Social Aspects of Air Pollution:
Sociodemographic Differences in Exposure, Perceived Annoyance and Concern about Air Pollution

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ACADEMIC DISSERTATION

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ABSTRACT

The main interest of this study is to observe the sociodemographic (gender, age, education and occupational status) differences in personal exposure, perceived annoyance and concern about air pollution, for the purpose of reducing such differences. Another important aim is to compare the measured exposure data with perceived annoyances and concern about air pollution.

The target population of this study was adult (25-55 y) inhabitants of Helsinki region. Personal exposures to (n=201) and microenvironment concentrations of fine particles ($PM_{2.5}$) and nitrogen dioxide (NO_2) were measured during the *EXPOLIS* study in 1997-1998. An Environmental Attitude Questionnaire (EAQ) survey (n=428) was compiled on the concerns about air pollution and environmental problems in general in December 1998. Information of perceived annoyance (n=677) was collected both with *EXPOLIS* questionnaires and the EAQ. In addition public discourse in Helsingin Sanomat on air pollution as an environmental risk was elucidated between 1996-2000, since it both reflects and influences public concerns about air pollution. Data were analysed mainly by statistical methods.

The strongest sociodemographic factor influencing exposure to fine particles ($PM_{2.5}$) was occupation, with workers having double the exposure of white-collar employees, and this difference was mostly caused by work exposure. Smoking and exposure to environmental tobacco smoke amplified the socioeconomic exposure differences, but did not explain all of them. The younger (25-34 y) were more exposed to fine particles than the older probably because of differences in time use patterns. Those having less than 14 years of education were more exposed to nitrogen dioxide (NO_2) than those having more education in the model adjusted with the other major determinants of NO_2 exposure including e.g. exposure to tobacco smoke and living conditions.

Concern about air pollution and its health effects increased the perceived annoyance from air pollution. Exposure to air pollution (fine particles and nitrogen dioxide) does not necessarily coincide with annoyance and concern about it. While men and the younger were in average more exposed to these air pollutants, older women were more annoyed by air pollution and concerned about it. Only the less educated were both exposed to high concentrations and very annoyed by air pollution.

Health effects of air pollution can be reduced only via understanding the factors that influence the exposure, perceived annoyance and concern. Indirect health effects of air pollution, however, are poorly understood. A holistic view of the different (social and psychological) dimensions of perceived risks and risk propabilities is essential for proper risk management and policies to reduce sociodemographic differences.

To My Family

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CONTENTS

1 Introduction

Environmental problems have developed slowly side by side with industrialisation and technological change in modern societies. After the first studies on changes in the natural environment and nature conservation, in the second half of the twentieth century the increasing awareness of environmental accidents, the rise in environmental activism, etc. meant that environmental problems came to be seen as social problems as well. At the same time news and articles about environmental problems increased rapidly in the media and the first studies on environmental social sciences appeared. At the end of 1990s some progress was achieved in collaboration between the traditional environmental studies and social sciences. Today environmental issues are taken into consideration in every sector of society and decisions with implications for the environment have become part of everyday life.

Environmental health risk assessment includes chemical, biological and physical adverse factors impacting human health and these risks are traditionally evaluated on the basis of accrued deaths. Individuals and the society might end up in different risk assessments of the same threat. If the probability of a health impact is statistically small, an individual may think that it will not happen to him. From the society's point of view, however, consequences are definite and may cause a lot of costs yearly. Or conversely, since laymen usually consider the equality of risks, possibility to manage the risks or the disastrous potentiality included in the risks, they may be much more concerned about what experts consider to be statistically marginal environmental risks. This means that methods to decrease health risks are different depending on the risk and who is assessing it. Therefore environmental risk assessment and management should include also the social and psychological dimensions of environmental risk. In addition the consequences of environmental risks are not equally divided between the the sociodemographic groups. Therefore identifying and focusing on risk groups is sensible risk assessment (Kamppinen et al. 1995).

Environmental pollution surrounds us in the air, food, soil and drinking water. Air pollution is one example of man-made environmental problems produced by a multitude of technological activities. Air pollution has been investigated more systematically since the 1950s as a factor in dirty environments and environmental episodes. Fifteen years ago most experts thought that the prevailing air pollution levels in North America and Western Europe would rarely have any health impact at all. However, recent epidemiological studies on the health effects of air pollution and new ways of measuring personal exposure have given fresh information on air pollution. Nowadays the same experts consider that particulate air pollution, especially fine particles, cause several hundred thousand excess deaths from respiratory and cardiovascular diseases every year in Europe and shorten the life expectancy of these populations by months to years (WHO 1995a). Air pollution has also been linked to considerable exacerbation of asthma. Thus air pollution has both short-term and long-term effects on health. Apart from these direct health problems, air pollution also causes concern and annoys people.

Regulations and action taken by industry in late 1900's to reduce its own emissions and those of its products have improved air quality in the developed Western countries (Brown et al. 1999). However, traffic increases and emissions of nitrogen oxides and particles from traffic have decreased only slightly, besides emissions from traffic influence exposures more than from energy production because they are emitted close to were people breath. Until now, air pollution has been mostly measured at fixed monitoring sites in the cities. Such sites continuously record concentrations of many air pollutants at the same time. However, inhabitants are not exposed directly to these concentrations in ambient air, because they are not located where the monitors are and because they spend over 90% of their time indoors (Ackermann-Liebrich et al. 1995), which adds new pollution sources and modifies outdoor pollution levels. The personal exposure to air pollution of two neighbours with similar ambient residential concentrations may differ significantly because of different indoor sources at home and work, personal behaviour and time-activity patterns.

The European wide *EXPOLIS* (Air Pollution Exposure Distributions within Adult Urban Populations in Europe) study examined personal exposures to several air pollutants (Jantunen et al. 1998). This study made it possible to evaluate exposure distributions within populations and specific sub-populations, identify the determinants of exposure, assess the public health gains from environmental policy options in terms of population exposure by modeling and compare these results between different cities in Europe. Something new was that the social scientific view was included in this environmental science study. The target populations were the adult, working age (25-55 year old), urban populations. As part of the *EXPOLIS* project, the present study focuses on local air pollution concentrations and personal exposure in Helsinki, and air pollution is observed as a phenomenon that can cause direct and indirect health effects. Direct health effects, however, are not considered in this research. In personal exposure measurements only a few important compounds can be accounted for, because the measuring equipment must be included in a portable case. The target air pollutants in this study are fine particles ($PM_{2.5}$) and nitrogen dioxide (NO_2) (see detailed description in section 4.1.1). The perceived annoyance and concerns caused by air pollution, which may also affect health, are evaluated as well.

The *EXPOLIS* study was mainly designed for the needs of environmental health sciences, including exact measurements and quality control of measuring techniques. Here we have an extraordinary opportunity for a multidisciplinary study linking natural science and exposure research (measurements) to social science and environmental sociology (via questionnaires). However, a multidisciplinary European wide exposure study has also many restrictions especially for sociology.

The purpose of this study is to see air pollution exposure from a social science perspective, not simply as an object of natural science. Although air pollution exposure levels could be decreased in the future by new information, regulations, new technological innovations, etc., this may not reduce the impact of perceived annoyance and concern. Some kind of total risk assessment is not a target of this study, but to give information also from psychological, social and cultural dimensions of environmental risk assessment to complement the traditional assessment of risks about air pollution. Social dimensions of risk assessment include the public discourse on environmental pollution in Finland by a brief elucidation of articles about air pollution as a risk in Helsingin Sanomat. What should be taken into account in decision-making concerning air pollution exposure? The main interest of this study is in observing sociodemographic (gender, age, education and occupational status) differences of personal exposure, perceived annoyance and concern about air pollution for the purpose of diminishing these sociodemographic differences. Another important aim is to compare the observed exposure data to perceived air pollution annoyances.

This study consists of the following seven chapters:
The first chapter describes the basis of the study. The background to the study of environmental research and social sciences (section 2.1) is described by outlining the history of environmental studies and the revolution in environmental consciousness, followed by paradigm criticism and risk theories including definitions of risk analysis, environmental risk assessment, psychological, social and cultural dimensions of risk as well as environmental

health risk assessment. Also the findings of earlier relevant studies in the field of environmental social sciences, sociodemographic differences in morbidity and mortality, research on air pollution exposure and its health impacts and socio-economic differences related to air pollution are presented. This background description helps the reader to understand the context of the study. Section 2.2 describes briefly public discourse about air pollution and environmental problems in the way the biggest Finnish newspaper presents it. Media influences people's concerns about air pollution and therefore the picture that media draws forms the background for making conclusions about the concern data. Media reflects indirectly the knowledge that people are supposed to have. However, this description of air pollution articles is very brief and direct impacts on concerns cannot be established. Anyhow it helps understand the complicated environmental problems. Chapter 3 clarifies the objectives and framework of this study in relation to the specified study questions.

The first part of the results (chapter 4) consists of *EXPOLIS* study data analyses from Helsinki. Section 4.1 describes the design and focus of the study as well as its materials and methods. Participation activity and population sampling biases are also evaluated. Exposure levels and sociodemographic differences in personal air pollution **exposure** to fine particles and nitrogen dioxide are presented in section 4.2. Also the time-activity patterns, which have impact on exposures, are presented shortly. In the end of this section the most important sociodemographic differences in fine particle and nitrogen dioxide exposures and the causes of these differences are discussed. Sub-population differences in perceived **annoyance** from air pollution are presented in section 4.3. Sociodemographic differences in perceived annoyance caused by environmental factors are discussed.

The second part of the results (chapter 5) deals with **concern** about air pollution and the environment. This chapter includes the materials and methods, results and discussion of the Environmental Attitude Questionnaire data. The importance of environmental problems and air pollution among other social problems, as well as differences in concern about air pollution between sociodemographic groups among adult inhabitants in Helsinki are presented. Concern about local environment and air pollution, environmental problems in Finland in general and sociodemographic differences in these concerns are discussed and the impact of media is evaluated.

Associations between the three study elements are presented in chapter 6. First, perceived annoyance scores are compared to the measured air pollution exposures; individual and average values of perceived annoyances as well as sociodemographic differences in these associations are presented. Secondly, associations between personal exposure, perceived annoyance and concern about air pollution are presented and discussed. In the end, there is a more general discussion (chapter 7) including the relationship between these results, the theoretical framework and previous studies, and connections between the various findings and conclusions.

2 Background to the study

2.1. Environmental research and social sciences

2.1.1. History of environmental studies and the environmental revolution

The first signs of environmental pollution in Europe were mainly caused by poor waste management. While the importance of hunger as the main environmental threat decreased, new environmental problems become apparent. Local air and water pollution began to raise concerns, especially in the towns. Air pollution speeded up with the new energy resources, oil and coal. After World War II, with rapid urbanisation and industrialisation, air and water pollution were no longer local problems, but spread across the borders of nation states. From the beginning of the 1980s environmental changes and pollution had become problems of global concern and political processes.

In Finland smoke-heated cabins and saunas were common in the mid-nineteenth century certainly causing smog problems in the cities and also health concequences. Mortality and work statistics, sickness and residence studies and reports of district doctors about the conditions of the populace can be used as data for environmental history. For example municipal doctor Relander (1892) described the connections between living conditions and health in Haapajärvi in his doctoral thesis (Karisto 1981). The term 'environmental health' is relatively new, but research in the field has a long history. In the nineteenth century there were two broad medical systems, clinical medicine and public health. The public health system saw diseases more abstractly and focused on the individual and his/her environment (Karisto et al.1992).

Systematic research into environmental pollution in the natural sciences started surprisingly late, although clear indications of the destruction of nature could be seen particularly in the eighteenth century in towns with heavy dust and smoke from coal burning. Swedish chemist Arrhenius (1916) published the first analysis of the global climate change due to greenhouse effect. A couple of examples are Thomas et al. eds. (1956) publication about global environmental change (Man’s Role in Changing the Face of the Earth) and in Finland the publication of the geographers Hustich and Jaatinen eds. (1960) about man’s influence on nature. The smog episode in London in December 1952 killed more than 400 people immediately and ca. 4000 people are estimated to have died within a few days because of pollution (Brimblecombe 1987). The London catastrophe was reported in the media and had already been predicted from similar previous events. A few years later, in October 1957, the Windscale nuclear power reactor burnt releasing radioactivity. However, the public did not take this environmental accident too seriously. At the time environmental problems were not seen as of interest to the social sciences because of lack of both attitudinal sensitivity and informed readiness (Massa 1998).

Within the social sciences Malthus published some early warnings about ecological limits already in the early nineteenth century (see Glacken 1967) and in the end of the century Bogdanov tried to develop multidisciplinary research to solve environmental problems (see Susiluoto 1982). According to Giddens (1990) Marx, Durkheim and Weber had seen the social but not the ecological problems caused by industrialisation in the nineteenth and early twentieth centuries. Pigou (1920/1932) gave many examples of pollution and destruction of the environment caused by industrialisation and urbanisation. He probably produced the first quantitative assessment in the world of the local cost of air pollution in Manchester in 1918. However, the early research in the field of environmental social sciences began in the 1950s and 60s (see Glacken 1956, 1985; de Jouvenil 1968; Raumolin 1982, 1984). The 60s also saw some researchers (Marsh 1965; Titmuss 1968) try to approach environmental issues from a multidisciplinary viewpoint, linking social, natural and technical sciences.

The revolution in environmental consciousness

The revolution in environmental consciousness, in which environmental questions rose rapidly into public discussion and as a target of social criticism, started in the United States. The main reason for this environmental revolution in the 1950s and 60s was the awakening consciousness of risks and accidents which threaten environment and human health, spread by the new mass medium, television. Several events preceded this revolution, including Rachel Carson's book Silent Spring (1962) about environmental chemical pollution, economic growth and postmaterialistic values, radiation fallout from nuclear weapons tests, the appearance of environmental accidents, the increase in environmental research and examples of other new movements such as the hippie, student and human rights movements (Massa 1991). Also tragic consequences of new chemicals (e.g. DDT, Thalidomide) began to be revealed. Thalidomide (pharmaceutical) was banned in the early 1960s after it was found to cause severe birth defects and DDT (insecticide) was banned in the United States in 1972 after it was found to accumulate in the food chain and be extremely persistent in the nature.

A fundamental part of the environmental revolution was also ‘The limits to growth’-report by The Club of Rome (Meadows et al. 1972). They reminded the limited scope of the earth: “If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years.” A new environmental movement also focused on the protection of man and the human environment, along with previous focus on protection of nature. The US EPA (Environmental Protection Agency) was established in 1968 with responsibilities both in public health and nature conservation. In the 1970s the first green parties and ministries of the environment were created in industrialised countries.

Along with the environmental revolution, it was realised that the traditional nature conservation does not solve all environmental problems, but that social and cultural changes in politics, values, life styles, organisations and international collaboration are also needed. For example, the first solution to industrial air pollution was to build higher chimneys for power plants to dilute the emissions. However, when knowledge and conciousness about environmental consequences (e.g. acid rain) of human actions increased and was delivered by media, the need to clean and filter the smoke gases was finally realized. Most environmental scientists agree that collaboration between the social and natural sciences and an increase in environmental social and human research is required to achieve significant environmental progress. Environmental social science studies interact between society and the environment. The main question is how economics, technology, politics, social movements, social structures and value structures interact with the biophysical environment and natural resources. New environmental sociology brings social sciences, natural sciences and technical sciences closer to each other (Massa 1991).

In the early 1990s, three phases of development in modern environmental sociology could be distinguished (Massa 1991).

1) Ecosophy at the beginning of the 1970s in the United States, but also in many other western countries. Ecosophy means populist, socialist and anarchist writings about the environmental crisis. Representatives of this first period did not follow the social science

traditions, but tried to develop a new transdisciplinary synthesis. They criticised the anthropocentric world-view of western societies.

2) Criticism of paradigms in the late 1970s and early 1980s in the United States. Environmental discussion by social scientists broadened to criticise the meta-theories and paradigms of sociology. Anthropocentric thinking must change into bio-sphere-centric thinking. The criticism of the second period did not manage to convincingly incorporate environmental questions into the sociological tradition or create a holistic view of a society threatened by environmental crisis. This was, however, an important period for the development of American empirical environmental sociology.
3) The risk society in the late 1980s in Europe. Visible and observed environmental problems (like widespread forest death, observation of stratospheric ozone depletion, the greenhouse effect and the nuclear power plant accident at Chernobyl) were understood as social problems as well. The representatives of the third period finally tried to incorporate environmental questions into the sociological tradition and demanded a position among the environmental sciences.

Ecological modernisation and structural change, in which the principles of sustainable development are taken into account in all sectors of society, have been suggested as the fourth phase of environmental sociology (Spaargaren & Mol 1992). The term Sustainable Development was introduced in the United Nation's Earth Summit in Rio de Janeiro in 1992. Since the follow-up of Rio the World Summit in Johannesburg 2002 increasing interest has been focused in the issue of sustainable development, not only in the context of environmental policies but more recently, in the context of all policy decisions, be they economic, social or environmental. Although sustainable development ("Development that meets the needs of the present without compromising the ability of future generations to meet their needs.") is almost universally accepted in principle, it has turned out to be very difficult to find generally accepted ways of putting it into practice which could offer sufficient guidance for practical problem-solving or political decision-making.

2.1.2. Paradigm criticism and risk theories

Paradigm criticism from Human Exemptionalism to the New Ecological Paradigm

One reason for the late awakening of the social sciences to environmental problems was the widely-held Human Exemptionalist Paradigm that scholars like Catton and Dunlap have criticised since the 1970s. As a result of historical developments within sociology, the term "environment" is typically used by sociologists to mean something quite unlike what it means in most other disciplines and in public discourse. In non-sociological parlance "the environment" means our physical surroundings – including its chemical constituents and the biosphere, or a nearby portion of it. In contrast, in mainstream sociology "the environment" is used to refer to social and cultural influences on the entity being examined (see e.g. Catton & Dunlap 1978; Choldin 1978; Dunlap & Catton 1979). An individual's environment, for example, is likely to be viewed as comprising the social groups to which he or she belongs. For sociologists, "environment" seldom denotes the physical and chemical properties of the settings in which individuals participate, or the characteristics of the biophysical region (topography, natural resources, climate) in which communities are located. This terminology, and the disciplinary traditions behind it, imposed a set of "conceptual blinders" which made it difficult for the sociologist to recognise the importance of the ecological problem in our society in the late 1960s (Catton & Dunlap 1978, 1980).

A paradigm is a fundamental image of the subject matter in science. It serves to define what should be studied, what questions should be asked, how they should be asked, and what rules should be followed in interpreting the answers obtained. According to Ritzer (1975) a paradigm is the broadest unit of consensus within a science and serves to differentiate one scientific community from another. It subsumes, defines, and interrelates the exemplars, theories, and methods and instruments that exist within it. A paradigm is not a specific theory. These "background assumptions" are seldom made explicit, but do influence the way in which sociologists approach their subject matter and practice their craft (Gouldner 1970). No paradigm is so specific that it automatically generates a full-blown theory. It only makes certain kinds of questions askable and certain kinds of hypotheses conceivable (Catton & Dunlap 1980).

The societal implications of the “ecological crisis” which became so apparent in the 1970s led some sociologists to pay attention to environmental issues and to a process of conceptual redefinition. For eample, sociologists Michelson (1970) and Burch (1971) focused on a topic traditionally ignored in sociology, namely the relationship between human society and the biophysical environment. By their acceptance of environmental variables as relevant for understanding human behaviour and social organisation, all environmental sociologists at least implicitly and often unknowingly challenge the Human Exemptionalist Paradigm (particularly the 2nd and 3rd assumptions in Table I in Appendix 1) (Catton & Dunlap 1980).

There is much common ground between the New Ecological Paradigm (NEP) and the Human Exemptionalist Paradigm (HEP), but there are also significant differences (Table I in Appendix 1). In sharp contrast to the anthropocentric HEP, the NEP stresses the ecosystem-dependence of human societies. Despite their having exceptional characteristics, human beings are not exempt from ecological constraints. For a NEP-adherent, a social fact such as socioeconomic status may be related in important ways to such socially significant facts as exposure to pollution (Burch 1976). The NEP thus sensitises sociologists to the probable social impact of “non-social” phenomena (Catton & Dunlap 1980).

