be useful for further development of multisectoral health policy.

Supporting local health policy
The information from REBUS can be used to produce a general community diagnosis of the population. The information makes it possible to compare neighbourhoods in an objective way, for a large number of indicators.
The software package REBUS VISION makes it possible to present information in a way best suited to the specific user. The user is only confronted with the information requested for. REBUS VISION gives access to large amounts of information about health and health-related issues in an attractive way, without the user feeling drowned with information.

Conclusions

In answer to the first question posed by the study, it was shown that it is possible to design a geographic information system, which can be used to give insight into the health situation in the neighbourhoods, using existing data sources. Such a system was developed for the city of Rotterdam.
The second question was answered in that it was shown that the collected information can be used for health research. Examples were presented from three different points of view.
The first point of view is making health inequalities visible to local politicians. Research was carried out on mortality differences between neighbourhoods. This

unequal distribution of health has led to greater awareness of policy makers of these deprived areas. Policy proposals and activities were developed with considerable attention focused on neighbourhood-oriented work.

In two examples of the second point of view, the supportive possibilities for the local health care management were shown. In one example a relationship between the number of home visits and socioeconomic status of a neighbourhood was found. The results can be used for a correction in the allocation of personnel and funds to the various neighbourhoods based on socioeconomic status. In the example of attendance to cervical cancer screening, the results can lead in the future to focusing activities on improving attendance in those neighbourhoods identified as having low attendance rates (e.g. special promotion campaigns).

An example of the third point of view shows how the information system can be used to support and stimulate intersectoral policy. A study on the geographic relationship between alcohol use, bars, liquorshops and traffic injuries was performed. The results of this study can trigger the development of health policy outside the health sector itself.

The third question in this study was whether a geographic information system can be used for developing and supporting local health policy. In this study it was shown that a geographic information system can support local health policy by making existing epidemiological research better available to and suitable for policy makers. It is difficult to prove that one tool actually plays a supportive role in the policy process, because the policy process itself is rather untransparant. The collected information is used in different ways and at different levels in the city to support local health policy. In general it can be stated that REBUS has created a degree of standardisation in health information, thus facilitating interaction between researchers and policy makers. The information acts as a common reference for the different forces in the field of health. It contributes to a better notion of health and health related issues and has put health on the political agenda. REBUS produces information that provides an improvement in the communication between special interest groups and the local government and it contributes to the advancement of expertise of the workers in the neighbourhood as well as improving the involvement of the inhabitants.

Samenvatting

Achtergrond en doel van de studie

Dit boek gaat over de ontwikkeling en het gebruik van een geografisch informatiesysteem voor lokaal gezondheidsbeleid. Gezondheidsverschillen tussen populaties in verschillende geografische gebieden, groot (landen) dan wel klein (stadsbuurten) hebben altijd een uitdaging gevormd voor epidemiologen en beleidmakers. Voor epidemiologen geven deze verschillen inzicht in de gezondheidseffecten van bepaalde blootstellingen, voor beleidmakers geven deze verschillen aanleiding tot gerichte interventies.
Het toepasbaar en geschikt maken van epidemiologische kennis voor beleidmakers is een belangrijke taak van de Gemeentelijke Gezondheidsdienst. Een beschrijving van de gezondheidssituatie middels een "community diagnosis" kan tegemoet komen aan de wensen van de lokale beleidmakers. Hierbij is het echter wel gewenst dat een "community diagnosis" niet alleen gegeven wordt voor de totale gemeente, maar ook voor wijken en buurten. Voor dit doel heeft de Gemeentelijke Gezondheidsdienst van Rotterdam de ontwikkeling gestart van een geografisch informatie systeem. Drie vragen staan centraal in deze studie:

1. Is het mogelijk om een geografisch informatiesysteem op te zetten, waarmee inzicht kan worden verkregen in de gezondheidssituatie van buurten?
2. Kan een dergelijk geografisch informatiesysteem gebruikt worden voor epidemiologisch onderzoek?
3. Kan een dergelijk informatiesysteem gebruikt worden voor de ontwikkeling en ondersteuning van lokaal gezondheidsbeleid?

In het eerste deel van de studie wordt aandacht besteed aan recente ontwikkelingen in het gezondheidsbeleid, het concept van een "community diagnosis" en de mogelijkheden van geografische informatiesystemen voor lokaal gezondheidsbeleid. In het tweede deel van de studie wordt de theorie uitgewerkt voor de Rotterdamse situatie.

Gezondheidsonderzoek en lokaal gezondheidsbeleid

De ontwikkeling van een lokaal gezondheidsbeleid is een essentieel onderdeel van het "Healthy Cities Project" van de WHO. Ook de Nederlandse regering onderstreept in de Nota 2000 het belang van lokaal bestuur om een gezondheidsbeleid te ontwikkelen dat is toegesneden op de lokale omstandigheden. Bij de ontwikkeling en ondersteuning van een lokaal gezondheidsbeleid is een belangrijke rol weggelegd voor de Gemeentelijke Gezondheidsdienst.

Ten behoeve van lokaal gezondheidsbeleid dient aan vier noodzakelijke voorwaarden voldaan te worden. ***Politiek commitment*** is een basisvoorwaarde voor de ontwikkeling en implementatie van een nieuw gezondheidsbeleid. De gezondheidssector alléén is niet in staat om de complexe problemen gerelateerd aan de gezondheid op te lossen, ***intersectorale samenwerking*** is daarom noodzakelijk om de problemen aan te pakken. De bevolking dient bewust te zijn van haar eigen verantwoordelijkheid voor de gezondheid, welke bereikt kan worden door *actieve participatie* in de ontwikkeling en evaluatie van gezondheidsbeleid en het zoeken naar gezondheidsbevorderende oplossingen. Gezondheidsbeleid dient ondersteund te worden door *onderzoek en epidemiologische informatie*.
Wijken en buurten worden door de lokale politiek beschouwd als een goede basis voor de ontwikkeling van (gezondheids)beleid en zijn ook voor de bevolking herkenbare geografische eenheden, waardoor de participatie van de lokale bevolking gestimuleerd kan worden. Om een uitgebreide beschrijving van de gezondheidssituatie te geven, is het nodig dat gegevens van verschillende beleidssectoren met elkaar in verband worden gebracht. Dit zal resulteren in een zogenaamde "community diagnosis". Het doel van een dergelijke "community diagnosis" is (1) beschrijven en volgen van de gezondheidstoestand van de populatie, (2) fungeren als waarschuwingssysteem dat specifieke gezondheidsproblemen kan identificeren en (3) het verbeteren van de mogelijkheden voor de evaluatie van het lokaal gezondheidsbeleid en lokale gezondheidszorg.
Als de informatie eenmaal is verzameld, is het zaak deze over te dragen aan anderen. Grafisch weergegeven informatie kan op een snelle en aantrekkelijke wijze gepresenteerd worden, waarbij de aandacht gevestigd kan worden op de belangrijke zaken. Ruimtelijke verdelingen en patronen kunnen op eenvoudige wijze zichtbaar gemaakt en nader bestudeerd worden. Een geografisch informatiesysteem waarin informatie wordt verzameld over gezondheid en aan gezondheid gerelateerde factoren op buurtniveau lijkt in deze context een veelbelovend instrument.

Geografische informatiesystemen op lokaal niveau

Een geografisch informatiesysteem kan gezien worden als een speciale vorm van een database. Vier specifieke subsystemen of processen kunnen hierbij worden onderscheiden: data-verzameling, data-organisatie, analyse en produktie van overzichten. Het soort informatie dat geproduceerd wordt met behulp van een geografisch informatiesysteem is afhankelijk van het type gebruiker.
Onderzoekers die beleidsstudies uitvoeren dienen in staat gesteld te worden om onderzoek uit te voeren, gebaseerd op informatie die opgeslagen is in het geografisch informatiesysteem. De taak van de beleidmakers is de evaluatie van beleidsalternatieven, onder andere gebaseerd op informatie die aangeleverd wordt door onderzoek. De groeiende bewustwording van geografisch bepaalde problemen en de toenemende complexiteit en hoeveelheid van ruimtelijke gegevens betekent dat er een toenemende behoefte bestaat aan beleidsondersteunende instrumenten voor deze gebruikers. Een noodzakelijke voorwaarde is dat de

informatie die aangeleverd wordt aan de beleidmakers en regels voor de evaluatie van alternatieven ongecompliceerd en ondubbelzinnig is, om er van verzekerd te zijn dat beleidmakers er in optimale zin gebruik van maken.
Geïnteresseerde burgers, pressiegroepen en diverse sociale (lokaal georiënteerde) organisaties willen vaak continu geïnformeerd worden over onderwerpen als demografie, gezondheid, fysieke en sociale omgeving. Het is aannemelijk dat er een grote potentiële vraag is naar informatiesystemen die de meest actuele informatie over dergelijke onderwerpen beschikbaar maken. Voor deze groep gebruikers kan een geografisch informatiesysteem bijdragen aan de democratisering van besluitvorming.