Risk theories in social sciences

Discussion of the risk society was started in the early 1980s by Patric Lagadec (1981, 1982; Douglas & Wildavsky 1982; Perrow 1984), and Ulrich Beck (1986, 1988) has continued it since. They think that classic industrial society is changing into a risk society dominated by big risks, e.g. nuclear power plants, the chemical industry and gene technology. Classical interpretations and concepts of social sciences no longer work in the risk society, because of accumulative capitalism and an economic system that expends natural resources, and breaks class barriers, social structure and nation states. An environmental crisis implies a considerable danger befalling the whole culture. By using the term ‘risk’ the environmental crisis could be seen as more controllable than it actually is (Beck 1988).

Beck (1992) writes that, in the process of modernisation, hazards created by technology have increased, which means that the classic industrial society has changed into the risk society. The main question is how we can control, prevent and minimise the risks and dangers produced by modernisation. Man has created the most serious problems of mankind by economic-technological development. Pre-industrial hazards include natural disasters (like floods, drought or tornados) and epidemics, which were spread but not caused by man. Classical industrial society's hazards were events and destruction that were chronologically, locally and socially limited or controlled, like work accidents, traffic accidents or the risk connected with smoking. These were relatively voluntary risks and their probability could be assessed somehow (Beck 1990; see Jokinen 1995). The hazards of the risk society can no longer be temporarily, locally or socially controlled. Distrust has globalized and technology can only try to minimise the risks, not obviate them. The individual cannot avoid such risks. It is almost impossible to find those responsible for them. Typical of the risk society is that the dangers cannot be perceived by the senses, which means that people are increasingly dependent on expert systems and the media. Increasing knowledge of imperceptible threats and those which cannot be avoided, will be intolerable at some stage. In the end nobody wants to know about things that disrupt everyday life and cannot be changed. Autonomic and imperceptible change from the industrial society to the risk society is better called reflexivity, which is self-confrontational and self-dissolutional. (Beck 1987, 1990)

Beck (1986, 1988) has criticised the mechanistic-deterministic worldview of the traditional natural sciences in particular. While defining limits for pollution emissions, natural science has typically taken into account physical facts and measurable effects of pollution and poisoning only. By accepting and defining the probabilities and limits for pollution, the natural sciences have in a sense justified the degradation of nature. In contrast, according to sociological-historical interpretation of the risk society, risks are created historically and socially. Future risks are invisible and the major post-industrial risks are no longer voluntary personal risks. Society has to be persuaded to take a more ecological direction. Decision-making has to be based on sociopolitical considerations, not merely probability accounting.

Beck can be criticised for being one-sided. Aside from war, the big current risks still relate to disease, such as AIDS (mostly unrelated to technology). Further, in the pre-industrialised era there were also man-made risks like fire and war. Many of the pre-modern risks were also involuntary like plague epidemics, war, and natural disasters. Technological innovations have also solved many problems and developed more ecological products which decrease pollution and waste. Beck (1994) criticises natural sciences for concentrating only on micro-scale risk assessment, but his criticism actually focuses on the social sciences. Natural sciences do not have ways of assessing social and human values in risk assessment. The social sciences should produce this information in conjunction with the natural sciences. Macro-scale evaluation is also natural to the social sciences. Finally, both the facts and probabilities computed by the natural sciences and the knowledge produced by the social sciences are essential to risk management and political decision-making. However, according to Massa (1998) the purpose of the term 'risk society' is to help understand the world of environmental issues, interpret, and show the connections between previously isolated phenomena; after all, Beck's writings gave the first holistic picture of society led by environmental risks.

Risk assessment and different classifications of risk

Definitions of risk and risk analysis

There is hardly any human action that would not be connected to possibilities and choices. In common to different definitions of risk is the possibility of harmful, detrimental, unpleasant or dangerous event. When the consequences are not known for sure, but the probabilities of different consequences are known, we talk about decision-making in domination of risk. Instead uncertainty is meant when there are different alternatives of action and consequences, but the probabilities of these consequences are unknown. Unconsciousness is deeper than uncertainty, when some of the alternatives and possible consequences are unknown. (Kamppinen et al. 1995)

Uncertainty and the possibility that something goes wrong defines the term 'risk'. 1) Human being understands the world by using representation i.e. creating mental pictures about potential happenings with help of generalisations and prognosis. 2) Human being is a social animal sharing experiences with other people. Cultural entity includes shared knowledge about world. 3) Human being is able to built equipment and machines. Entity of these cultural equipment is called technology. These three characters influence how human being faces uncertainty and risks. Although these characters help people deal with risks they do not remove the risks. The number of risks increases and they changes all the time; new risks replace the old ones. (Kamppinen 2000)

Increase of understanding has developed more risks. Phenomena that used to be considered as safe or common earlier are being increasingly called risks from which one can in principle be protected. Culturally shared knowledge about the world and approving specific matters to be risks presume trust on other people. Risk consciousness (i.e. understanding of being exposed to danger) depends on experts and theoretical models. Hybrid systems include technological solutions mixed with social components. E.g. factories or traffic include besides technological and scientific components also human factors. Complex hybrid systems are enormous sources of uncertainty. (Kamppinen 2000)

Risk Analysis includes: 1) risk assessment, 2) risk management, and 3) risk communication. Risk assessment is a scientific multidisciplinary paradigm to identify, quatify, describe and compare risks (ECA 2000) and will be discussed later. One definition for risk communication is "an interactive exchange of information and opinions among individuals, groups, and institutions regarding risk". 'Interactive' means that risk communication is not simply a one-way conversation from the scientist to the public. Risk communication includes opinions and far more than two people. Since risk assessments always contain uncertainty, the opinions of all the participants should be part of the communication. Risk is more than the assessed hazard. It is a combination of hazard and outrage. When individuals are outraged, they tend to over-estimate risks; when they are not outraged, they tend to under-estimate risks. Knowledge of these perceptions along with risk assessments is the basis for formulating effective risk communication strategies.

Risk management is an admisitrative paradigm to develop and compare risk reduction priorities and alternatives, to organise and manage risk-controlling practices and to evaluate the achievements (ECA 2000). Risk management can be defined also as: "the evaluation, selection, and implementation of risk control actions". Evaluation and selection refer to the *decisions* that are based on a risk analysis. Implementation refers to the *actions* that are part of risk management. Risk management makes use of tools from economics, engineering, administration, and the law to support efforts towards sound decisions and effective actions. In other words, regulatory decisions (risk management) depend on far more than risk assessments. They also depend on the quality of communication that has developed, on the attitudes and perceptions of the participants, and on the engineering and other controls that are reasonably available to solve the problem. Every risk analyst must acknowledge the judgements that are part of their conclusions and the assumptions behind the decisions should be clearly stated.

Traditionally risk assessment and risk management have been separated from each other. The scientist should give the knowledge about risks for decision-making purposes (risk assessment). The politician should use this knowledge to choose the best methods to gain the set aims (risk management). However, recently have been emphasised the need for deliberation, meaning the interplay between science and policy, concerning environmental risks.

Environmental risks exist in complex systems including psychological and social dimensions. Risk management deepens also the complexity of risks, because management itself influences the way risks are perceived (Kamppinen 2000). For example, a perceived risk about air pollution may have different impacts than the exposure. Social and cultural backgrounds of perceiving risks have also been noticed lately as fundamental parts of risk assessment and management. Risks cannot be perceived in social vacuum, but as a part of changing social circumstances (Kamppinen 1989). In addition consequences of environmental risks are not divided equally between sociodemographic groups. Therefore identifying and focusing on risk groups is sensible risk assessment (Kamppinen et al. 1995). Reasons and impacts of social and psychological risks are difficult to evaluate and there are no established measurement scales for them. Improbable but possibly disastrous risks seem not commensurable with probable but only slightly detrimental matters (Kamppinen et al. 1995).

A more detailed description of the risk theory is presented by Matti Kamppinen (1989; Kamppinen et al. 1995). However a summary of the risks in society follows to make the structure and aims of this study understandable.

Environmental risk assessment

Covello and Merkhofer (1993) present the risk assessment as follows. A complete risk assessment consists of four interrelated but conceptually distinct steps: 1) Release assessment (describing and quantifying the potential of a risk source to release or otherwise introduce risk agents into an environment accessible to people, plants, animals or other things that people value). 2) Exposure assessment (describing and quantifying the relevant conditions and characteristics of exposure). 3) Consequence assessment (describing and quantifying the relationship between specific exposure to a risk agent and the health and environmental consequences of that exposure). 4) Risk estimation (integrating the results from the previous three steps to produce quantitative measures of health and environmental risk. These measures typically include (a) the estimated numbers of people experiencing health effects of variable severity over time, (b) measures indicating the nature and magnitude of adverse consequences to the natural environment, and (c) probability distributions, confidence intervals, and other means of expressing the uncertainties in these estimates).

The commonly used tool in environmnetal risk assessment and decision-making processes is Cost-Benefit Analysis (Bentkover et al. eds. 1986, Shrader-Frechette 1985) e.g. in Technology Assessment and Environmental Impact Assessment. However public health risks were assessed even before technology risks (Kamppinen et al. 1995). Cost-Benefit Analysis consists of three steps. 1) Identifying (What is dangerous?): identifying of risks and identifying of consequences. 2) Estimation (How dangerous it is?): assessing probabilities of these consequences and counting expectation values of risks. 3) Evaluation (What should be done in a dangerous situation?): choosing the best alternative. The benefits may compensate the costs/detriments.

Social and psychological risks could be “measured” by giving them cost and benefit estimates e.g. as money, however, this has its own problems. Shrader-Frechette (1985) has criticised the cost-benefit analysis being psychologically unrealistic since laymen do not count probabilities in everyday decision-making but act based on intuition, earlier experiences and wisdom. Those who use the Cost-Benefit Analysis realise its problems: unequal distribution of costs and benefits between socio-demographic groups, evaluating costs and benefits as commensurable units (usually as money), attachment of relevant probabilities and values (Kamppinen 1989).

Psychological dimensions of risk

Psychological impacts of environmental risks are strongly perceived annoyances, threats or dangers that are feared and avoided or adapted to (Kamppinen et al. 1995). Environmental risks (both real events/accidents and threat of ones) create stress, which has its own consequences, both physiological and social. Stress connected to environmental pollution exposes to illnesses and creates anxiety and depression (e.g. Evans et al. 1988; Palinkas et al. 1993). In addition to direct detriments of environmental pollution stress also denies us the recovery needed after the workday (Ulrich & Pankrath eds. 1983).

Psychological dimensions of risks have no established measurement scales. One way to assess environmental values is price them by asking people how much they are willing to pay to avoid some risk or how much cash they want to accept it (willingness to accept). This method, however, is not unproblematic, because money is not a neutral meter (Kamppinen et al. 1995).

As cognitive categories, evaluation of both probabilities and detriments depend on the social environments of the decision maker. Psychological studies of risk assessment have focused on the questions how we perceive and categorise detriments and possibilities and how the environment influences us (Kamppinen 1989). These studies have created several classifications for analysing psychological risks. For example uncertainty may be qualitatively different (character of the event, lack of knowledge, correctness of the information, or connected to the purposes of those who provide the information). Environmental risks include all different shapes of uncertainty only emphasised differently (Kamppinen et al. 1995).

One factor, which has been shown to predict risk ratings is the controllability of the hazard (Fischhoff et al. 1978; Slovic et al. 1980, 1985a). Since a hazard which the individual perceives to be beyond his/her control is typically perceived as more threatening than a more manageable one, one might expect that the degree to which people desire control would have some bearing on their assessment of the risk. In fact, although little is known specifically about the role of the need for control, there is evidence that perceived control may play a role in reactions to technological hazards. For example, it has been found to be an important moderator of stress (Glass & Singer 1972). People with a great desire for control have a greater tendency to engage in health promoting behaviour than do people with less desire for control (Burger 1992). The uncontrollability of exposure was found to be a major predictor of risk ratings (Slovic et al. 1980, 1985a; Gould et al. 1988, Myers et al. 1997).

Rationality is closely linked to risk assessment. Voluntary risks are easier to accept than involuntary ones. Voluntary risks are assumed to be really known and to have alternatives (Kamppinen et al. 1995). Slovic et al. (1985b) created risk maps for different events based on 9 or 18 dimensions and 'voluntary/involuntary exposure' was one of them. Other examples of these dimensions are 'consequences shown slowly/fast', and 'familiarity/obscurity of the risk'. These dimensions could be analysed further through 3 factors: fear-factor, obscurity-factor and number of exposed –factor.

Tversky and Kahneman (1974) presented three issues that can bias evaluation of possibilities and probabilities of laymen, namely representativeness, anchorage and availability. *Representativeness* refers to the similarity of new events to known processes (and thought to be representative). Known processes can help us evaluate new processes, but unfortunately, it can also lead to errors. Probabilities are evaluated by *anchoring* to some constant, which may have nothing to do with the current problem. *Availability* of knowledge concerning current situation includes the fact that recently given information is better remembered. According to Koné and Mullet (1994) intensity of news about specific risks influence risk assessment. Large sudden accidents are more likely to be publicised than the more common small accidents in routine tasks. For example media described hard sea circumstances to be the reason for accidents in North Sea oil drilling rigs, although most of the bad accidents could have been avoided by better planning and safer equipment (Heimer 1988).

Not only evaluation of probabilities can be biased, but also perception of risks as well (Kamppinen 1989). For example, the numerically assessed risks (probabilities) are typically overestimated and impact of human elements under-estimated ('over-trust'). Also the uncertain matters may be ignored and decisions are based on only the known facts ('willingness to be sure'). All risk assessments require assumptions. If these assumptions are forgotten or simply treated as facts, this can influence our perceptions of risk. Therefore, these assumptions must be clearly stated.

Risk assumptions of laymen and experts

From the view of politics laymen are those who are exposed and the decision-makers are the experts. Another definition to expert is a person who knows more about the specific problem than most of other people. Risk discourse is connected especially to expertise based on education (community of different experts). However, the scientific knowledge is not better than that of laymen (local expertise). Assessments of laymen and experts are equally rational, but their basic presumptions are different (Kamppinen et al. 1995). Risk experts estimate usually lost working hours or numbers of deaths, while laymen take into account also equality of risks, possibility to manage the risks or the disastrous potentiality included in the risks (Kamppinen 2000).

According to a Baron et al. (2000) study, the general tendency of people to support action, to worry, and to assign high probabilities to bad events are related to gender, expertise, politics, age, marriage, and parenthood. Expertise seemed to be the main determinant of the pattern of beliefs about the probability of risk. Experts and non-experts did not differ much in what determined their worries or their desire for action, but they did differ in their beliefs about particular risks (see also Lichtenstein et al. 1978). Non-experts were much more concerned about what experts consider to be slight risks of cancer from environmental sources. Experts were more concerned about statistically more frequent, but more mundane, events such as car accidents.

Risk assessment of laymen differed strongly from the statistical probabilities of these risks in Slovic et al. (1985b) study about factors influencing risk perception. Assessments of experts were instead close to the annual death rates of the specific risks. Laymen did not even link their risk assessments to their assessment of the annual death rates of these risks, but they had other basics to evaluate and value different risks. Potential destruction was one reason to assess nuclear power to be much more dangerous than its risk probability showed. According to Slovic's (1987) risk map presenting social consequences of technological risks the higher a risk is assessed by frightening (dread) and unknown (knowability) dimensions the bigger the risk is assessed to be. Decisions of environmental risk include so much social uncertainty and social agreements that exact probabilities may be irrelevant (lose significance) (Kamppinen et al. 1995).

Social and cultural dimensions of risk

The psychological research of risk perception focuses mainly on assessing hypothetical risks. Research on the social and cultural context of risk perception and risk behaviour is essential for understanding how the existence of risks are negotiated, how these negotiations influence perceptions of individuals and how the constructed risk changes in time (Kamppinen 1989). Also social networks influence the perceptions of risks. Evaluation of decisions or planning is not possible without discussion of values. In social decision-making processes individuals make decisions that may not be identical with any of the personal decisions (Kamppinen et al. 1995).

Category of danger is a part of the symbolic structure, which is used for negotiations of the meanings of situations. These negotiations are needed especially when the situation is unclear and consequences of our own acts are unpredictable. E.g. in communities that believe on technology to manage nature, many natural phenomena like birth, death etc. are seen risky but on the other hand also manageable. (Kamppinen 1989)

According to anthropologists Douglas and Wildavsky (1982) communities perceive risks more likely on the basis of moral issues instead of objective or psychological reality; how the risks are linked to health, environment or safety. Risk identification happens in social processes and therefore the risks are social constructions. An example of three phases (redefinition of risk, legitimisation of risk and institutionalisation of risk management) of social construction of risks is presented in Lahti’s (1996) dissertation.

Environmental health and risk assessment

The term 'environmental health' is relatively new, but the research field itself has a long history. Well-being includes ecological and aesthetic goods, but also health broadly understood (environmental health) (Allardt 1989). According to the WHO (1990) definition: "Environmental health comprises those aspects of human health and disease that are determined by factors in the environment. It also refers to the theory and practice of assessing and controlling factors in the environment that can potentially affect health". Environmental health can be an experiential, functional and societal phenomenon, which many social and psychic factors influence indirectly (Korpela et al. 1999). The sectors of preventive health related to environmental health include the intention to create an environment that supports health and a social policy that prevents disease (Perttilä 1999). In the circumstances of globalization and increased consciousness of risk, interest in and concern about individual health have increased rapidly (Petersen & Lupton 1996).

According to Tuomisto (1993) risk management as it affects political decision-making must also take the attitudes and assumptions of individuals into account in addition to economic and social consequences. The purpose of risk assessment in environmental health is thus only to obtain the information needed and compute the probabilities to help the decision-making process. Environmental health risk assessment could also provide information about the perceived environmental risk issues for decision-making purposes. However, psychosocial health risk assessment needs further research, since perceived inconvenience from environmental factors, for example, has no commonly accepted measurement scales.

Environmental health risks vary in time and depend on individual behaviour. Most of the risk assessment is based on toxicological information from animal experiments. The major environmental health risks can also be investigated epidemiologically. Risks shown to be statistically significant in epidemiological studies must be considerable. The individual risk of getting sick or dying of environmental exposure is usually very low. However, at the population level, even a low relative risk may be significant, because the number of those exposed may be very large (Suomen kansall… 1997).

Fifteen years ago Lautkaski et al. (1988) assessed that the major causes of death in Finland are cardiovascular deseases (>50%), cancer (20%) and accidents (10%). The death risk is strongly related to gender and age as well as to education and civil status (men, less educated and single living having higher risk). Alcohol consumption was assessed to cause more than 4% of deaths yearly, tobacco smoking 41% new cancer cases for men and 12% for women plus a considerable share of cardiovascular deaths, and traffic accidents ca. 1% of all deaths. Ambient air pollution concentrations are evaluated to cause 200 to 400 deaths in Finland and 30,000 to 40,000 respiratory infections to children annually (Suomen kansall… 1997). Aside from air pollution other environmental health risks in Finland include chlorinated tap water causing less than 0.5% of new cancer cases in a year and mould allergies of which ca. 5% of the school children suffer (Suomen kansall… 1997).

Jantunen published a risk assessment model which combines the toxicological, sensory-irritation and psychosocial causal chains leading from a source of contamination to the agent, irritation and stress-specific health effects (ECA 2000). Figure 2.1 shows this multidisciplinary construct of all causal links from air pollution sources to various health outcomes. The model not only shows the various chains of events from air pollution sources to health outcomes, but also highlights the strong internal linking between them and the fact that they cannot always be fully separated.