Geografische informatiesystemen op het gebied van gezondheids onderzoek en gezondheidsbeleid hebben in het algemeen drie functies: (1) bewaking en evaluatie, (2) beleidsformulering en planning en (3) onderzoek. Gezondheidsbeleid wordt uitgevoerd op verschillende bestuurlijke niveaus. Alhoewel elk niveau geconfronteerd wordt met dezelfde gezondheidsonderwerpen, bestaan er aanzienlijke verschillen in beleid tussen deze niveaus.
De WHO houdt zich met name bezig met beleid waarbij op wereldschaal trends worden bestudeerd en nieuwe beleidsprogramma's worden vormgegeven. Geografische informatiesystemen worden op dit niveau gebruikt om verschillen in gezondheid tussen lidstaten duidelijk te maken. Dergelijke inzichten kunnen gebruikt worden om nieuwe gezondheidsstrategieën te ontwerpen en te ondersteunen.
Op het nationale niveau is informatie nodig over de gezondheidssituatie en gezondheidszorg per regio. In Nederland zijn hiertoe zogenaamde Regionale Gezondheidsprofielen samengesteld voor elk van de 65 gezondheidsregio's. Het doel van de profielen is het verschaffen van gezondheidsinformatie aan lokale beleidmakers om richting te kunnen geven aan interventies en onderzoek in hun eigen regio.
Lokale gezondheidsdiensten zijn betrokken bij de planning van de gezondheidszorg, gezondheidsbevordering en epidemiologisch onderzoek in hun eigen stad of regio. Lokale bestuurders hebben er belang bij de beschikking te hebben over informatie op een laag niveau, zoals het buurtniveau. Het gebruik van een geografisch informatiesysteem maakt het relatief eenvoudig om gebieden te lokaliseren met gezondheidsproblemen en om factoren vast te stellen die mogelijk samenhangen met deze problemen.

De opzet van het Rotterdams Epidemiologisch Buurtkenmerken Systeem

Het Rotterdams Epidemiologisch Buurtkenmerken Systeem (REBUS) werd ontwikkeld als een continu informatiesysteem voor de gezondheidssituatie in Rotterdam op buurtniveau. De centrale doelstellingen van het informatiesysteem zijn: (1) het bewaken van de gezondheidssituatie en daaraan gerelateerde

factoren in de stad op wijk- en buurtniveau en (2) bijdragen aan de ontwikkeling van een lokaal gezondheidsbeleid om de waargenomen verschillen in gezondheid te verminderen.
De informatie die in REBUS verzameld wordt is informatie op buurtniveau, het onderwerp van onderzoek is de buurt, niet het individu. Om dit soort informatie te verzamelen en vast te leggen is een systeem opgezet dat bestaat uit een centrale database met daaraan gekoppeld een aantal toepassingsprogramma's. Alle gegevens worden in de centrale database opgeslagen. De vastgelegde informatie omvat geografische kenmerken en relevante gegevens over de buurt of wijk.
Informatie wordt opgeslagen over de gezondheidssituatie, leefstijl, de sociale en fysieke omgeving en de gezondheidszorg. De gegevens zijn afkomstig van bestaande bronnen van het Centraal en Gemeentelijk Bureau voor de Statistiek, gezondheidszorginstellingen, regionale en gemeentelijke instellingen en van lokale gezondheidsenquêtes. De database wordt jaarlijks aangevuld.

Mogelijkheden van het Rotterdams Epidemiologisch Buurtkenmerken Systeem

Het Rotterdams Epidemiologisch Buurtkenmerken Systeem kan gebruikt worden voor het uitvoeren van gezondheidsonderzoek en om het lokale gezondheidsbeleid te ondersteunen, waarvan voorbeelden worden uitgewerkt.

Sociaal-economische status en sterfteverschillen tussen buurten
Onderzoek werd gedaan naar de verschillen in sterfte tussen Rotterdamse buurten en de relatie met sociaal-economische status. Dit onderzoek liet zien dat de sterfte hoger is in buurten met een gemiddeld lagere sociaal-economische status dan in buurten met een gemiddeld hogere sociaal-economische status. Na correctie voor sterfte in verpleeghuizen bleek, dat dit verband voor mannen en vrouwen ongeveer gelijk was. Bovendien bleek dat in de periode 1978-1987 buurten met een lage sociaal-economische status geen andere trend in sterfte vertonen dan buurten met een hoge sociaal-economische status. Geconcludeerd kan worden dat diverse buurten in Rotterdam gekarakteriseerd worden door zowel sociaal-economische en gezondheidsproblemen. Deze sociaal-economisch ongelijkheid in gezondheid is een belangrijk onderwerp in het huidige Rotterdamse gezondheidsbeleid.