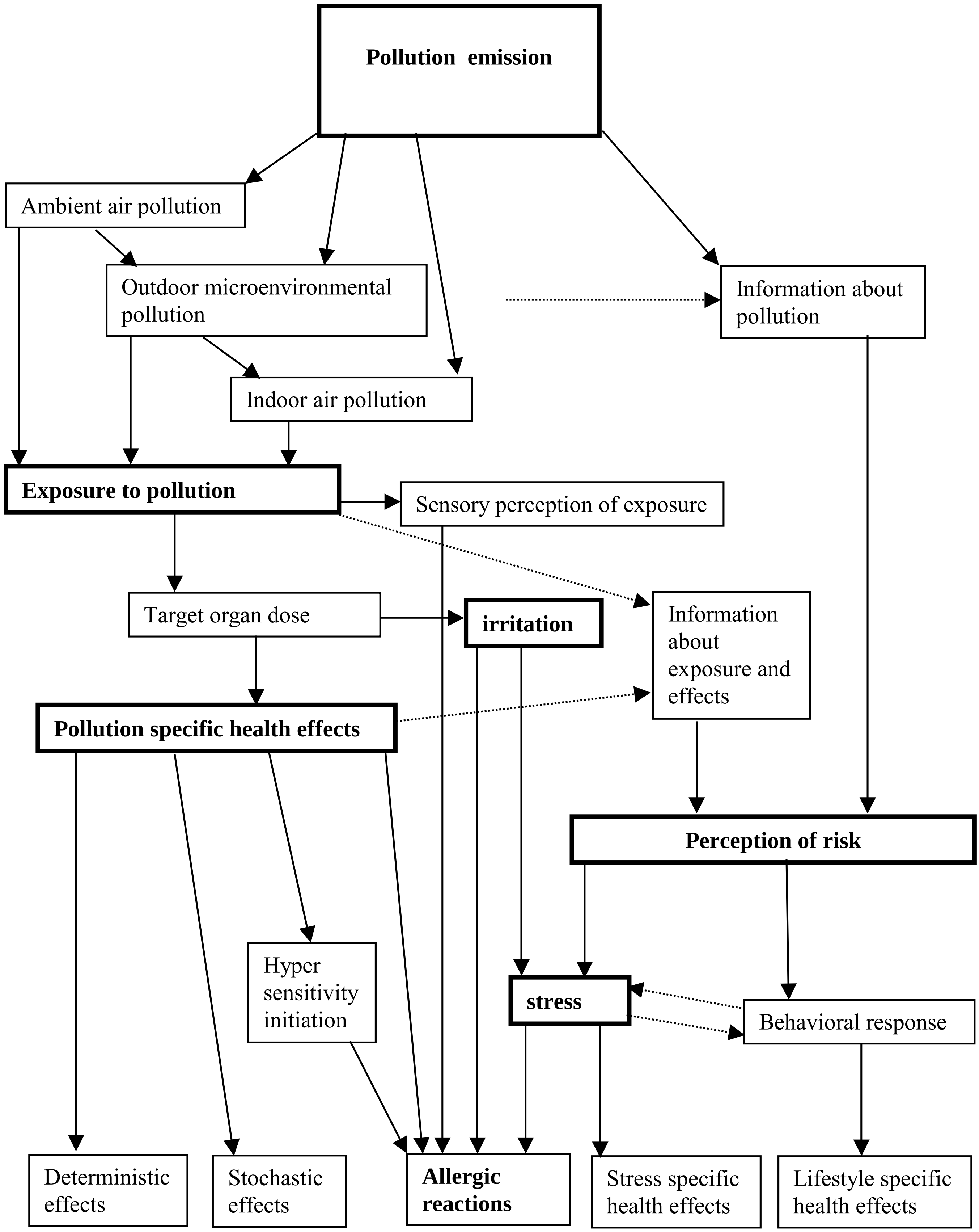


Figure 2.1. A multidisciplinary construct of the types of causal link from air pollution sources to various health outcomes (ECA 2000).

2.1.3. Recent related studies

Environmental social sciences

A research tradition which focuses on the social consequences of pollution has developed in the United States. This tradition began in geography and sociology. Sociological research started from studies of catastrophes. During the 1960s and 1970s many case studies were conducted about reactions toward threats created by nature and technology (Cutter 1993), interesting new themes emerging from the environmental sociological studies in each decade. At the same time, however, the "old" problems continued to be of interest, which led to the expansion of environmental concerns in sociology. According to Dunlap and Jones (2002) in the 1960s researchers investigated air, water and soil pollution. In the 70s, nuclear power was a new and interesting subject, while in the 80s hazardous waste and acidification captured the attention of researchers. In the 90s global phenomena like climate change became challenges for environmental sociology.

American researchers Fitchen, Heath and Fessenden-Raden (1987) studied social consequences of ground water and drinking water pollution. They reported the circumstances that influence how people receive information on the risk of water pollution based on several water-pollution case studies. Edelstein (1988) wrote about the psychological and social consequences of ground water and soil pollution, and Szasz (1994) investigated hazardous waste. Couch and Kroll-Smith (1991, 1994) compiled data from many case studies of pollution accidents. Their work focused on collective reactions toward technological dangers from many different viewpoints, especially how individuals and groups adapt themselves when facing environmental problems and how this adaptation changes local social structures. In Sweden Drottz-Sjöberg and Sjöberg (1990) studied the reactions of the Swedish population to the Chernobyl accident. Many studies in environmental sociology have also been conducted in Germany, but unfortunately most of these have been published only in German.

Individual differences in personality characteristics play an important role in people's perceptions and fears concerning technological hazards. Sociodemographic variables have been found to be associated with risk perceptions (Myers et al. 1997). For instance it has previously been found that women exhibit higher levels of concern about technological hazards than men do (Vlek & Stallen 1979; Harding & Eiser 1984; Gould et al. 1988; Pilisuk & Acredolo 1988; Drottz-Sjöberg & Sjöberg 1990; Gutteling & Wiegman 1993). In addition, race (Vaughan & Nordenstam 1991), socioeconomic status (Pilisuk & Acredolo 1988; Vaughan & Nordenstam 1991; Cvetkovich & Earle 1992), educational level (Melber et al. 1977; Pilisuk & Acredolo 1988), nationality (Keown 1989; Kleinhesselink & Rosa 1991), and the presence of children in the home (Hallman & Wandersman 1992) have all been found to be related to technological risk perception. For example the overall level of concern about risks associated with contemporary technology was elevated among women, minorities, and less educated (Pilisuk & Acredolo 1988). Risk perceptions have also been shown to be associated with religiosity (Pilisuk & Acredolo 1988) and political orientation (Harding & Eiser 1984; Pilisuk & Acredolo 1988). Far less, however, is known about the attitudinal correlates of risk perception. Gould et al. (1988), on the other hand, found only a weak relationship between attitudes toward the environment, attitudes toward technology, and perception of technological risk. These sociodemographic variables that are associated with risk perceptions and concern about air pollution as well as relationship between risk perception and concern about air pollution were evaluated in this study.

Research in Finland

Environmental sociology developed in Finland from paradigm criticism to empirical and theoretical research of environmental questions. It consists of studies on environmental attitudes and consciousness, environmental movements and conflicts, environmental politics and discussion about it, the social impact of environmental change, energy research and the relation between environmental problems and modernization development (Viinikainen ed. 1996). The Finnish pioneers started research into the environmental social sciences in the 1970s, and by the 1990s the number of studies in this field had increased spectacularly (Massa 1998). One example of the studies in the field of environmental sociology is the doctoral thesis by Lahti (1996) based on a case study of water pollution in the village of Oitti in Southern Finland, based on interviews with inhabitants of the polluted area and representatives of the municipality. Lahti describes how people react to a massive, health threatening pollution accident.

In another ongoing project (Korpela et al. 1999) sociologists, psychologists and architects studied the experiences of living environment and self-reported health, annoyance from noise and pleasant and undesirable locations in people's immediate surroundings. Urban planners in previous years supported decentralization and suburban areas were planned to offer light, air and tidiness for everybody (Lapintie 1995). Paradoxically, the suburban lifestyle is based on and led to vastly increasing motor traffic, which has become one of the worst environmental and health problems. The perceived threat has real health effects as well as the pollution itself (Korpela et al. 1999). Half of the subjects of this study (Päivänen & Vuorela-Wiik 1999) reported that air pollution was the most important reason for their intention to leave the area. People are also contradictory. While they value the good traffic connections in the residential area, the traffic emissions annoy them.

Pertti Suhonen (1994) studied the development of environmental journalism and environmental attitudes. Environmental attitudes, environmental behaviour and differences between population sub-groups have been monitored in surveys by Kaila-Kangas et al. (1994), and Statistics Finland (Tulokas 1990, 1998; Tanskanen 1995), and similar studies have been done in the cities of Helsinki (Haavisto & Lankinen 1991; Lankinen 1995; Lankinen & Sairinen 2000) and Turku (Kouvo 2000).

Järvelä and Wilenius (1996) studied the definitions of environmental risk by Finnish opinion leaders and politicians. This multi-disciplinary SILMU project focused on climate change. The most recent studies in environmental policy are by Sairinen (2000) and Haila and Jokinen (2001). A recent Finnish study of the origins of water protection in Helsinki describes environmental history in Finland for the first time (Laakkonen 2001). According to this study water pollution had already been noticed in Helsinki in 1880 and several protection plans have been brought up. The environmental history of Helsinki is closely related to environmental health questions and this multidisciplinary study combined natural, technical and social sciences.

Sosiodemographic differences in morbidity and mortality

The doctoral thesis by Waris (1932, 1934) on workers' residential environment and health conditions in Helsinki is one of the pioneering publications in health (medical) sociology in Finland (Karisto et al. 1992). Socioeconomic factors influencing disparities in health have been considered for a long time. In Britain the health impact of social factors has been studied since the 1850s (Antonovsky 1967; Macintyre 1997). In Finland health and mortality differences have been investigated for over a hundred years (Lahelma & Riska 1988; Karisto et al. 1992, Lahelma & Karisto 1995). In the 1980s, some reports (Black Report (Townsend & Davidson 1982/1992) and WHO 1985) evaluated general health objectives. In recent years many studies have been published about the magnitude of and reasons for socioeconomic health and mortality differences in Finland (Valkonen et al. 1990, 1992; Valkonen 1993; Martikainen & Valkonen 1995; Lahelma et al. 1997) and in other countries (Marmot et al. 1984; Illsley & Svenson 1986; Fox ed. 1989; Feinstein 1993; Mackenbach et al. 1997). These studies, mostly from European countries and from North America, consistently show that those in lower socioeconomic status groups have in average worse health and shorter lives than those in upper socioeconomic status groups. This conclusion has been reached in many studies, in many countries, both for men and women, for different age groups, using different health and socioeconomic indicators and various methods (Antonovsky 1967; Illsley & Svenson 1986; Feinstein 1993; Macintyre 1997). In Finland mortality differences in socioeconomic groups are the second largest (after France) among Western European countries (Mackenbach et al. 1997) and have been increasing since 1980 (Valkonen et al. 1992).

Socioeconomic factors have also been considered confounders in air pollution epidemiology and mortality/morbidity rates (e.g. Kunst & Mackenbach 1994; Carrozzi 1997; Notkola & Husman 1997; Phillimore 1997). Some studies have shown large differences in respiratory symptoms and morbidity (primary health effects of air pollution) between socioeconomic groups (Carrozzi et al. 1990; Kunst & Mackenbach 1994; Notkola & Husman 1997). Usually the rank order between the occupational groups is the same in many European countries and the same as in studies of mortality in general (Valkonen et al. 1992); workers having the highest mortality, followed by lower and upper white-collar employees (Notkola & Husman 1997).

The Black Report divides the explanations of socioeconomic variation in mortality and inequalities in health into four types: artefact, social selection, cultural or behavioural, and materialist (Townsend & Davidson 1982/1992). Macintyre (1997) points out that more detailed studies of the mechanisms which generate and maintain social inequalities in health are needed. Methodological and empirical developments since the Black Report raise important issues for future research: the ubiquity of socio-economic differentials across industrialised countries, continuing or increasing differentials, stepwise gradients, interest in psychosocial mechanisms, the hypothesis of biological programming in utero or infancy, controls for behaviour, and evaluations of interventions.

Marmot et al. (1984) present a few explanations for socioeconomic inequalities in mortality. “Smoking and other coronary risk factors are more common in the lowest grades, but these differences account for only a part of the mortality difference. Further, the similarity of the risk gradient from a range of specific diseases could indicate the operation of factors affecting general susceptibility and the inverse relation between height and mortality suggests that factors operating from early life may influence adult death rates.” Valkonen et al. (2000), however, suggest that “Changes in mortality and socioeconomic inequalities in mortality result from a complex combination of different and even opposite trends in mortality from various causes of death. In the light of this complexity it seems unlikely that there exists any major single explanation for changes in inequalities in mortality.”

Research on air pollution exposure and the health impacts

Some previous studies have sought the determinants of and differences between the exposures of sub-populations to fine particles (Özkaynak et al. 1996) and nitrogen dioxide (Dockery et al. 1981; Noy et al. 1986; Quackenboss et al. 1986; Spengler et al. 1994; Alm et al. 1998; Levy et al. 1998). As health implications fine particles have been observed to cause respiratory symptoms in asthmatic children (Pekkanen et al. 1997) and ultra-fine particles in asthmatic adults (Peters et al. 1997; Penttinen et al. 2001) as well as shorten life especially of those with cardiovascular diseases and respiratory symptoms. Recent studies have shown that nitrogen dioxide has significant effects on children’s health (Schwartz et al. 1991; Dab et al. 1996) and increases respiratory symptoms among healthy children (Mukala et al. 1996, 1999). Nitrogen dioxide has also been shown to increase daily mortality (Touloumi et al.

1997) and cause respiratory symptoms among asthmatic children (Timonen & Pekkanen 1997). A connection has been found between respirable particles and increased deaths at much lower concentrations than most previous studies (WHO 2000; Pope et al. 2002). This is important, because large populations are exposed to relatively low concentrations of air pollution every day, so that even a small increase in relative death risk will result in considerable number premature deaths.

Ambient air pollution concentrations are evaluated to cause 200 to 400 deaths and 30,000 to 40,000 respiratory infections to children annually in Finland (Suomen kansall… 1997). According to WHO (1995b), fine particles cause 1-2% of all deaths, 7-10% of respiratory diseases of children and 3-15% of new asthma diagnoses in Europe. WHO Air Quality Guidelines (WHO 2000) concludes that a daily outdoor air $PM_{2.5}$ increase of 25 $\mu g/m^3$ increases daily total mortality by 15% based on the literature review of short-term health effects (time series studies). Long-term effects of fine particles - based on cohort studies - are even larger shortening expected lifetime (Nevalainen and Pekkanen 1998). A cohort study on long-term health effects evaluated a difference in the annual average $PM_{2.5}$ level from 10 to 30 $\mu g/m^3$ was associated with a mortality increase of 26% in total and 37% in lung and heart disease (Dockery et al 1993). According to WHO (1995b) nitrogen dioxide is considered to cause 0.3-0.5% of respiratory infections. Nitrogen dioxide has also been shown to increase daily mortality (Touloumi et al. 1997) and cause respiratory symptoms among asthmatic children (Timonen & Pekkanen 1997).

Studies on socioeconomic differences related to air pollution

Many studies in the USA have noted inequities with regard to the socioeconomic status or racial character of communities and their relative exposure to environmental disamenities (Northridge et al. 2003; Samet et al. 2001; Sexton et al. 1993). Some examples of the findings follow. Compared with White children, a substantially higher proportion of African-American children lived in poor households that were located in relatively close proximity to one or more industrial sources of air pollution in three different study areas in the USA (Perlin et al. 2001). Also increased segregation was associated with increased disparity in potential exposure to air pollution (air toxics concentrations) in several US metropolitan areas (Lopez 2002). Children of color and from low-income families had higher potential exposure to vehicle emissions in California (Gunier et al. 2003). Clear relationships between modelled emissions of carbon monoxide (CO) and nitrogen dioxide (NO_2) in an English study (Brainard et al. 2002,) as well as sulphur dioxide (SO_2) pollution around power plants in the USA (Corburn 2001) and poverty indicators and ethnicity, were reported. Dwelling values (Buzzelli et al. 2003), low income and unemployment were significant predictors of exposure to total suspended particulates (TSP) in a Canadian study (Jerrett et al. 2001).

These disparities between racial/ethnic minority and low-income populations in cities and the general population in terms of environmental exposures and related health risks have prompted the 'environmental justice' or 'environmental equity' discussion. However, these studies are usually based on ambient concentrations of air pollutants and the exposure is related to socioeconomic status variables at the census tract, not individual level.

Only a few studies have analysed sociodemographic differences in personal air pollution exposures. Neas et al. (1991) found that in the United States nitrogen dioxide (NO_2) concentrations were higher in homes with lower parental education and single parent family status. Alm (1999), however, reported the mother's or father's education as not affecting the NO_2 exposure of preschool children in Helsinki, Finland. Further, father's high education reduced the children's carbon monoxide (CO) exposure while mother's education level had no significant effect (Alm et al. 2000).

Some studies on health consequences of air pollution have also focused on socioeconomic differences. A Canadian study reported that neighbourhood levels of income and air pollution (total suspended particulates (TSP) and sulfur dioxide (SO_2)) were important correlates of mortality (Finkelstein et al. 2003). Pope et al. (2002) reported that the association (Relative Risk ratio) with fine particulate (PM2.5) pollution was stronger for both cardiopulmonary and lung cancer mortality for participants with less education after adjusting for age, sex and smoking status. Levy et al. (2002) constructed a model to estimate the magnitude and distribution across subpopulations of health benefits associated with air pollution emission controls at five power plants in the Washington, DC, area. The study determined the primary and secondary fine particulate matter ($PM_{2.5}$) concentration reductions associated with the hypothetical application of "Best Available Control Technology" to the selected power plants. Because individuals with lower education appear to have both higher background mortality rates and higher relative risks for air-pollution-related mortality, stratifying by educational attainment implies that 51% of the mortality benefits accrue among the 25% of the population with less than high school education (Levy et al. 2002).

Some sociodemographic differences also in perceived annoyance from air pollution have been reported in previous studies. Female gender (Oglesby et al. 2000a, Klaeboe et al. 2000; Forsberg et al. 1997) and downtown living indicating high traffic volume near home (Forsberg et al. 1997) were shown to be determinants of perceived air pollution annoyance. Also current smoking status (Oglesby et al. 2000a; Lercher et al. 1995), older age and low education level (Klaeboe et al. 2000) were found to be determinants of perceived annoyance from air pollution. A few studies observing the association between annoyance from air pollution and air pollution exposure have been conducted (Forsberg et al. 1997; Klaeboe et al. 2000; Oglesby et al. 2000a).

Concern about environment

Unemployment and environment have both been very important social concerns for at least 10 years according to the inhabitants of the Helsinki region (Haavisto & Lankinen 1991; Lankinen 1995; Tulokas 1998; Lankinen & Sairinen 2000). 'Decreasing unemployment' and 'protection of the environment' were seen as very important social aims by all social strata (Lankinen and Sairinen 2000). Women, the youngest and the more educated inhabitants preferred protection of environment more often than other sub-populations (Tulokas 1998).

Based on the Europeans and Environment surveys Europeans are more concerned about global and national environmental problems than local ones and typically most environmental problems are seen more dangerous in general than for the respondent himself (Tanskanen 1997). At national level air pollution concerned twice as many Europeans than at local level. At local level the amount of traffic concerned most often followed by air pollution, damaging of the landscape and waste disposal (Europeans and Environment 1992). The rank order of concerns about local environmental problems among adult inhabitants of Helsinki Metropolitan area in 1994 was 'littering', 'air quality' and 'excessive building' (Tulokas 1998).

In Finland every fifth respondent thought that environmental pollution impact their health and women were more concerned about the health implications of pollution than men (Suhonen 1994). According to Kouvo (2000), more educated people seemed to think more often that they could influence the environment by their own life style than the less educated.