Sociaal-economische status en het gebruik van wijkverpleging
De relatie is onderzocht tussen de sociaal-economische status van een buurt en het gebruik van de wijkverpleging. Gecorrigeerd werd voor verschil in leeftijdsopbouw, het aantal patiënten in verpleeghuizen en het beperkte aanbod van de zorg. Dit onderzoek liet zien dat er geen verband bestaat tussen het aantal patiënten in zorg in een bepaalde buurt en de sociaal-economische status van die buurt. Wel werd een verband gevonden tussen het aantal huisbezoeken door

de wijkverpleeging en de sociaal-economische status van een buurt. Patiënten uit een buurt met een lage sociaal-economische status kregen meer huisbezoek van de wijkverpleging dan patiënten in een buurt met een hoge sociaal-economische status. Alhoewel een dergelijk verband geen causaliteit aantoont, kan het wel leiden tot een verdere differentiatie in de allocatie van mensen en middelen voor de wijkverpleging.

Opkomst bij het bevolkingsonderzoek op baarmoederhalskanker
De opkomst is een belangrijke factor die bijdraagt aan het gezondheidseffect van het bevolkingsonderzoek op baarmoederhalskanker. Onderzoek is gedaan naar de geografische verdeling van de opkomstpercentages en de uitslag van het uitstrijkje en op hun ruimtelijke samenhang met sociaal-economische status, burgerlijke staat, etniciteit en de huisartsendichtheid.
Tussen de 50 geselecteerde buurten bestaat een groot verschil in opkomstpercentage, variërend van 24.6% tot 58.6%. Correlatie-analyse liet zien dat een hoog sociaal-economisch niveau van een buurt en een laag percentage migranten samenhangt met een hoog opkomstpercentage. Geen significant verband werd gevonden tussen de huisartsendichtheid en het opkomstpercentage. Er werd een zwak verband gevonden tussen de sociaal-economische status en het percentage migranten aan de ene kant en het percentage deelnemers met een positieve uitslag aan de andere kant. De resultaten maken het mogelijk vast te stellen welke buurten een laag opkomstpercentage in het bevolkingsonderzoek te zien geven. Toekomstige activiteiten om de opkomstpercentages bij het bevolkingsonderzoek te verhogen kunnen gericht worden op specifieke buurten of op de lagere sociaal-economische groepen.

Verband tussen alcoholgebruik, bars, drankwinkels en verkeersongevallen
Deze studie was gericht op het verband tussen het percentage alcoholgebruikers, het aantal bars, het aantal drankwinkels en het aantal verkeersongevallen per buurt. Significante correlaties werden gevonden tussen het percentage alcoholgebruikers en verkeersongevallen per buurt, het aantal bars en verkeersongevallen per buurt en het percentage alcoholgebruikers en het aantal drankwinkels per buurt. Alhoewel een zekere mate van verstoring optreedt zijn de waargenomen relaties goed te verklaren. Kennis over de geografische relaties tussen alcoholgebruik, verkeersongevallen, en aantallen bars kan bruikbaar zijn de verdere ontwikkeling van een intersectoraal gezondheidsbeleid.

De ondersteuning van lokaal gezondheidsbeleid
De informatie uit REBUS kan gebruikt worden om een algemene "community diagnosis" van de bevolking samen te stellen. De informatie maakt het mogelijk buurten met elkaar te vergelijken op een objectieve wijze, aan de hand van een groot aantal indicatoren.
Het computerprogramma REBUS VISION geeft de mogelijkheid om informatie te presenteren die optimaal aansluit aan de specifieke wensen van de gebruiker. De gebruiker krijgt slechts die informatie te zien waar om gevraagd is. REBUS

VISION geeft toegang tot een grote hoeveelheid informatie over gezondheid en aan gezondheid gerelateerde onderwerpen op een aantrekkelijke wijze, zonder de gebruiker het gevoel te geven overspoeld te worden met informatie.