Tanskanen (1997) has studied the association between environmental knowledge and concern about environmental problems. Knowledge of environmental problems in general did not explain the expressed concern/dangerousness about environmental problems. Correct knowledge about environmental problems may either increase or decrease the perceived dangerousness of environmental problems. Measurement of the level of knowledge about environmental problems is difficult, because the knowledge seems to be filtered through attitudinal aspects connected to the problem. Cognitive and value-based factors are very difficult to separate in survey-studies. It seems more important to keep the picture of environmental problems consistent rather than to answer correctly to a single question about environmental knowledge. This means that value-based assumptions (moral issues) may lead to giving false answers to some specific questions. In general in the countries with high level of knowledge, environmental problems were indicated as less dangerous, and in the countries with low level of knowledge, environmental problems indicated as more dangerous than average (Tanskanen 1997).

Suhonen (1994) classified the dimensions of environmental assumptions as cognitive and value based. The younger and more educated were more often found on average to have cognitive concern, while women, the older and less educated made value-based assumptions about the environment (Kaila-Kangas et al. 1994).

2.2. Public discourse on air pollution and environmental problems

Public discourse influences the attitudes, concerns and consciousness of air pollution. While the media are an essential part of modern society, the media system both formulates and manifests public opinion. Media represent prevalent assumptions and ideas and also influences these assumptions (Heiskala ed. 1993). Media has the potential to manipulate the information delivered by selecting the important topics (Suhonen 1994). People establish their assumptions about the environment partly through the information they get from the news (or other trusted sources). The less personal experience somebody has of something, the more he or she has to count on information from the media (Zucker 1978). These assumptions have an impact on the attitudes, behaviour, concern and consciousness that people report.

A news item is an interesting, unusual and important new happening. In the 1960s, when researchers observed harmful changes in the environment, news criteria restricted their access to the media agenda. While the environmental problems developed slowly and persisted, they were not seen as news (Rentola 1983; Reunanen 1991). But the general understanding then changed. As more and more environmental events like accidents, research findings, international meetings and environmental movement actions occurred, the significance of environmental issues were realized (Schoenfeld et al. 1979). However, no society can react to even difficult environmental problems before these are published and became part of the public discourse (Luhmann 1988). For example, the increase in ozone at ground level is a physical not a social phenomenon, before it is communicated. Environmental risks become social with the help of communication (Suhonen 1994).

Environmental consciousness and changes in the publication of environmental articles have been analysed in two earlier Finnish studies about environmental problems in one newspaper and two magazines (Heiskala ed. 1993; Suhonen 1994). Suhonen's study included material (a sample of over 3000 article titles) from Helsingin Sanomat from 1956 to 1990. The data of the other study included all headline news/articles and main cartoons expressing an environmental view from Helsingin Sanomat, all editorials and all topics on the cover page of Suomen Kuvalehti and all the articles from Suomen Luonto from 1951 to 1990 (Heiskala ed. 1993).

The view of environmental problems in Finnish journals

The studies by Heiskala ed. (1993) and Suhonen (1994) showed the same trend in environmental news and articles in Finland. There have been two big changes, quantitative and qualitative, in the period 1951-1990. The number of environmental articles has increased rapidly, the first substantial step being noticed at the beginning of the 1970s, followed by a marked decrease. A similar pattern was noticed in other western industrialized countries a little earlier (Suhonen 1994). The second step was noticed in the beginning of the 1980s. The quantity of environmental news increased dramatically in national and international sections as well as in the "letters to the editor" section through the 1980s; the same development was not as obvious in the main news page. The increased number of environmental articles among international news reflects globalization of environmental problems and the internationalization of environmental policy (Suhonen 1994).

The qualitative change was noticed as the viewpoint of the texts changed from the natural sciences to the social sciences and the environment was gradually interpreted as a social problem (Suhonen 1994). Environmental consciousness changed during the study period. First of all, nature became environment and secondly, the environment was everywhere. This was due to changes in society during the study period. According to Heiskala ed. (1993) environmental risks were attendant upon all activities and these had to be taken into account in social decision-making. Environmental problems also became abstract, hard to understand and unavoidable, and so complicated that they needed special expertise to be understood. Concern about the environment increased, but at the same time the objectives became increasingly abstract.

According to Suhonen (1994) the causes of environmental problems were seldom discussed in the headlines of Helsingin Sanomat. Environmental changes have health, psychological, economical and social effects on human beings. These human and social consequences were mentioned only in one title out of ten, but it is possible that they were mentioned more often in the text. The proportion of environmental policy articles increased from 1956 to 1990. One third of the articles were about water system pollution, but the proportion of these had decreased. Meanwhile the number of articles about environmental problems in general almost tripled and about air pollution increased 1.5 times. More environmental articles were written about energy production (26%) and industry (19%) than about closely to individual behaviour related waste management (18%) and traffic (13%).

To complement these studies, to focus on air pollution and to understand the concerns about air pollution better, a small preliminary study was carried out. Articles mentioning air pollution in Helsingin Sanomat from 1996 to 2000 were collected, the aim being to describe the picture of air pollution conveyed by the main Finnish newspaper. Since media influences people's concerns about air pollution, this background information should help make conclusions about Environmental Attitude Questionnaire data. Media also reflects indirectly the knowledge that people are supposed to have. However, this description of air pollution articles is very brief and the direct impacts on concerns cannot be drawn. In addition, knowledge of air pollution communicated by the media and individual concerns about air pollution also influence the perceived annoyance from air pollution.

Description of data collection and media

First, the proportion of articles dealing with air pollution among articles in Helsingin Sanomat were evaluated from the titles (n=691) in the Heiskala ed. (1993) dataset. This was done to observe the trend in the number of air pollution articles over recent decades. Thirty air pollution articles were found among the 691 articles published from 1952-1990 (Table IIa Appendix 1).

Helsingin Sanomat is the major national daily newspaper in Finland, particularly in the Helsinki region (circulation 454,800). The Internet version of this newspaper was started on 17th May, 1996. The data covers articles from a four-year period ending on 16.7.2000 (Firuge 3.1.). Almost all edited articles (90-98%) from the newspaper version are also published on the web pages, (the exception being the letters to the editor and cartoons). The search was conducted by using the words '**air pollution**' (*ilmansaaste*) and '**air quality**' (*ilmanlaatu*). The data consists of 142 articles, of which 108 (76%) were mainly about air pollution, while 34 did not actually deal with this subject, but merely mentioned the issue. It is possible that some relevant articles about air pollution were not found in the used search, because the words 'air pollution' were not mentioned in them. This article collection covers only four-years (of which 2.5 years is before EAQ-survey) and therefore a deeper analysis is unfounded.

These articles were classified qualitatively and the analyses were mainly quantitative. Qualitative notions do not become quantitative by just giving them numbers while saving the data, which means that qualitative interpretations and conclusions are based on the quantitative results. The 'main' air pollution articles included the idea of air pollution being a **risk,** explicitly or implicitly. However, term 'risk' itself was mentioned only in a few of these artcles (n=10) and was therefore not an own classification basis. The articles in Helsingin Sanomat about air pollution were classified into several classes, which can be seen in Table IIc and some classification examples in Table IIb (Appendix 1). The article classification was based on erlier studies, e.g. 'geographical perspective' was compared to the environmental concerns among Finns (Tulokas 1990, Tanskanen 1997) and 'health mentions', 'scientific orientation' and 'viewpoint on the issue' to results of Suhonen (1994).

An extra search was done (26.6.2003) since the letters to the editor (readers' opinions) became available in the Helsingin Sanomat web pages. The purpose of this search was to find out what matters connected to air pollution made Helsinki inhabitants express their opinions, and it was focused (9.12.1997 – 13.1.1999) to the year before the Environmental Attitude Questionnaire was mailed. Seventeen articles from the letters to the editor section were found; 8 by using the words '**air pollution**' (*ilmansaaste*), 5 with '**air quality**' (*ilmanlaatu*) and 4 with **'risk & air'**.

Air pollution articles in Helsingin Sanomat

As environmental articles, the number of air pollution articles increased likewise in Helsingin Sanomat during the period researched (1951-1990) and, more importantly, the proportion of air pollution articles among environmental headline news increased from 1.7% in the 60's to ca. 10% in the 80's (Table IIa Appendix 1). As the increasing tendency of the articles about environmental problems (Suhonen 1994) also the increased number of air pollution articles reflects the worsening of the problems and the increased interest in and publicity about the issues of environmental problems and air pollution especially nationally and internationally.

According to table IIc (Appendix 1) half the air pollution articles were reports on how man had destroyed or damaged nature. Thirty-six percent were articles about how man tried to solve problems, including regulations. Two-thirds of the air pollution articles were written from the view of the natural sciences, and 17% were written from the view of the social sciences (including politics and economics). Suhonen (1994) reported that already during the 1980's environmental articles from the viewpoint of social sciences increased, however, only few air pollution articles were written from social point of view between 1996-2000.

Forty-two percent of the air pollution articles handled local items in Finland (mainly the Helsinki region) and every fifth dealt with local problems somewhere else than in Finland (Table IIc in Appendix 1). In contrast to environmental problems in general (Suhonen 1994) air pollution is reported more often at local than national or global level. Finns, however, are still more often concerned about global air pollution than local air quality (Tanskanen 1997). Tulokas (1990) suggested that assumptions about the local environment are strongly based on one's own experiences. In addtion human health was mentioned in every third article. Respectively every fifth respondent in Finland were concerned about environmental problems impacting their health (Suhonen 1994). Half of the articles (excluding those that mainly discussed the climate) mentioned nitrogen oxides (NO or NO_2) and 37% were written about particles (including all size fractions, inhalable particles often being mentioned).

The locally-oriented articles included detailed information about air pollution compounds. In addition, one-third of the articles discussing human health also mentioned some air pollution components. Particles were mentioned more often in the articles where man had caused the problem than in those in which man tried to solve the problem. The reverse was true for nitrogen dioxide (NO_2). Human being was most often the main subject of the article at local or global level. In contrast, nature was most often the main subject in those articles concerned with the whole of Finland. Two-thirds of those articles mentioning human health dealt with local problems. Health was mentioned in 39% of the articles in which man had caused the problem and in 15% of those in which man tried to resolve it.

At the local (Finnish) and European level air pollution articles were more frequently about regulations and about man trying to resolve the problems, while at national, local beyond Finland or global levels more articles were written about created air pollution problems.

Interestingly, more of those articles written from the natural science point of view were those in which man had caused the problem, and of those written from the social science point of view more were concerned with man trying to solve existing problems. However, there were in total still more natural science articles about man solving problems than social science articles. Human actions (techniques, modernization, traffic, infrastructure, etc.) have caused a lot of air pollution problems, but societal decisions preceded these actions. The fact that man-made decisions cause environmental problems was not emphasized understates human and individual responsibility.

Of the 17 letters to the editor three were not really about the air pollution (but about e.g. quality of building work and mold). From the remaining 14 articles two were about climate change, one about smoking, two about energy production and the rest nine about traffic. Many of the articles about traffic were opinions against private cars (n=5).

The number of articles on air pollution has increased, the health effects are discussed and detailed information is offered about such things as fine particles. Nitrogen oxides and inhalable particles were mentioned so often in Helsingin Sanomat in late 1990's that at least the terms should be familiar to public. Although Helsinki air is today relatively clean, concentrations of e.g. ultra fine particles ($PM_{0.1}$) are in Helsinki similar to other European cities (Ruuskanen et al. 2001). In addition, although the emissions from power plants have decreased, traffic emissions have increased. As conclusion based on the letters to the editor, Helsinki inhabitants seem to focus their interest to the relevant issues concerning air pollution. Traffic concerned most often and it is indeed the major local ambient air pollution source that impacts our health after smoking. In addition, traffic emissions can be reduced by impacting the social decisions and regulations. These results and the impact of media to increase concerns in general are discussed further in section 5.4.

3 Framework and objectives of the study

Framework of the study

According to Haila (2001a), both natural and social sciences are required to define environmental problems. The significance of a particular environmental problem cannot be evaluated by natural sciences only. This evaluation is always based on cultural and political criteria. Environmental justice/equity studies have shown disparities between racial/ethnic minority and low-income populations in cities and the general population in terms of environmental exposures and related health risks. For example, children of color and from low-income families had higher potential exposure to vehicle emissions in California (Gunier et al. 2003) and lived close to industrial air pollution sources in West Virginia, Louisiana and Maryland (Perlin et al. 2001).

In this text we focus on environmental risk assessment as activities of people and communities. The environmental risks are closely linked to several impacts: economic, political, aesthetic, health and social. Complexity of environmental risk assessment includes decision-making with possibilities, costs/detriments and benefits, as well as psychological and social aspects like (level of) knowledge, values, probabilities and prognosis (Kamppinen et al. 1995). In addition to toxicologically and epidemiologically assessed risks based on exact measurements, also psychological, social and cultural dimensions belong to the environmental health risks. Not only illness or amount of deaths is important, also well being as such, stress, annoyance, etc. should be assessed.

This work tries to connect two traditions, the social and natural sciences. Although human health is not directly considered here, similar methods to those used in health (medical) sociology to determine differences between population sub-groups are used. Exposure analysis is an integral prerequisite for controlling environmentally-caused disease. Quantitative exposure analysis allows us to relate exposure, susceptibility, and adverse health outcomes better.

Air pollution is taken as an example of risk. Air pollution is not studied here via a particular episode or accident and reactions to it. We are interested rather in the everyday air pollution and the exposure of the general urban population. As indicated in chapter 2 the environmental risk assessment consists of three parts (Figure 3.1). The purpose of this study is to present psychological, social and cultural dimensions of risks for consideration along of probabilities calculated in the traditional environmental risk assessment. The first dataset of this study, *personal exposure*, relates to the traditional environmental risk assessment, the second, *perceived annoyance*, to psychological and the third, *concern about air pollution*, to social and cultural dimensions of risk assessment. Public discourse influences the concerns about air pollution. These concerns have an influence on annoyance from air pollution, behaviour and exposure. Elucidation of public discourse on air pollution as an environmental risk in Helsingin Sanomat was presented in section 2.2.

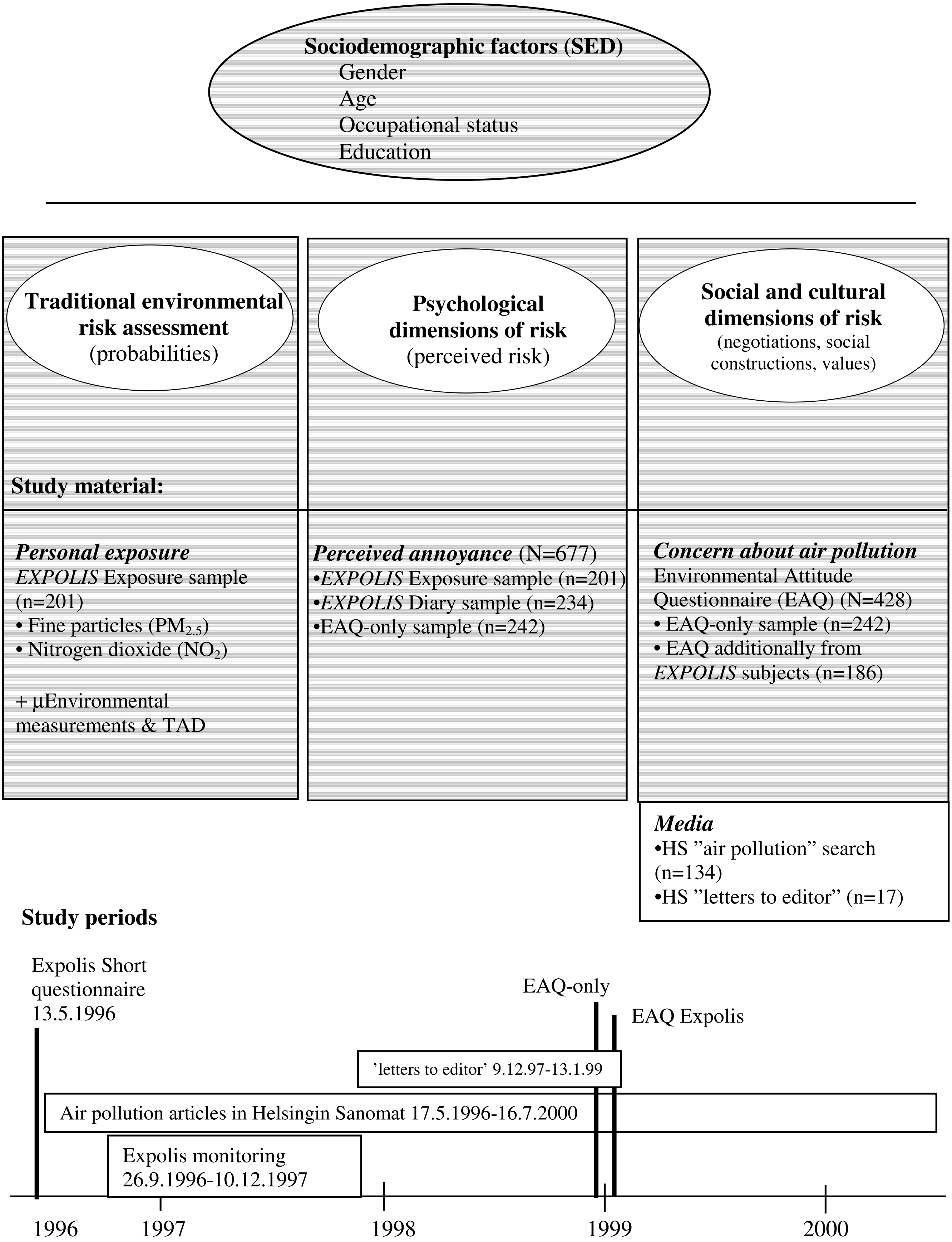


Figure 3.1. Three levels of environmental risk assessment and the *data sets* and study periods of this study.

Summary of risks related to the data sets of this study

Based on the literature review about risk theories and other previous related studies (chapter 2.1) risks are evaluated in relation to the data sets of this study. Information about specific air pollutants and their health effects, like fine particles that are presently the air pollutants of greatest health concern and interest, are delivered by media. However even correct knowledge (from media) about air pollution may either increase or decrease concern about it (Tanskanen 1997).

Global and national problems concern typically more than local environmental problems and many environmental problems are perceived more dangerous in general than specifically for the respondent herself or her family in Western countries. However, in the countries where local environmental problems are considered as the most serious, environmental problems are perceived more dangerous for oneself and the health concerns relate typically to the local environmental problems (Tanskanen 1997). Health consequences may be delayed as in long-term exposure to fine particles, but they might still be fatal (epidemiological studies show that fine particles shorten life-expectancy). However, despite the health consequences of nitrogen dioxide for susceptible populations (e.g. children and asthmatics), only very high concentrations appear to affect healthy people.

From the viewpoint of perceived risks, annoyance and concern about air pollution, the identifiable sources (e.g. tobacco, traffic, power plants) are more important than single air pollution compounds (e.g. fine particles or nitrogen dioxide). Although some compounds might be hard to detect by senses at low concentrations, the main sources of fine particles (smoking, soil incl. spring dust, and vehicle exhaust) and nitrogen dioxide (vehicle exhausts, power plant emissions, gas stoves, and smoking) are detectable and might therefore annoy people and cause concern. However, invisible chemicals might frighten and cause more concern than visible/detectable ones, for example ultra low concentrations of long-range transported dioxins might cause more concern than local and familiar smoke plumes.

The fact that air pollution can be somewhat managed (e.g. regulations for smoking) can decrease the concern, although the easy emission control methods (e.g. electrostatic filters in power plants) have already been utilized in the Western countries and the traffic (emissions) keeps on growing. Although ambient air quality may be quite equal regionally (e.g. fine particles concentrations), differences in exposures exist between sociodemographic groups.

Air pollution impacts everybody; for example ambient air polluted by e.g. traffic and industrial sources is unvoluntary, which probably increases perceived annoyance. Yet, smokers choose voluntarily to breathe polluted air. When personal exposure can be influenced (e.g. by avoiding exposure to tobacco smoke, choosing the residential area, means and route of transportation) perceived annoyance from air pollution is probably decreased.

Objectives of the study

To obtain the psychological, social and cultural dimensions of environmental risks the differences between demographic and socioeconomic groups in air pollution exposure, perceived annoyance from air pollution and concern about air pollution are analysed. The main objective of this study is to observe how the various sociodemographic sub-populations differ in air pollution exposure, annoyance and concern. The links between sociodemographic factors and health have been researched for over a hundred years and the link between air pollution exposure and health effects (e.g. epidemiology) has also attracted a lot of attention. The sociodemographic factors - exposure relationship has been studied very little so far and therefore this is analysed in the present study. Perceived annoyance and concern may also constitute a risk factor for (indirect) health effects independently of the actual exposure.

This study uses three different datasets (Figure 3.1). Personal exposure data (for $PM_{2.5}$ n=201 and for NO_2 n=176) was collected in the *EXPOLIS* study and the study design is presented in section 4.1 and results in section 4.2. Perceived annoyance from air pollution was collected both in the *EXPOLIS* study (Exposure group n=201, Diary group n=234) and the Environmental Attitude Questionnaire Survey (n=244 EAQ only) and the results are presented in section 4.3. Concern about air pollution was collected in the Environmental Attitude Questionnaire Survey (n=430) and the study design and results are presented in chapter 5. The associations between the measured values, perceived annoyance and concern are also evaluated. Associations between these three datasets are presented in chapter 6.

Specified aims (study questions)

- What are the socioeconomic and demographic differences of personal exposure to
  - fine particles ($PM_{2.5}$)?
  - nitrogen dioxide (NO_2)?
- What are the possible causes for the exposure differences between different sub-populations within the *EXPOLIS* city Helsinki?
- What are the sociodemographic differences in perceived annoyance from air pollution in Helsinki? (Which population groups become more annoyed than others?)
- What are the differences in concern about air pollution between sociodemographic groups?
- What are the associations between the perceived annoyance and the measured air pollution concentrations and differences between population sub-groups?
- What are the association between exposure, annoyance and concern about air pollution by sociodemographic groups?

4 Air pollution exposure and annoyance (the *EXPOLIS* study)

4.1. *EXPOLIS* materials and methods

4.1.1. EXPOLIS study design

This chapter introduces the *EXPOLIS* (The Air Pollution Exposure Distributions within Adult Urban Populations in Europe) study design, exposure measurements, analysis methods, population sampling and the challenges of a large multidisciplinary and multi-centre exposure study. Response rates and participation in the context of possible sampling bias and quality of data are evaluated and discussed in section 4.1.4. The response activity and willingness to participate in the study also reflects people's attitudes to and concern about air pollution in general.

The objective of the *EXPOLIS* study was to supply information on European air pollution exposure data, which can be used to assess air pollution distributions in populations, to identify the determinants of high exposure and to evaluate exposure distributions within specific sub-populations (Jantunen et al. 1998). A database for exposure modelling for alternative future scenarios and another for source apportionment of fine particle samples were created in the *EXPOLIS* study. Six European cities, Athens, Greece; Basel, Switzerland; Helsinki (Metropolitan area), Finland; Milan, Italy; Oxford, United Kingdom; and Prague, the Czech Republic, were selected to represent different European regions, air pollution situations and populations. This study focuses on *EXPOLIS*-Helsinki data. In the other *EXPOLIS* cities Athens, Basel, Milan, Oxford and Prague the monitored sample was small and somewhat different sampling and monitoring procedures were used (details in Rotko et al. 2000a).

The target populations of the *EXPOLIS* study were the adult, urban populations of Europe. *EXPOLIS* focused on active, working age, 25-55 year-old individuals, because their exposure is most affected by urban traffic planning, zoning and occupational conditions. The major air pollutants were selected for their health effects and their environmental implications. Personal exposure and microenvironmental concentrations (residential indoor and outdoor and workplace indoor) of fine particles ($PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO) and 30 selected volatile organic target compounds (VOCs) were measured for a year from autumn 1996 to winter 1997-98. In addition, questionnaire and time-activity-diary data was compiled. This study concentrates on determinants and exposure to fine particles ($PM_{2.5}$) and nitrogen dioxide (NO_2), representing two different types of air pollutant. The essential terms are defined in the paragraphs following.

Exposure Exposure to a pollutant is the contact of a chemical, physical or biological agent with the outer boundary (skin, mouth or nostrils) of an organism (EPA 1992). First there has to be an air pollution source and emissions of a pollutant from this source. Before human contact, ie. exposure, pollutants from a source are transported, transformed and dispersed in the air, contributing to local air pollution concentration levels. Following the exposure some amount of the pollutant usually crosses the body boundary and some is absorbed, which is called a dose. Direct health effects are not possible without a dose of an air pollutant. According to another definition of exposure "an event that occurs when there is contact at a boundary between a human and the environment with a contaminant of specific concentration for an interval of time" (National Academy of Sciences 1991) it is also related to the time and duration of exposure. Personal exposure measurements are defined as measurements made in an individual's immediate environment using active or passive devices (EPA 1992). (Exposure can only be personal.)

Microenvironment Microenvironments are well-defined surroundings (e.g. home, office, automobile, store, etc.) that can be treated as homogeneous or well defined for the concentration of a pollutant or other agent (EPA 1992). The total exposure to a pollutant is a total of time-weighted microenvironmental concentrations.

Fine particles ($PM_{2.5}$) Particulate matter with a 50% cut-off aerodynamic diameter of 2.5 μm (1 μm = 0.001 mm). For example, visible street dust consists mainly from larger particles, but include also the fine fraction. Fine particles are presently the air pollutants of greatest health concern and interest. Fine particles cause health problems (like respiratory symptoms and diseases and shorten life-expectancy mainly via increased cardiac attacks) because they are so small that they penetrate deep into the lungs (alveoli). The main sources of fine particles ($PM_{2.5}$) are smoking, long-range transported particles, soil minerals, and vehicle exhaust (Koistinen et al. 2001). Spring dust in Helsinki consists mostly of larger than $PM_{2.5}$ particles, but include also fine particles. There is no guideline value or ambient air quality standard for fine particle concentration in Europe. A threshold concentration value under which no health effects would occur cannot be presented either for fine particles.

It should be noted that mass concentration of fine particles is not a single air pollutant, but consists of different particle sizes from many sources with various chemical components. It is not known what constituents of fine particles make them the most toxic. Sociodemographic differences in the exposure to some fine particles of the most harmful characteristics may be greater than differences in exposure to total mass concentration. However, in this study only the mass concentration of fine particles is analysed.

Nitrogen dioxide (NO_2) Nitrogen dioxide is a yellowish-orange to reddish brown, irritating, corrosive, highly oxidizing toxic gas with a characteristic pungent odor at high concentrations (EPA 1993). Nitrogen dioxide (NO_2) is both a primary and a secondary pollutant, since it is both emitted directly into the air and formed by atmospheric reactions of nitric oxide (NO). The major source of NO_2 in the atmosphere is the oxidation of primary NO in the presence of ozone (O_3). Natural sources of nitrogen oxides (NOx) are emissions from soil, forest fires, lightnings, stratospheric injection, and ammonia oxidation (Seinfeld & Pandis 1998). Man-made nitrogen oxides are created by burning fossil fuels and biomass at high temperatures. Vehicle exhausts, power plants and some industrial processes are the most important sources of nitrogen oxides in urban air. The most important indoor sources of NO_2 at home are unvented gas appliances like gas stoves, gas ovens, gas space and water heaters, kerosene heaters, and smoking. The major health consequences are increased incidence of lower respiratory tract infections among children and increased airway responsiveness among asthmatics. Nitrogen dioxide exposure increases the sensitivity of the respiratory system to other irritants like cold air and allergens. Annual average guideline value for nitrogen dioxide in Europe is 40 $\mu g/m^3$ (WHO 2000).

Description of the study region

The study area covers Helsinki region or in other words Helsinki metropolitan area including cities Helsinki, Espoo, Vantaa and Kauniainen (shortly called Helsinki in this study). The population of the Helsinki region is about one million. The most important sources of ambient air pollution in Helsinki are traffic, energy production, soil dust, long-range transportation and, only to a small degree, industry (Hämekoski ed. 1998). The main indoor sources of air pollution include smoking (23% of Finns smoked daily and 11% were exposed to environmental tobacco smoke at work in 1999 (Helakorpi et al. 1999)), gas stoves (are rare in Helsinki region), fireplaces (are more common in small houses), and unvented gas appliances or kerosene heaters (are almost non-existent in Helsinki).

Air quality in the Helsinki region is in average good and concentrations of many different pollutants have decreased during the late 1900's. Although air quality is improving, concentrations of nitrogen dioxide and fine particles will not decrease significantly. Annual average concentrations of ambient fine particles ($PM_{2.5}$) (measured since 1997) and nitrogen dioxide (NO_2) in three measurement sites in Helsinki region between 1988 and 2002 are presented in Figure 4.1.1. Proportions of the different particle emission sources and nitrogen oxides are presented in Figure 4.1.2. Traffic emissions, however, influence exposures more than emissions from energy production because they take place were people move and breath. Moreover emissions of power plants have decreased considerably during the 1980's and 1990's, while emissions of nitrogen oxides and particles from traffic have decreased only slightly.

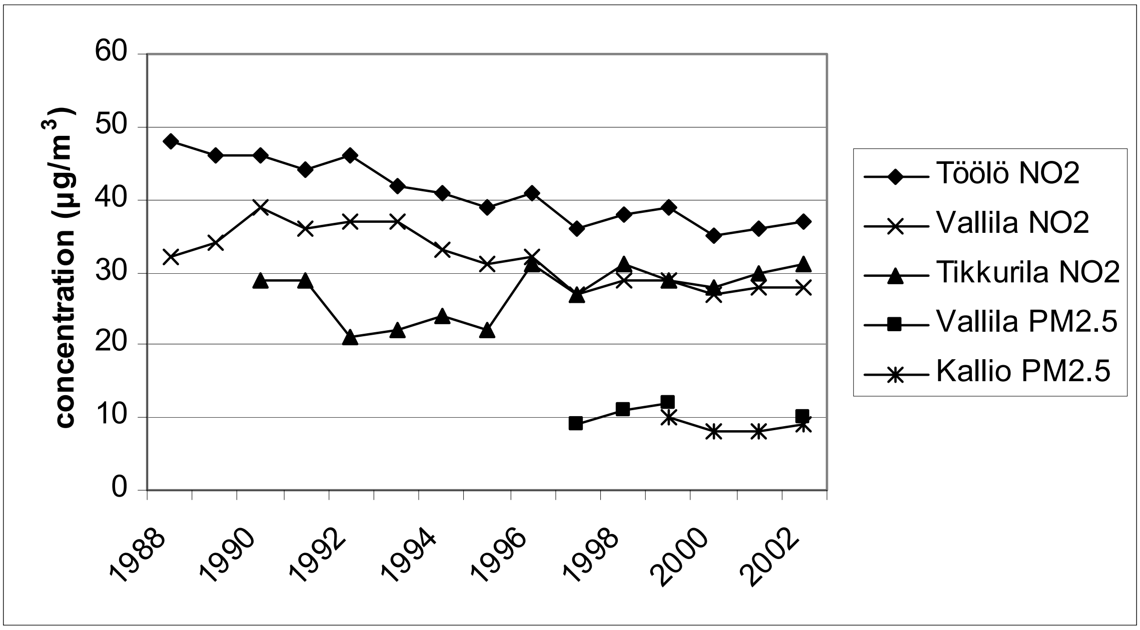


Figure 4.1.1. Annual average concentrations of ambient fine particles ($PM_{2.5}$) (measured since 1997) and nitrogen dioxide (NO_2) in four measurement sites in Helsinki region (Haaparanta et al. 2003).

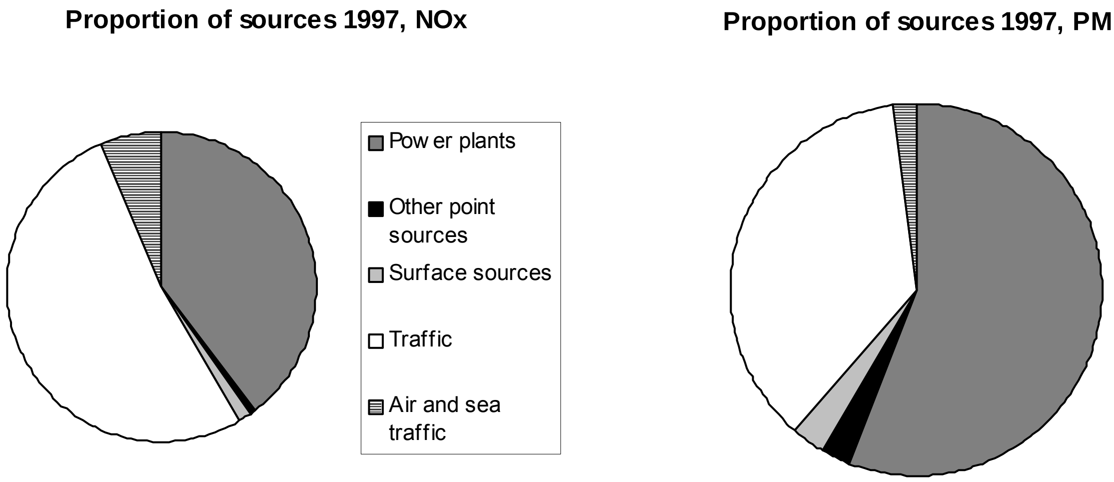


Figure 4.1.2. Proportion of emission sources of nitrogen oxides (NOx) and total particles (PM) in Helsinki region in 1997 (Hämekoski ed. 1998).

Spatial and temporal variation in fine particle concentrations is moderate in the Helsinki region. In contrast, especially nitrogen dioxide concentrations depend mostly on the main street traffic arteries; the closer and more loaded the route the higher the concentrations. Also the temporal variation in ambient concentrations of nitrogen dioxide is significant. According to Haaparanta et al. (2003) ambient average fine particle concentrations were highest during April and again in August and lowest during the winter in 2002 (varying between 5-16 $\mu g/m^3$). Daily variation was about 5 $\mu g/m^3$, highest at 10-11 in the evening and a moderate increase in the morning rush hour, and lowest around 10 in the morning. Ambient nitrogen dioxide concentrations were highest during April and lowest during June and November in 2002 (varying between 18-53 $\mu g/m^3$ depending on the measurement site). Daily variation (about 20-25 $\mu g/m^3$) was highest around 8 in the morning rush hour and lowest at 5 in the morning. One reason for the difference between the spatial and temporal variation of fine particles and nitrogen dioxide is that their major outdoor sources are different (Kousa 2002). A large proportion of fine particles originate from long-range transport, while nitrogen dioxide is derived mostly from local traffic emissions in the Helsinki region (Karppinen et al. 2000; Koistinen et al. 2004).

The EXPOLIS Questionnaires

In the *EXPOLIS* study there were four questionnaires relating to air pollution measurements designed to elicit background information from the participants. These questions were mainly exposure-related and helped in understanding the risk factors involved in personal air pollution exposure. The *Base* sample subjects (n=2523) in the *EXPOLIS* study were contacted using a mailed survey, the *Short Screening Questionnaire* (Appendix 2). These subjects received a cover letter shortly describing the purpose of the *EXPOLIS* study and the two-page questionnaire, which they were asked to complete and send back to the local *EXPOLIS* centre in a prepaid, preaddressed envelope. The purpose of the *Short Screening Questionnaire* was to evaluate the subjects' eligibility (living and working in the study area), their availability for participation in the study and to gather some basic background information about their home and work environment, socioeconomic status, commuting and some personal characteristics (Jantunen et al. 1998; Rotko et al. 2000a). In Helsinki some of the information (gender, birth year, home type, home floor area, number of adults and children in the house) was obtained directly from the census.

Three other questionnaires were filled in by the sub-samples of the *Exposure* monitoring (n=201) and *Diary* groups (n=234). The *core questionnaire* (Appendix 3) covered the indoor air quality related characteristics of each subject's home and workplace, as well as commuting and some exposure-related personal characteristics, such as smoking. The *retrospective 48-hour exposure questionnaire* (Appendix 3) was to be filled at the end of the 48-hour measurement period of each subject. The 48-hour recall questions addressed specific activities, which could influence personal exposure and perceived air pollution annoyance. Finally the *time-microenvironment-activity diary* (Appendix 4) was used to determine the subject’s location (microenvironment) in each 15-minute interval. The microenvironments selected for *EXPOLIS* were 'home indoors', 'home outdoors', 'workplace indoors', 'workplace outdoors', 'traffic' (with subcategories), and 'other outdoors' and 'other indoors'. All questionnaires were originally prepared in English, translated into the six *EXPOLIS* languages and back translated independently to control for the meaning and comprehensibility of each question (Jantunen et al. 1998).

Population sampling

At the beginning a *Base* sample was selected randomly from the 25-55 year-old inhabitants. In Helsinki the *Base* sample (n=2523) was composed of Finnish-speaking citizens living in the Helsinki metropolitan area (Helsinki, Espoo, Vantaa, Kauniainen) (Figure 4.1.3). The *Short Questionnaire* was mailed to them and a short letter inviting them to the study. After a reminder mailing, a computer-assisted telephone interview conducted by the CATI laboratory of the Regional Institute of Occupational Health in Kuopio was organized to contact those who had not responded to the mailed questionnaires. A 74% response rate (n=1871) was achieved (Rotko et al. 2000a).

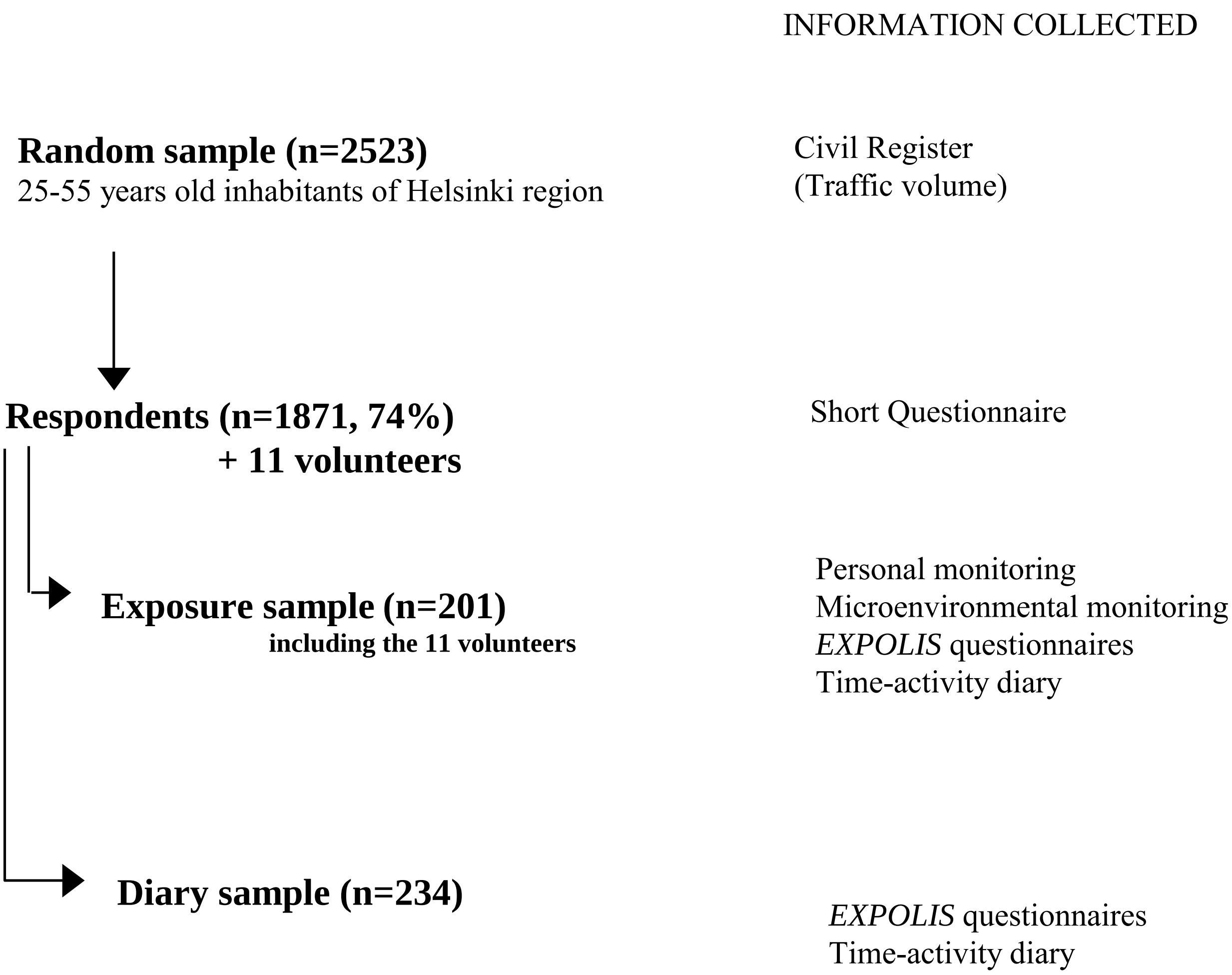


Figure 4.1.3. *EXPOLIS*- study population samples and collected data in Helsinki.