Conclusies

In deze studie is aangetoond dat het mogelijk is een geografisch informatiesysteem te ontwerpen, dat gebruikt kan worden om inzicht te krijgen in de gezondheidssituatie van buurten, waarbij gebruik wordt gemaakt van bestaande gegevensbronnen. Voor Rotterdam is een dergelijk systeem ontwikkeld.
Op de tweede plaats is aangetoond dat de verzamelde informatie gebruikt kan worden voor het doen van gezondheidsonderzoek. Voorbeelden worden gegeven vanuit verschillende gezichtspunten.
Om gezondheidsverschillen zichtbaar te maken voor het lokaal bestuur is onderzoek uitgevoerd naar de sterfteverschillen tussen buurten. De ongelijke verdeling van gezondheid heeft geleid tot een grotere aandacht voor de achtergestelde gebieden in Rotterdam. Beleidsvoorstellen en activiteiten werden ontwikkeld, met grote aandacht voor buurtgericht werken.
In twee voorbeelden wordt aandacht gegeven aan de mogelijkheden voor ondersteuning van de lokale gezondheidszorg. In het eerste voorbeeld werd een verband gevonden tussen het aantal bezoeken door de wijkverpleging en de sociaal-economische status van de buurt. De resultaten kunnen gebruikt worden voor een correctie voor sociaal-economische status bij de toewijzing van mensen en middelen aan de verschillende buurten. In het voorbeeld over de opkomst bij het bevolkingsonderzoek op baarmoederhalskanker kunnen de resultaten in de toekomst leiden tot activiteiten ter verhoging van de opkomst in buurten met een lagere sociaal-economische status (bijvoorbeeld speciale promotie-campagnes).
Een voorbeeld vanuit een derde gezichtspunt laat zien hoe het informatiesysteem gebruikt kan worden om intersectoraal beleid te ondersteunen en te stimuleren. Een onderzoek werd gedaan naar de geografische verbanden tussen alcoholgebruik, bars, drankwinkels en verkeersongevallen. De resultaten kunnen aanleiding vormen voor de ontwikkeling van gezondheidsbeleid buiten de gezondheidssector zelf.
De derde vraag in deze studie was of een geografisch informatiesysteem gebruikt kan worden voor de ontwikkeling en ondersteuning van lokaal gezondheidsbeleid. Aangetoond werd dat een geografisch informatiesysteem het lokaal beleid kan ondersteunen door bestaande epidemiologische informatie beter beschikbaar en geschikt te maken voor beleidmakers. Het is moeilijk om aan te tonen dat een enkel instrument daadwerkelijk een ondersteunende rol speelt in het beleidsproces, omdat het beleidsproces zelf tamelijk ondoorzichtig is. De verzamelde informatie wordt daadwerkelijk gebruikt, op verschillende manieren en op verschillende niveaus in de stad. In het algemeen kan gesteld worden dat REBUS de voorwaarden verbeterd voor interactie tussen onderzoekers en beleidmakers. De informatie fungeert als een gezamenlijke referentie voor de

verschillende krachten in het gezondheidszorgveld. Het draagt bij aan een grotere bewustwording van gezondheid en aan gezondheid gerelateerde onderwerpen, en heeft gezondheid (hoger) op de politieke agenda geplaatst. REBUS produceert informatie die de communicatie kan verbeteren tussen interessegroepen en het lokaal bestuur, het draagt bij aan de expertise van werkers in de buurt en het verhoogt de betrokkenheid van de bevolking.

Curriculum Vitae

13 februari 1956 Geboren te den Haag.

1968 – 1972	MAVO Moerwijk te den Haag
1972 – 1974	HAVO Thomas More College te den Haag
1974 – 1978	Opleiding tot chemisch technoloog aan de Gemeentelijke Hogere Technische School te den Haag.
1978 – 1979	Avondopleiding tot statistisch assistent en statistisch analist.
1980 – 1984	Avondopleiding tot statisticus VVS.
1978 – 1983	Statistisch onderzoeksmedewerker bij de Chemisch Biologische Hoofdafdeling van het Rijksinstituut voor Drinkwatervoorziening te Leidschendam.
1983 – 1986	Statisticus bij het Centrum voor Wiskundige Methoden van het Rijksinstituut voor Volksgezondheid en Milieuhygiëne te Bilthoven.
1986 – heden	Senior onderzoeker bij de afdeling Epidemiologie van de Gemeentelijke Gezondheidsdienst Rotterdam en omstreken.
1993 – heden	Coördinator alcoholonderzoek (in deeltijd) bij het Instituut voor Verslavingsonderzoek van de Erasmus Universiteit Rotterdam.