Further, two sub-samples were drawn randomly from the *Respondents* of the *Base* sample (Rotko et al. 2000a). Subjects in sub-sample one (the *Exposure* sample, n=201) participated in exposure and microenvironment monitoring for 48-hour period and filled in the time-activity- diary and the general questionnaire. The aim of the *Exposure* sample was to estimate both population exposure distributions and exposure differences between sub-populations as well as the relative roles of potential determinants to the exposure. The subjects of the second sub-sample (the *Diary* sample, n=234) filled in the time-activity-diary (48-hour) and the general questionnaire without participating in exposure and microenvironment monitoring. The purpose of the *Diary* sample is both to evaluate the possible changes in the time use of the *Exposure* sample during the monitoring period and to create a larger and more representative time-activity-diary database for exposure-modelling purposes. In addition, 11 volunteers were recruited independently of the *EXPOLIS* random sample from among participants of the ULTRA study (Penttinen et al. 2001) and were included in the *Exposure* sample.

Monitoring procedure in the EXPOLIS-Helsinki

EXPOLIS exposure monitoring continued for one year in the Helsinki region from autumn 1996 to autumn 1997. Six subjects participated to the monitoring in each week, three of them at the same time. The measurements were carried out during weekdays, from Monday morning to Wednesday morning or from Wednesday afternoon till Friday afternoon. Participants of the *Exposure* monitoring group carried a personal sampler case for a sampling period of 48 hours. For the same period three microenvironment monitors were placed (1) in the subject's home indoors (usually in the living room) and (2) outdoors (on the balcony or in the yard) and (3) at the workplace (same room). In addition to carrying the case the *Exposure* participant changed filter holders (work/leisure) of the personal sampler three times as well as filled in the questionnaires and time-microenvironment-activity-diary. The spatial distribution of the monitored homes and workplaces is presented in Figure 4.1.4.

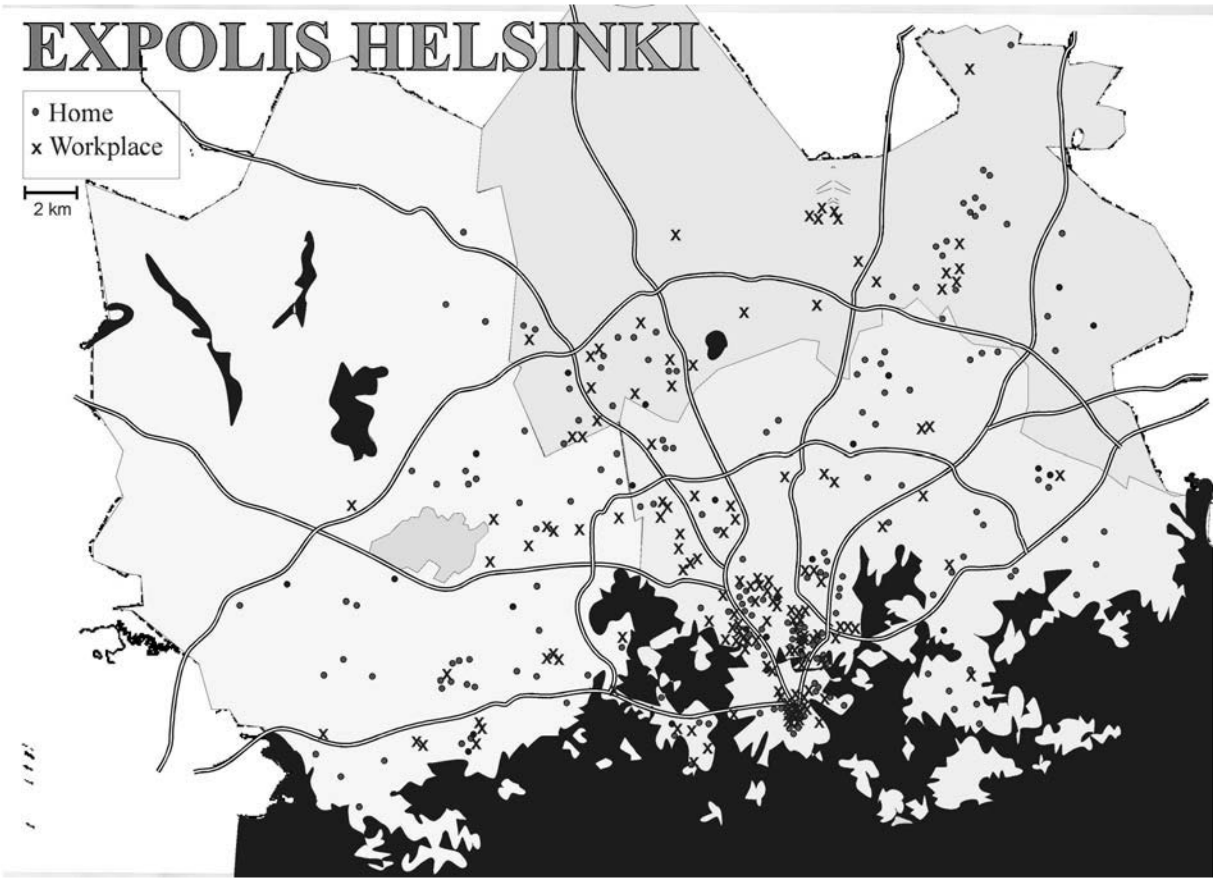


Figure 4.1.4. Map of monitored homes and workplaces in *EXPOLIS*-Helsinki between autumn 1996 and autumn 1997.

The *Diary* group data was collected over the same period as the *Exposure* monitoring group data by contacting and giving the instructions and matrials to about 5-10 subjects in a week. The *Diary* participant filled in similar exposure questionnaires and time-microenvironment-activity-diary for 48 hours. The contact letter (in Finnish), instructions for the personal sampler (in Finnish) and the Standard Operating Procedures for the *Exposure* and *Diary* samples are presented in the Appendix 6.

The personal monitor (Figure 4.1.5) used in the *EXPOLIS* study collected fine particles ($PM_{2.5}$) on two filters; one for the working and commuting hours of two consecutive workdays and the other for the remaining (leisure time) hours of the 48-hour sampling period. The sampling case weighed 5.2 kg and made a droning noise. The microenvironment monitors (Figure 4.1.6) were programmed to run and collect fine particles at home during the expected non-working hours and in the workplace during the expected working hours of each subject. If the subject did not go to work, the workplace monitor was placed in his/her home and programmed to run for 8 hours during daytime.

Figure 4.1.5. ***EXPOLIS*** **Personal exposure monitoring case (PEM) carried with for 48 hours.**

The nitrogen dioxide (NO_2) samples were collected using Palmes passive tubes (Palmes et al. 1976) attached to the personal and microenvironment monitors for a 48-hour average concentration. For more detailed description of the monitoring equipment and methods, gravimetric analyses, duplicates, blanks and detection limits, pilot phase, weighing and buoyancy correction, etc. see Koistinen et al. (1999) for fine particles ($PM_{2.5}$), and Rotko et al. (2001) and Kousa et al. (2001) for nitrogen dioxide (NO_2).

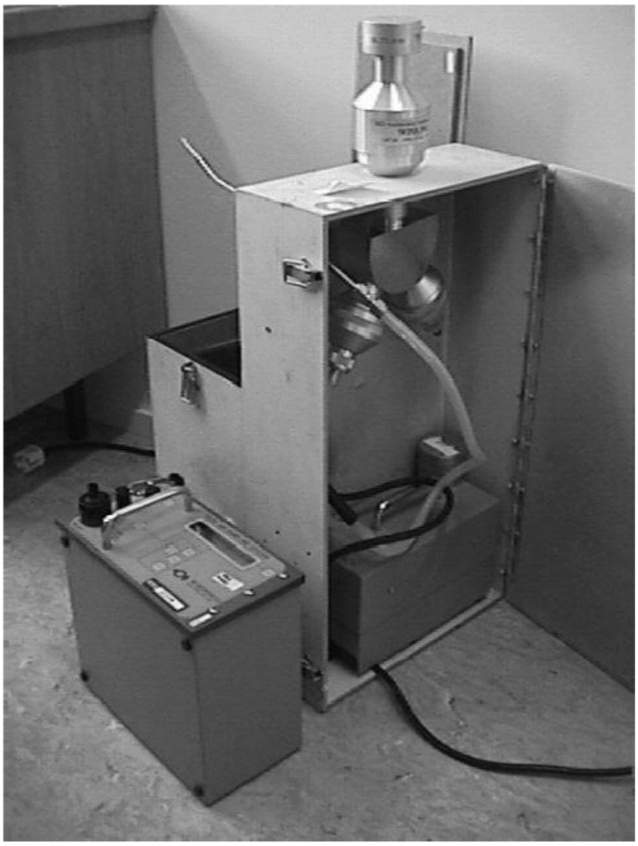


Figure 4.1.6. ***EXPOLIS*** **Microenvironmental monitoring box (MEM) placed at home indoors, outdoors and workplace for the 48-hour measurement period (3 MEMs per subject).**

Quality assessment/Quality control

A data integrity protocol was established according to the privacy protection requirements of the *EU Directive on Protection of Individuals with Regard to Processing Personal Data in Medical and Epidemiological Research.* This protocol includes the content and security of the *EXPOLIS* databases, using personal numbers that cannot be identified, and training for the whole staff. Identical equipment and procedures were used in all *EXPOLIS* centres, and the same instructions were followed to obtain comparable exposure data from around Europe. Quality control is an essential question in such a complex and multi-city study (Jantunen et al. 1998).

4.1.2. Methods

Classifications

The purpose of the *EXPOLIS* questionnaires was to find possible exposure determinants for those compounds that were monitored (Jantunen et al. 1998). The questions were also classified based on possible exposure differences.

The sociodemographic variables were first classified in smaller groups like age in six five-year groups to see were the major exposure differences exist. The final analyses were done between two classes (Rotko et al. 2000b, 2001) to avoid too small number of subjects in each group. The variables were gender (men/ women), age (25-34 years old/ 35-55 years old), occupational status (white-collar/ non-white-collar employees), education (<14 years/ ≥14 years), employment status (employed/ not employed), number of adults in the household (one/ two or more) and number of children in the household (no children less than 18 years/ one or more children). Socioeconomic status was defined by years of education (self-reported years of education completed) and by occupational status (Rotko et al. 2000b). The subjects were asked about their present occupation, which was then classified into 7 classes (white-collar employees including upper-level employees with administrative, managerial, professional and related occupations and lower-level employees with administrative and clerical occupations and non-white-collar employees including manual workers, students, pensioners, others and entrepreneuers or self-employed persons) according to the Statistics Finland classification (Statistics Finland 1989).

Tobacco smoke is known to be the most significant determinant of personal exposure to fine particles (Özkaynak et al., 1996; Koistinen et al. 2001). Tobacco smoke exposure is also related to socioeconomic status (Cavelaars et al. 1998). Among *EXPOLIS* Helsinki subjects 26% of the white-collar employees and 39% of the subjects in lower socioeconomic groups either smoked or were exposed to environmental tobacco smoke. Since these differences increase the exposure differences between sociodemographic groups, the results were also analysed separately without the subjects exposed to tobacco smoke either from their own or someone else's smoking. Those exposed to environmental tobacco smoke (ETS) were identified by three variables from the questionnaires (Rotko et al. 2000b). This ETS-exposed category included subjects who (1) smoked regularly (at least 1 cigarette/cigar/pipe per day for the last year) by themselves and subjects who (2) reported exposure to environmental tobacco smoke at home or (3) at work. For active smokers most of the exposure is obtained by active smoke inhalation, which was not measured or estimated in the *EXPOLIS* study (Rotko et al. 2000b).

Statistical analysis

<u>Bias.</u> Population sampling bias was evaluated by comparing the *Respondents* of the *EXPOLIS Short Questionnaire* with the city populations. First, the possible bias (in general) was evaluated considering the main demographic and socioeconomic variables (Rotko et al. 2000a) and, secondly, the relevant exposure-related selection bias was evaluated (Oglesby et al. 2000b). In comparing sub-populations by background variables the chi-square (χ^2) -test was carried out to test whether the differences were statisticaly significant.

Figure I (in Appendix 1) illustrates the sampling steps in *EXPOLIS*-Helsinki, where five levels of participation status could be defined, starting with those not reached at all (Trend status = 1), up to those actually participating (Trend status = 5) (Oglesby et al. 2000b). Bias, if present, might have been enhanced at each step, as each consecutive level was more demanding for participants. To evaluate the representativeness of the monitored samples, distributions of demographic factors (sex, age) of the participants and non-participants, as well as socio-economic (occupational class) and exposure-relevant (traffic volume at home, active smoking) factors were compared. The trend patterns across these participation levels for the major covariates were investigated. For continuous variables, the significance (p) for trend was estimated by linear regression, while for categorical variables chi-square (χ^2) -test for trend was applied (Oglesby et al. 2000b).

Traffic volume was obtained from the local authorities (based on traffic counts by the Helsinki Metropolitan Area Council) and linked to the residential addresses of the random samples to enable evaluation of exposure-relevant selection bias (Oglesby et al. 2000b). In Helsinki "cars per hour at morning peak" were used as proxies of traffic-related air pollution exposure. For univariate analysis, "traffic volume" was categorised into quartiles, based on the distributions in the random sample of Helsinki.

Exposure differences. In search for the sociodemographic factors and determinants of personal exposure, the possible variables were first divided into two groups. The significance of the differences between these two groups were tested by a non–parametric Kolmogorov-Smirnov two-sample test to compare the maximum absolute difference between the two distributions using the 95% confidence level (Rotko et al. 2000b, 2001). The explanations of the differences in personal exposure were sought for from the home indoor, outdoor and workplace results. A parametric T-test with ln-transformed data comparing the mean values and a non-parametric Wilcoxon two-sample test to compare the median levels were also conducted. Since the results were similar to the Kolmogorov-Smirnov test, these are not shown in the tables. A natural logarithm transformation was applied to all fine particle and nitrogen dioxide concentrations before parametric analysis (that assumes normal distribution), because the concentration distributions were positively skewed (Rotko et al. 2000b, 2001).

A multiple regression model (analysis of variance, Fox 1997) was applied to evaluate the importance of each exposure determinant and sociodemographic factor. The multiple regression model with fine particle and nitrogen dioxide exposure as dependent variables included all the major determinants of personal exposure (Rotko et al. 2000b, 2001). These were defined as those that had significant individual effects on exposure (age (continuous), years of education (continuous), exposure to environmental tobacco smoke (yes/no), hours keeping windows open at home (continuous), home location (downtown/suburban)). The nitrogen dioxide model included the following additional determinants (season (summer/winter (Oct-Mar), work location (downtown/suburban), use of gas stove (yes/no), home building type (high-rise/single-family house), number of adults in the household (one/two or more), traffic volume near home (high/moderate or low), home floor area (<60m2/≥60m2), construction year of home (<1970/≥1970)). Both the unadjusted estimates and the adjusted model were computed. Occupational status was excluded because of its correlation with education to minimize the multi-collinearity problems. The assumptions of homoscedasticity, independence, and normality of residuals were met.

In comparing sub-populations by background variables in the perceived annoyance comparisons the chi-square (χ^2) -test was carried out to test whether the differences were statisticaly significant. The associations between individual annoyance scores and the measured $PM_{2.5}$ and NO_2 exposures and concentrations were tested by Pearson correlation (Rotko et al. 2002a). All statistical tests were done by a STATA statistical package (version 5.0, STATA 1997) or SPSS statistical package (version 9.0, SPSS 1998).

4.1.3. Response rates, bias and participation activity

Respondents and city populations

In order to evaluate how well each population sample represents the overall population, the gender, age and occupational status distributions of the *EXPOLIS Respondents* (25-55 years old) to the mailed *Short Questionnaire* in Helsinki were compared to the same age population of the city (Table 4.1.1). In Helsinki the *Respondents* sample was somewhat biased towards women, the older age group and upper social status (white-collar employees).

Table 4.1.1 describes also the participating sub-populations. The *Exposure* and *Diary* sub-samples were compared to all *Respondents* to see what selection biases might have been caused by the rather involved requirements for the *Diary* sample subjects and the quite invasive procedures and requirements of the *Exposure* sample. The *Exposure* sample, compared to all *Respondents*, included a significantly smaller proportion of those working at home or not working at all and less train or metro commuters. On the other hand, the *Diary* sample included a significantly greater proportion of white-collar employees compared to all *Respondents*.

Table 4.1.1. The *Respondents* of the *EXPOLIS Base* sample versus 25-54 year-old city population and comparison between the *Exposure* and *Diary* sub-samples and the *Respondents* in *EXPOLIS*-Helsinki by chi-square test (according to Rotko et al. 2000a).

	Helsinki region [1] N=449,515 %	Respondents N=1882 %	Exposure[2] N=201 %	Diary[3] N=234 %
GENDER				
Men	48	44	44	38
Women	52	56	56	62
AGE				
25-34	36	32	31	35
35-44	31	32	36	28
45-55	33	36	33	37
SMOKER	Na	28	26	25
NO. OF ADULTS IN HOUSEHOLD				
One	Na	26	22	21
Two	Na	59	64	62
3 or more	Na	15	14	17
WORKPLACE				
One building / room	Na	71	82 *	78
Outdoors (including traffic)	Na	4	5	3
Other (multiple locations daily)	Na	9	6	7
Home or not working	Na	16	8	10
OCCUPATIONAL STATUS				
Other	35[4]	22	18	15 **
Worker	19[4]	19	20	16
White-collar	46[4]	59	62	69
COMMUTING IN WINTER [5]				
Car	Na	40	44	43
Bus or tram	Na	36	35	38
Train or metro	Na	14	8 *	16

[1] City of Helsinki, Urban Facts, The Helsinki Region in Statistics 1996, [2] Chi-square test Expo/Resp., * = $p < 0.05$, ** = $p < 0.01$, [3] Chi-square test Diary/Resp., * = $p < 0.05$, ** = $p < 0.01$, [4] only Helsinki city area (N=259,974), [5] multiple choices allowed, Na = data not available

Comparing the characteristics between men and women among the *Respondents* the largest significant (χ^2-test) differences that probably influenced exposure were in smoking, commuting and work conditions. The proportion of smoking men (31%) was higher than smoking women (26%). Men worked more outdoors (11% vs. 1%) and were more often car commuters than women (58% vs. 28%).

Selection trends and the impact of traffic volume on participation

Table 4.1.2 reveals consistent and significant selection trends across the five sample categories (Figure I in Appendix 1). Overall, selection can be observed towards females, older age groups and low street traffic volume (1^{st} quartile) in residential neighbourhood. It favours also married or cohabiting couples and those residing in single-family houses. Those with undeliverable surveys clearly had the lowest proportion of females, the lowest mean age, the highest neighbourhood traffic of all sample categories. With respondents as the reference, increasing proportions of non-smokers and subjects with higher socio-economic status were observed among those not willing to participate over those not selected as pooled participants.

Oglesby et al. (2000b) evaluated willingness to participate and the impact of neighbourhood traffic volume on participation (Table 4.1.3). In Helsinki (model I) low neighbourhood traffic, female gender and older age were independent and significant predictors of responding. For willingness to participate, similar associations with low neighbourhood traffic and female gender were observed. Adjusted for occupational class and smoking status, low neighbourhood traffic was still associated with willingness to participate (model II). Blue-collar workers were about 50 percent less likely to be willing to participate than entrepreneurs. Neighbourhood traffic was not signicantly associated with participation in either the Exposure or Diary samples. Adjustment for gender and age in model I and in model II for occupational class and smoking did not substantially change the estimates for neighbourhood traffic (Oglesby et al. 2000b).

Table 4.1.2. Selection trends across the multistage sampling process of the *EXPOLIS* study in Helsinki for demographic, socio-economic and exposure-relevant factors (according to Oglesby et al. 2000b).

	Total	not reached (undeliverable survey)	non-responders (SQ not valid)	not willing (dropped by subject)	not selected (dropped by study)	participants (pooled exposure and diary)	p for trend
Helsinki	**(n=2523)**	**(n=47)**	**(n=605)**	**(n=653)**	**(n=794)**	**(n=190+234)**	
Females (%)	52.8	40.4	43.6	53.9	56.6	58.5	<0.001*
Mean age (years)	39.6	36.9	38.2	40.6	39.8	39.7	0.005†
Traffic volume							
1st quartile (<247 cars/h)(%)	25.2	12.8	24.0	23.9	25.9	28.8	0.018*
4th quartile (>859 cars/h)(%)	24.9	27.7	26.6	26.0	23.6	22.6	0.070*
Non-smokers (%)‡	71.4	N/A	N/A	68.0	72.7	74.1	0.023*
Occupational class ‡							
Upper white collars (%)	24.8	N/A	N/A	21.5	26.2	27.2	0.024*
Lower white collars (%)	34.0	N/A	N/A	30.5	34.1	39.2	0.003*
Blue collar/worker (%)	19.0	N/A	N/A	24.6	15.4	17.0	<0.001*
Married (%)	59.3	17.0	36.4	64.8	66.4	74.4	<0.001*
Living in a high-rise building (%)	69.1	77.5	77.1	68.9	67.0	62.1	0.002*
Sensitive to air pollution (%)	18.6	N/A	N/A	16.8	19.9	18.7	0.083*

* chi-square test for trend
† estimated by linear regression
‡ data available from responders only
§ missing value for 24 (of 40) full-time students
N/A = not applicable

Table 4.1.3. *EXPOLIS* Helsinki: Impact of traffic volume close to home (crude and adjusted odds rations), sex, age, occupational class and smoking status on response and participation status (Oglesby et al. 2000).

	Exposure Sample † (n=190)			Diary Sample † (n=234)			Willing to Participate † (n=1428)			Responders † (n=1871)		
	OR	(95%CI)		OR	(95%CI)		OR	(95%CI)		OR	(95%CI)	
I Basis Random Sample (N=2523)												
Crude Estimate												
Per 100 cars/h	0.992	(0.972	1.014)	0.993	(0.974	1.012)	0.980	(0.969	0.990)	0.986	(0.974	0.997)
Multivariate Model												
Per 100 cars/h	0.992	(0.971	1.014)	0.992	(0.973	1.012)	0.979	(0.968	0.990)	0.985	(0.974	0.997)
Female sex	1.090	(0.809	1.467)	1.484	(1.126	1.956)	1.573	(1.342	1.844)	1.659	(1.384	1.987)
Age (per 10 years)	1.007	(0.851	1.192)	1.021	(0.876	1.191)	1.068	(0.976	1.170)	1.275	(1.150	1.414)
*II Basis Responders * (N=1871)*												
Crude Estimate												
Per 100 cars/hours	0.997	(0.975	1.019)	0.997	(0.977	1.017)	0.979	(0.965	0.993)	N/A	N/A	N/A
Multivariate Model												
Per 100 cars/h	0.998	(0.977	1.020)	0.999	(0.979	1.018)	0.979	(0.965	0.993)	N/A	N/A	N/A
Female sex	0.957	(0.692	1.323)	1.183	(0.875	1.599)	1.184	(0.939	1.494)	N/A	N/A	N/A
Age (per 10 years)	0.960	(0.803	1.147)	0.938	(0.798	1.102)	0.902	(0.795	1.023)	N/A	N/A	N/A
Occupational class ‡												
Upper white collars	0.873	(0.478	1.592)	1.236	(0.653	2.342)	0.954	(0.576	1.581)	N/A	N/A	N/A
Lower white collars	0.776	(0.426	1.414)	1.448	(0.774	2.707)	0.935	(0.568	1.539)	N/A	N/A	N/A
Blue collar/workers	0.722	(0.382	1.361)	0.992	(0.507	1.942)	0.515	(0.312	0.851)	N/A	N/A	N/A
Student	0.881	(0.358	2.172)	0.538	(0.180	1.609)	1.885	(0.785	4.526)	N/A	N/A	N/A
Other	0.286	(0.121	0.673)	0.731	(0.342	1.559)	0.512	(0.299	0.874)	N/A	N/A	N/A
Non-smoking	1.002	(0.708	1.417)	1.149	(0.832	1.588)	1.126	(0.885	1.432	N/A	N/A	N/A

* with valid occupational class and active smoking data available

† overlapping samples: Non-Exposure = 0, Exposure =1; Non-Diary = 0, Diary =1; Non-Willing = 0, Willing =1; Non-Responders = 0, Responders =1 respectively

‡ reference = entrepreneur

N/A = not applicable

4.1.4. Evaluation of selection bias and quality of data

Response rates

Response rates in American mailed surveys published in medical journals (219 articles) have been around 60% and a 13% increase on average in the response rate has been observed when mailed or phoned reminders have been used (Asch et al. 1997). In a lifestyle survey (Hill et al. 1997) the response rate to a mailed questionnaire was 58% and when those who did not answer were telephoned, the total response rate was increased to 81%. Survey response rates have usually been high in Finland. According to the annual mailed survey "Health behaviour and health among the Finnish adult population" the response rate was 85% in 1979, but fell to 68% in 1999 with three reminders (Helakorpi et al. 1999). In the mentioned study, inhabitants of the Helsinki Metropolitan Area responded somewhat less frequently than other parts of the country. In the *EXPOLIS* study a short mailed survey was the first contact with the study population because it is easy and cheap and the subjects were asked no sensitive questions. Mailed reminders and complementary telephone interviews increased the response rate to 74% in Helsinki, which is satisfactory.

Selection bias and representativeness

Selection bias has been evaluated by contacting non-responders by telephone (Hill et al. 1997; Martin et al. 1997) and has also been reported in several epidemiological studies. The observed bias in *EXPOLIS*-Helsinki regarding demographic and socio-economic factors is consistent with these reports on non-response and selection bias. Survey respondents have been found to be older (Drottz-Sjöberg & Sjöberg 1990; Hill et al. 1997; Holt et al. 1997; Martin et al. 1997; Lankinen & Sairinen 2000), to have higher socio-economic status (Spengler et al. 1994; Holt et al. 1997; Luthi et al. 1997; Lankinen & Sairinen 2000), more likely to be female (Drottz-Sjöberg & Sjöberg 1990; Spengler et al. 1994; Hill et al. 1997; Helakorpi et al. 1999), and non-smokers (Bostrom et al. 1993; Hill et al. 1997; Holt et al. 1997). In addition, the proportions of unmarried and those living in high-rise buildings were significantly greater in Helsinki among the non-responders than the responders. As those under-represented in the monitored samples could be motivated by prompting, the effort of two reminders seems to have been worthwhile and bias may have been somewhat reduced. Both the *Exposure* and *Diary* samples differed from *Respondents* in having more employed and highly-educated individuals. It seems that it was easier to get women, the employed and educated individuals to participate in this demanding population study.

The largest sample bias seems to be introduced at the first and easiest step of responding to the *Short Questionnaire* and agreeing to participate, and not at the last and most demanding stage of the exposure sample in Helsinki. It seems that the *Exposure* sample represents the population better or at least as well as the much less tedious *Diary* sample. The Duan and Mage (1997) idea of splitting the more demanding exposure and less demanding diary sample does not seem to improve sample representativeness, although it may still be useful for cost reasons. People have other priorities than just minimizing their efforts, including curiosity, interest, being a part of something deemed important and different, or having some interesting conversation subject at their workplace coffee break or at the lunch table, i.e. a social competitive edge. Within these conflicting priorities, the *Diary* sample, although less demanding, is also less rewarding than the *Exposure* sample, and the *Short Questionnaire*, although quickly and easily answered, has almost no reward at all - just a duty from an anonymous body which can easily be ignored.

Willingness to participate and exposure-relevant bias

Although there were no great differences in population sub-groups compared to the same-age city population, some exposure-relevant bias might have occurred. In many urban agglomerations low socio-economic status and young age is related to both non-response and deprived living situations with probable higher traffic-related exposure (Oglesby et al. 2000b). Several studies using traffic density data as an exposure proxy have shown consistently deleterious health effects from traffic-related air pollution (Brunekreef et al. 1997; Schilderman et al. 1997; van Vliet et al. 1997). The exposure sample in Helsinki is biased towards lower neighbourhood traffic volume and thus probably lower traffic-related air pollution exposure, which especially applies to nitrogen dioxide exposure. In particular, exposure at the high end of the distribution, which is most likely to occur in low socio-economic classes, may be under-represented.

The tasks that a survey imposes upon the study subjects may affect their behaviour during the monitoring. According to Boudet et al. (2000) the *EXPOLIS* participants in Grenoble spent more time at home and less time in commuting, outdoors and other indoor microenvironments during direct exposure measurements than on non-monitoring days. Therefore the measured exposures may be somewhat smaller than they would have been without monitoring.

While exposure-relevant selection bias occurred, the exposure results apply to the more educated, working age population (25-55 years old). Those of low socio-economic status are under-represented (because of selection bias), but usually more exposed, because they have often dirtier workplaces, greater neighbourhood traffic volumes, and greater smoking prevalence than those of higher social status. The actual exposure differences within this age population thus probably exceed those presented here. In addition, the small proportion of 25-55 year-old institutionalized adults is excluded from the study population. This population is expected to be less exposed than the study population (not in traffic, mostly indoors).

EXPOLIS residential outdoor measurements represent the spatial variability of the outdoor concentrations more accurately than the fixed site monitoring data considering the large number of sampling sites representing the distribution of the residences of the population. Because of the selection bias the workplaces of educated individuals and thus cleaner work environments are somewhat over-represented. However, the selection bias is only a minor concern in analyses about predictors of personal exposure, especially with multivariate models, or analyses within a city. The main concern related to selection bias was that sociodemographic differences would have remained unseen. Yet, significant sociodemographic differences were observed regardless of selection bias.

Questionnaires

The purpose of the *EXPOLIS* questionnaires was to identify exposure determinants for the monitored compounds. Therefore many questions were related to e.g. VOC exposures and were not used in this study. The different intentions of researhers in six European cities and the fact that the questionnaires must not be too long to exhaust the participants formulated the used questionnaires. However, the basic sociodemographic variables were useful and practical. Also the perceived annoyance questions were useful and appropriate for comparisons to personal exposures.

4.2. Air pollution exposure

4.2.1. Personal exposure to fine particles and nitrogen dioxide

This part of the study uses the measurements of personal air pollution exposures and microenvironment concentrations of the *EXPOLIS*–Helsinki data, concentrating on the exposure of adult populations (25-55 years old) and sociodemographic differences in the fine particle ($PM_{2.5}$) and nitrogen dioxide (NO_2) exposure. Evaluation of the air pollution exposure differences between demographic and socioeconomic goups has become possible only recently now that personal exposure monitoring and indoor microenvironment measurements have became available. The earlier air pollution concentrations from ambient outdoor air monitoring sites gave only an integrated proxy for air pollution exposure of a large population. Details of the monitoring methods for fine particles and nitrogen dioxide in the *EXPOLIS* study as well as the study design, materials and methods were introduced in chapter 4.1.

The questions to be answered in this chapter are: What are the levels of personal exposures to fine particles ($PM_{2.5}$) and nitrogen dioxide (NO_2) in Helsinki? What differences occur in exposure to fine particle and nitrogen dioxide between socioeconomic and demographic sub-populations? What are the possible reasons for the exposure differences between the various sub-populations, and between different air pollutants?

Personal exposure and microenvironment concentration levels

The mean levels of individual fine particle ($PM_{2.5}$) exposure and concentrations in all measured microenvironments were low in Helsinki (Table 4.2.1)(for comparisons also Basel and Prague levels are presented). In Helsinki the mean workday exposure level was the highest (19 $\mu g/m^3$) followed by the work indoor concentration and personal 48-hour exposure levels. Also the variation (standard deviation) in workday exposure concentrations was large. Home indoor concentrations and leisure time exposure to fine particles were almost at the same low level (< 13 $\mu g/m^3$), and home outdoor concentrations were the lowest in Helsinki.

Table 4.2.1. Basic statistics on *fine particles* ($PM_{2.5}$) and *nitrogen dioxide* (NO_2) exposure and microenvironment levels ($\mu g/m^3$) in *EXPOLIS*-Helsinki (and comparison to two other *EXPOLIS* cities).

	Helsinki					Basel			Prague		
	N	AM[1]	Std[1]	50%[1]	90%[1]	N	AM[1]	Std[1]	N	AM[1]	Std[1]
Fine particles ($PM_{2.5}$)											
Personal (48-hours)	194	15.4	18.8	9.9	33.1	47	30	42	42	36	28
Personal 'leisure time' (non working hours)	196	12.6	15.3	7.8	23.7	47	34	52	42	28	24
Home indoor (non working hours)	192	12.2	15.1	8.2	21.5	48	24	25	43	38	32
Home outdoor (non working hours)	170	9.7	6.9	7.4	18.9	47	19	12	18	27	11
Personal 'work' (working hours)	194	18.8	30.3	10.5	38.3	49	25	34	43	45	33
Workplace (working hours)	151	15.9	34.9	7.3	27.5	38	28	39	42	45	47
Nitrogen dioxide (NO_2)											
Personal (48-hours)	176	25.0	10.9	22.9	40.6	50	33	24	43	44	19
Home indoor (48-hours)	175	17.7	11.1	15.4	31.8	50	30	27	39	43	23
Home outdoor (48-hours)	161	23.9	11.7	23.4	38.0	50	36	13	31	61	21
Workplace (48-hours)	126	27.0	15.4	23.5	46.4	29	35	17	37	31	18

[1] AM= arithmetic mean, Std= standard deviation, i^{th} %= i^{th} percentile

The mean individual nitrogen dioxide (NO_2) levels were low in Helsinki (Table 4.2.1). The mean workplace nitrogen dioxide concentration (27 $\mu g/m^3$) was the highest, the average home outdoor concentration and personal 48-hour exposure were almost at the same level and the home indoor concentration level was the lowest. However, the variation of the nitrogen dioxide measurements was smaller than for fine particles.

4.2.2. Sociodemographic differences in air pollution exposure

Fine particles ($PM_{2.5}$)

The associations between the 48-hour fine particle ($PM_{2.5}$) exposure and sociodemographic factors are shown in Table 4.2.2. Age group was identified as a significant factor by the Kolmogorov-Smirnov test and the maximum absolute difference between the two age groups occurred around the median values of the distributions. The younger participants (25-34 years old) were significantly more exposed than the older participants (35-55 years old). The personal 48-hour fine particle exposure was strongly associated with occupational status. The Kolmogorov-Smirnov test showed significantly and markedly lower exposure for the white-collar employees than non-white-collar employees, especially among men. The difference between the groups increased among the most exposed individuals. Consistent with occupational status, the personal 48-hour exposure was also strongly associated with educational level. The participants with 14 years or more of education had lower mean exposure to fine particles than those with less than 14 years of education.

Table 4.2.2. Distribution of personal 48-hour fine particle ($PM_{2.5}$) exposure by socio-demographic subgroup in *EXPOLIS*-Helsinki (μg/m³) (according to Rotko et al. 2000b).

Helsinki	N	AM[1]	Std[1]	50%[1]	95%[1]	K-Smirnov[1]
Gender						
Men	85	17.7	25.0	10.5	55.9	
Women	109	13.2	10.6	8.9	39.1	0.355
Age						
25-34 years	58	16.3	15.5	12.2	42.5	
35-55 years	134	14.8	19.6	8.7	41.6	**0.012**
Occupational status						
White-collar	123	12.0	9.5	8.7	32.2	
Non-white-collar	70	20.5	27.1	12.4	59.1	**0.020**
Education years						
<14 years	65	19.0	20.6	11.7	42.9	
≥ 14 years	124	13.4	17.3	8.8	41.2	**0.034**
Employment						
Employed	177	14.4	15.0	9.9	41.3	
Not employed	17	22.6	39.4	9.3	170.8	0.488
No. of Adults in house						
One	43	15.6	13.9	10.5	42.5	
2 or more	150	15.1	19.6	9.1	41.3	0.412
No. of Children in house						
No children	96	14.6	12.6	10.1	41.6	
One or more	97	15.8	22.9	9.8	42.5	0.848

[1] AM= arithmetic mean, Std= standard deviation, i^{th} %= i^{th} percentile, K-Smirnov= p-value of Kolmogorov-Smirnov test to compare the maximum absolute difference between the two distributions, N/A = not applicable

A detailed look at the differences in average exposure to fine particles between socioeconomic groups in Helsinki indicates that entrepreneurs were exposed the most, followed by workers, the group 'other' (students, retirees, housewives, the unemployed), lower white-collar employees and finally upper white-collar employees, in that order. Entrepreneurs had more than twice the average personal fine particle exposure level (22 μg/m³) of the upper white-collar employees (10 μg/m³). In the whole sample gender, employment status and family size were not significant factors in personal exposure to fine particles. There were interesting differences, however, between men and women; the exposure differences between population sub-groups being much larger among men than among women. In the extreme, for men, unemployment appeared to dramatically increase the $PM_{2.5}$ exposure (42 μg/m³ vs. 16 μg/m³), while unemployed women were exposed less than the employed (Rotko et al. 2000b).

The associations of the workday fine particle exposures, workplace concentrations, leisure time exposures, and home indoor and outdoor concentrations with sociodemographic factors are shown in Table 4.2.3. Gender differences were noticed in home indoor $PM_{2.5}$ concentrations, women having somewhat greater concentrations inside the home than men on average. Age was a significant factor in workday $PM_{2.5}$ exposure, younger people having greater exposure than older, but this was not due to workplace concentrations. Personal leisure exposure and home indoor concentrations were greater among the younger age group (especially the most exposed individuals), but this was not driven by differences in home outdoor concentrations. On average the younger participants (25-34 years) in *EXPOLIS*-Helsinki lived in smaller residences (53% $\leq 60m^2$) than the older participants (35-55 years) (29% $\leq 60m^2$) and the difference was significant.

The association between high fine particle ($PM_{2.5}$) exposure and low occupational status was clear in personal workday exposure and workplace concentration, but not in leisure time exposure, home indoor or outdoor concentrations (Table 4.2.3). Similarly, increased education levels were associated with decreased workday exposure and workplace concentration, but not with decreased home outdoor concentrations relative to those with lower education.

The mean personal 48-hour fine particle ($PM_{2.5}$) exposure for those who were not exposed to environmental tobacco smoke (ETS), was considerably lower (mean 10 $\mu g/m^3$) than for the whole sample (15 $\mu g/m^3$), which was driven up dramatically by the 31% of subjects who were exposed to ETS. After these were excluded, the associations between 48-hour exposure to fine particles and age, education and occupation status remained similar to the whole sample, but the differences were considerably smaller, and no longer significant for occupation status (Rotko et al. 2000b).

Table 4.2.3. Statistics on fine particle ($PM_{2.5}$) personal workday exposure and workplace concentration, leisure time exposure and home indoor and outdoor concentrations by sociodemographic subgroup, *EXPOLIS*-Helsinki (μg/m^3) (according to Rotko et al. 2000b).

Helsinki	Personal workday				Workplace				Personal 'leisure time'				Home indoor				Home outdoor			
	N	AM[1]	Std[1]	Test[2]	N	AM[1]	Std[1]	Test[2]	N	AM[1]	Std[1]	Test[2]	N	AM[1]	Std[1]	Test[2]	N	AM[1]	Std[1]	Test[2]
Gender																				
Men	85	24.1	42.7		60	19.0	47.7		86	13.5	19.5		80	9.3	7.6		78	9.0	5.5	
Women	109	14.7	13.7	0.560	91	13.8	22.7	0.759	110	12.0	11.0	0.602	112	14.2	18.4	**0.041**[4]	92	10.4	8.0	0.184
Age																				
25-34 years	58	20.4	27.0		44	16.1	36.3		59	13.8	15.9		59	13.6	16.0		50	10.0	7.9	
35-55 years	134	18.4	31.9	**0.031**	107	15.8	34.3	0.795	135	12.3	15.2	**0.038**	131	11.6	14.7	**0.004**	118	9.7	6.6	0.834
Occupational status																				
White-collar	123	12.0	10.3		103	8.2	7.8		124	11.7	12.9		121	11.6	14.3		107	9.3	6.0	
Non-white-collar	70	30.4	46.4	**0.001**	47	32.8	58.2	**0.000**	71	14.2	18.9	0.126	70	12.9	16.4	0.835	62	10.3	8.5	0.990
Education years																				
<14 years	65	26.8	40.3		48	28.6	58.0		66	13.7	12.0		67	13.5	14.9		58	9.4	6.7	
≥ 14 years	124	15.1	23.3	**0.002**	97	9.7	10.4	**0.044**	125	12.3	17.1	**0.033**	118	10.0	9.8	0.152	107	9.9	7.2	0.921
Employment[3]																				
Employed	177	17.7	26.9		136	16.3	36.5		179	12.1	12.3		175	11.9	13.5		154	9.9	7.1	
not employed[3]	17	30.2	54.3	0.301	15	12.2	12.2	0.164	17	18.6	33.8	0.754	17	14.7	27.0	0.601	16	8.0	6.1	0.085

[1] AM= arithmetic mean, Std= standard deviation, [2] p-value of the Kolmogorov-Smirnov test, [3] work measurement done at home during office hours, [4] only 13 of the 80 men and 30 of the 112 women live alone; in most households both genders are present.

Multiple regression model for fine particles

Multiple regression analysis was used to evaluate the importance of the significant sociodemographic factors among other exposure determinants. According to Koistinen et al. (2001), the most dominant behavioural and environmental determinant of fine particle ($PM_{2.5}$) exposure in Helsinki was environmental tobacco smoke (including active smokers). Other variables that identify sub-groups and periods in which personal exposure to fine particles ($PM_{2.5}$) is significantly elevated above the rest of the population (those exposed to environmental tobacco smoke excluded) were summer season, keeping windows open at home (>15 hours per day), and downtown residence (vs. suburban family homes).

The model including all the major determinants with significant independent effects (age (continuous), education (continuous), exposure to environmental tobacco smoke (ETS, yes/no), keeping windows open (continuous), home location (downtown/suburban)) explained 35% of the variation in ln-transformed personal exposure to fine particles ($PM_{2.5}$) in Helsinki (Table 4.2.4). (Season and occupational status were not included in the same model with the correlated variables keeping windows open and education). In this model, which took into account all these variables at the same time, all the determinants turned out to be significant ($p<0.05$). Exposure to environmental tobacco smoke ($\beta=0.84$), occupational status (non white-collar) ($\beta=0.25$) and home location (sub-urban) ($\beta=-0.23$) had the most marked effects on personal fine particle exposure.

Table 4.2.4. Multiple regression model for ln-transformed personal 48-hour fine particle (PM2.5) exposure in Helsinki. ANOVA statistics ($F=19.51$, $df=5$, $p=0.000$, $R^2=0.351$)

Coefficients	**Unadjusted**			**Adjusted**		
	β	Std. Error	Sig.	β	Std. Error	Sig.
(Constant)				3.18	0.34	0.00
Exposed to tobacco smoke	0.88	0.10	0.00	0.84	0.10	0.00
Occupation status, non white-collar*	0.32	0.11	0.00	0.25	0.09	0.01
Home location, sub-urban	-0.25	0.13	0.05	-0.23	0.11	0.04
Years of education	-0.04	0.01	0.01	-0.03	0.01	0.02
Years of age	-0.01	0.01	0.12	-0.01	0.01	0.02
Hours windows open at home	0.01	0.00	0.03	0.01	0.00	0.02
Winter season (Oct-Mar)*	-0.13	0.11	0.22	-0,01	0.09	0.85

* Occupation status and season not in the same model with education and windows open

In addition to ETS and home location, personal fine particle exposure was significantly associated with occupational status, education and age. Non-white-collar employees, less educated and the young adults were more exposed to fine particles than other sub-populations. The unadjusted estimates were somewhat reduced in the adjusted model indicating that ETS and home location explained these differences only partly. However, work exposures of fine particles were not included, which probably explain most of the education and occupational status differences in exposures.

Nitrogen dioxide (NO_2)

Personal exposure to nitrogen dioxide (NO_2) was significantly associated with the education level and number of adults in the household (Table 4.2.5). The less educated and single participants had somewhat greater exposures than those with more education (≥ 14 years) and married or cohabiting participants. The differences in the arithmetic means were 2 $\mu g/m^3$ and 3 $\mu g/m^3$ respectively. The single participants lived more often downtown (35%), high-rise buildings (82%), old (<1970) (48%) and small (≤ 60 m^2) (69%) apartments than the married or cohabiting participants (19%, 56%, 31% and 26% respectively) (Chi-square (χ^2) p-values varying between $0.000 < p < 0.056$). In addition, employment status influenced the exposure to NO_2, the employed having greater exposure than those not employed, but this difference was only significant for men (mean difference = 6 $\mu g/m^3$). No significant differences in personal exposure to NO_2 were observed between the genders, age groups, occupational status or number of children in the household in Helsinki.

A significant association of the home indoor and outdoor concentrations with number of adults in the household was noticed (Table 4.2.5). The single living adults had greater exposure especially at home indoors than the married or cohabiting inhabitants. A significant age difference was noticed in the workplace concentrations of nitrogen dioxide, the younger having somewhat greater concentration at workplace than the older on average. The less educated had greater workplace concentration than those with more education (≥ 14 years), but the difference was not significant. The passively measured 48-hour workplace concentrations were influenced – mostly reduced - by the non-working hours when the subject was not present.

Table 4.2.5. Statistics on nitrogen dioxide (NO_2) personal 48-hour exposure and home indoor and outdoor and workplace concentrations by sociodemographic subgroup, *EXPOLIS*-Helsinki (μg/m³) (according to Rotko et al. 2001).

Helsinki	Personal 48-hour						Home indoor				Home outdoor				Workplace			
	N	AM[1]	Std[1]	50%[1]	95%[1]	Test[2]	N	AM[1]	Std[1]	Test[2]	N	AM[1]	Std[1]	Test[2]	N	AM[1]	Std[1]	Test[2]
Gender																		
Men	77	25.5	11.3	24.3	46.1		77	17.6	10.8		73	22.6	10.6		49	26.2	15.8	
Women	99	24.6	10.6	22.3	45.3	0.544	98	17.8	11.3	0.889	88	25.1	12.5	0.657	77	27.6	15.2	0.154
Age																		
25-34 years	54	25.1	9.7	23.7	43.6		54	18.1	10.2		46	23.3	9.5		35	28.1	12.2	
35-55 years	120	25.0	11.5	22.0	46.1	0.271	119	17.5	11.5	0.379	113	24.1	12.6	0.389	90	26.7	16.6	**0.048**
Occupational status																		
White-collar	110	24.8	10.5	23.1	45.9		109	17.4	11.7		102	24.0	12.1		90	27.2	13.9	
Non-white-collar	65	25.5	11.5	22.9	45.9	0.864	65	18.2	10.1	0.227	58	23.7	11.2	0.902	36	26.5	18.9	0.349
Education years																		
<14 years	60	26.3	11.4	26.5	46.0		59	18.1	10.3		55	23.3	11.5		38	29.7	18.9	
≥ 14 years	109	24.4	10.6	21.9	45.9	**0.045**	109	17.5	11.6	0.236	100	24.4	12.1	0.903	83	26.2	13.8	0.704
Employment[3]																		
Employed	155	25.4	11.1	23.3	45.9		154	17.6	11.5		143	23.8	12.1		121	27.3	15.5	
not employed[3]	21	22.0	9.0	20.6	35.1	0.247	21	18.3	7.6	0.198	18	24.9	8.4	0.091	5	19.4	13.2	0.631
No. of Adults in house																		
One	40	27.2	9.3	24.4	45.6		39	21.0	10.6		33	26.7	8.9		N/A	N/A	N/A	
2 or more	135	24.4	11.3	22.8	46.1	**0.036**	135	16.8	11.1	**0.002**	128	23.2	12.3	**0.007**	N/A	N/A	N/A	N/A
No. of Children in house																		
No children	88	25.0	9.7	23.0	44.0		87	18.1	9.8		76	24.2	11.0		N/A	N/A	N/A	
One or more	87	25.0	12.0	22.9	47.3	0.405	87	17.4	12.3	0.231	85	23.7	12.4	0.222	N/A	N/A	N/A	N/A

[1] AM= arithmetic mean, Std= standard deviation, i^th^ %= i^th^ percentile, [2] p-value of the Kolmogorov-Smirnov test to compare the maximum absolute difference between the two distributions, [3] work measurement done at home during office hours, N/A = not applicable

Multiple regression model for nitrogen dioxide

Environmental and behavioural determinants of nitrogen dioxide exposure in Helsinki were the living conditions, workplace location (downtown), summer season (April-September), gas stove use (vs. electric stove), keeping windows open at home (≥20h /48h) and exposure to environmental tobacco smoke (Rotko et al. 2001). Those living or working downtown, in high-rise buildings or buildings built before 1970 were significantly more exposed than the participants residing or working in suburban areas, single-family homes and recently built residences. In addition low education and self-reported heavy traffic volume on the street next to home was associated with significantly increased NO_2 exposure.

The importance of each variable (determinant) was evaluated in a multiple regression model (Table 4.2.6). The model, including all the major (significant independent effects) determinants, explained 39% of the variation in ln-transformed personal exposure to nitrogen dioxide (NO_2) in Helsinki. In this model, which took into account all these variables at the same time, the following determinants turned out to be significant: summer (Apr-Sep), work located downtown, education <14 years, use of a gas stove, keeping windows open, and home built before 1970. Use of a gas stove (β=0.41) and keeping windows open (β=0.27) had the most substantial effects on personal nitrogen dioxide exposure. The effect of education reducing personal exposure to nitrogen dioxide was emphasized in the adjusted model, but the unadjusted estimates of home/work location, neighbourhood traffic, home characteristics (built year, home floor area, high rise building) and exposure to tobacco smoke decreased in the adjusted model.

Table 4.2.6. Multiple regression model for ln-transformed personal 48-hour nitrogen dioxide (NO_2) exposure in Helsinki. ANOVA statistics ($F=5.93$, $df=12$, $p=0.000$, $R^2=0.391$)

Coefficients	Unadjusted			Adjusted		
	β	Std. Error	Sig.	β	Std. Error	Sig.
(Constant)				3.61	0.17	0.00
Gas stove used	0.21	0.17	0.20	0.41	0.14	0.01
Hours window open at home	0.23	0.07	0.00	0.27	0.07	0.00
Home building built ≥1970	-0.29	0.07	0.00	-0.26	0.08	0.00
Work located suburban	-0.29	0.08	0.00	-0.23	0.08	0.01
Winter season (Oct-Mar)	-0.10	0.08	0.20	-0.22	0.09	0.01
Education (≥ 14 years)	-0.05	0.08	0.50	-0.16	0.07	0.02
High traffic volume near home	0.29	0.08	0.00	0.11	0.10	0.28
Exposed to tobacco smoke	0.15	0.08	0.05	0.10	0.07	0.16
Home floor area ≥ 60 m^2	-0.14	0.07	0.05	0.09	0.08	0.26
Two or more adults in house	-0.17	0.08	0.04	-0.08	0.09	0.43
Living in high-rise building	0.25	0.07	0.00	0.04	0.08	0.58
Home located suburban	-0.29	0.08	0.00	-0.01	0.10	0.90

4.2.3. Time use and its impact on air pollution exposure

In the *EXPOLIS* study 48-hour time-microenvironment-activity-diary data (Appendix 4) of 435 randomly drawn subjects (age 25-55) were collected during one year in 1996-97 in Helsinki. Air pollution exposures depend on both air pollution concentrations in the microenvironments of concern and time-microenvironment-activity patterns of the exposed.

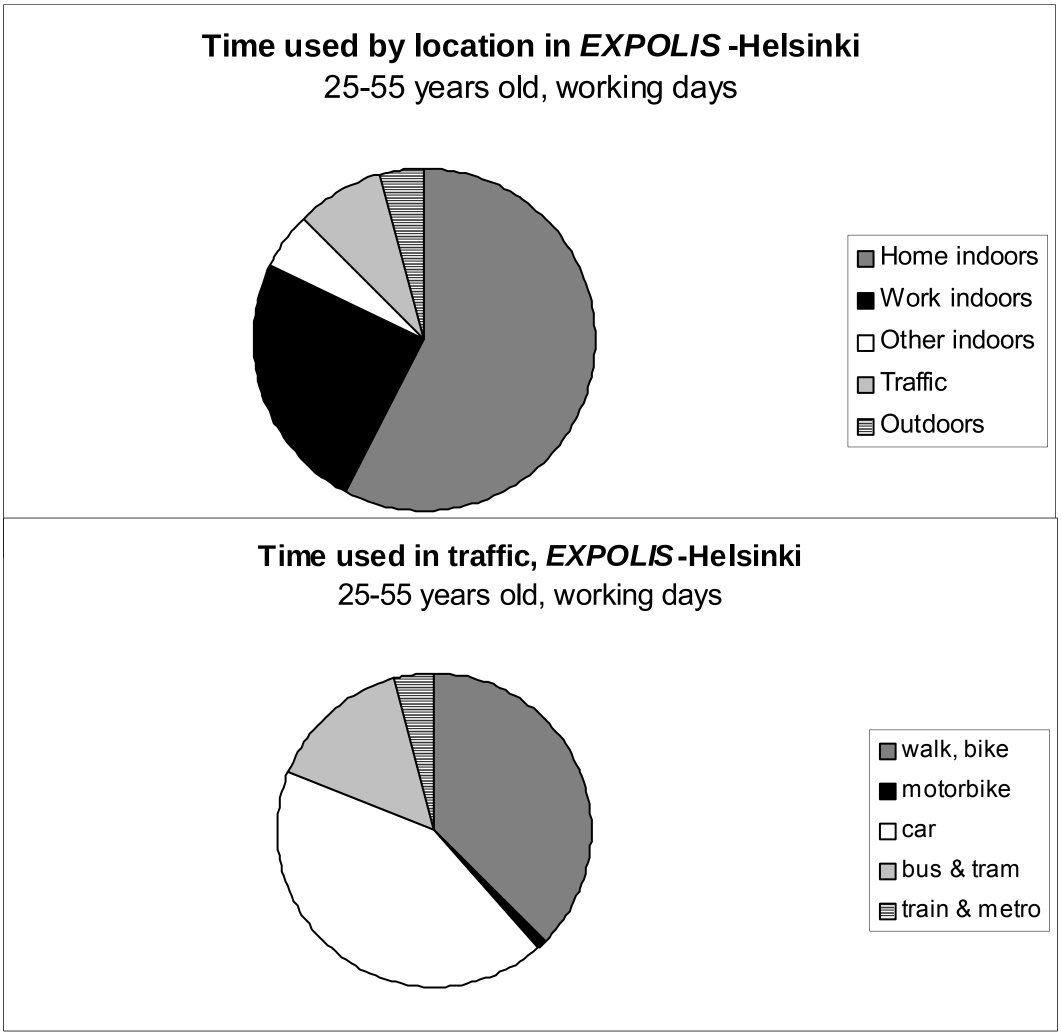


Figure 4.2.1. Time used by location and by means of transportation in *EXPOLIS*-Helsinki (n=434).

The study subjects in Helsinki spent in average 20 hours 38 minutes (86%) indoors, of which 13 and half hours home indoors plus 7 hours in other indoor microenvironments during working days (holidays and weekends excluded)(Figure 4.2.1). In traffic they spent in average 1 hour 57 minutes (8%) per 24-hours; 45 minutes by walking or biking, 50 minutes in car and 23 minutes in public transport. Compared to the Finnish Time Use Survey (Pääkkönen and Niemi 2002) more time was spent at work and in traffic and less at home among the *EXPOLIS*-Helsinki subjects (Table 4.2.7). At least two reasons explain the difference between these studies; namely the classifications of time use were not exactly the same and the *EXPOLIS* time-activity data reflects the 25-55 years old Helsinki inhabitants and workdays only, while the Finnish Time Use Survey consists of diaries of over 10 years old population in the whole Finland. Though, time use of Finnish has changed only a little during the last 20 years (Niemi and Pääkkönen 2001).

Table 4.2.7. Time used in the different microenvironments in *EXPOLIS*-Helsinki and comparing to the Finnish Time Use Survey[1] (≥10 years old).

	***EXPOLIS*-Helsinki** (n=434) 25-55 yrs, working days Hours: minutes /24h	**Statistics Finland [1]** (n=6272) 25-44 years Hours: minutes /24h	**Statistics Finland [1]** (n=6272) ≥10yrs weekdays Hours: minutes /24h
Total	24:00	24:00	24:00
Home indoors/ at home	13:35	14:49	15:34
Work indoors/ at work/school	5:50	3:41	3:33
Other indoors/ visiting someone or at the vacation residence	1:13	1:34	1:22
Outdoors	0:59	-	-
Total traffic	1:57	1:29	1:17
Walk & bike	0:45	0:15	0:18
Car	0:50	0:57	0:44
Public transport	0:23	0:15	0:13
Other	0:28	2:29	2:15

[1] (Pääkkönen and Niemi 2002)

In addition to time spent in indoor environments with indoor sources of air pollution, time spent outdoors and especially in traffic is important for personal exposure. Comparing the *EXPOLIS*-Helsinki data to the other *EXPOLIS* cities the total time spent in traffic is almost the same as well as the time used in buses and trams (Table 4.2.8). However, car is used more in Helsinki than in Basel, while walking and biking is clearly more rare. On the other hand walking and biking are more frequent and the use of train and metro are less frequent in Helsinki than in Milan.

Table 4.2.8. Time used in traffic by different means of transportation in *EXPOLIS*-Helsinki (and comparison to two other *EXPOLIS* cities).

	Helsinki (n=434) Hours: minutes /24h	Basel (n=322) Hours: minutes /24h	Milan (n=300) Hours: minutes /24h
Total traffic	1:58	2:03	2:04
Walk / Bike	0:45	1:09	0:38
Motorbike	0:01	0:02	0:04
Car	0:50	0:28	0:54
Bus / Tram	0:18	0:17	0:16
Train / Metro	0:05	0:06	0:12

Sociodemographic differences in the times spent in different means of transportation were also analysed (Rotko et al. 2002b, a conference abstract). The *EXPOLIS* 48-hour time-microenvironment-activity-diary data was used to identify the vehicles used in traffic. In addition, $PM_{2.5}$ concentrations in the different means of transportation were assessed by 3 to 11 hour measurements in 39 vehicles. Men, the oldest group (45-55 years) and non white-collar workers spent significantly more time in traffic than women, the younger and white-collar employees (Figure 4.2.2). The employed spent two times more time in cars than the non-employed. The measurements in Helsinki, on the other hand, showed the fine particle ($PM_{2.5}$) concentrations to be double in cars, buses and trams (22-25 $\mu g/m^3$) compared to walking, biking and in train/metro (10-12 $\mu g/m^3$). And indeed, men and non-white-collar workers were more exposed to fine particles in Helsinki than women and white-collar employees.

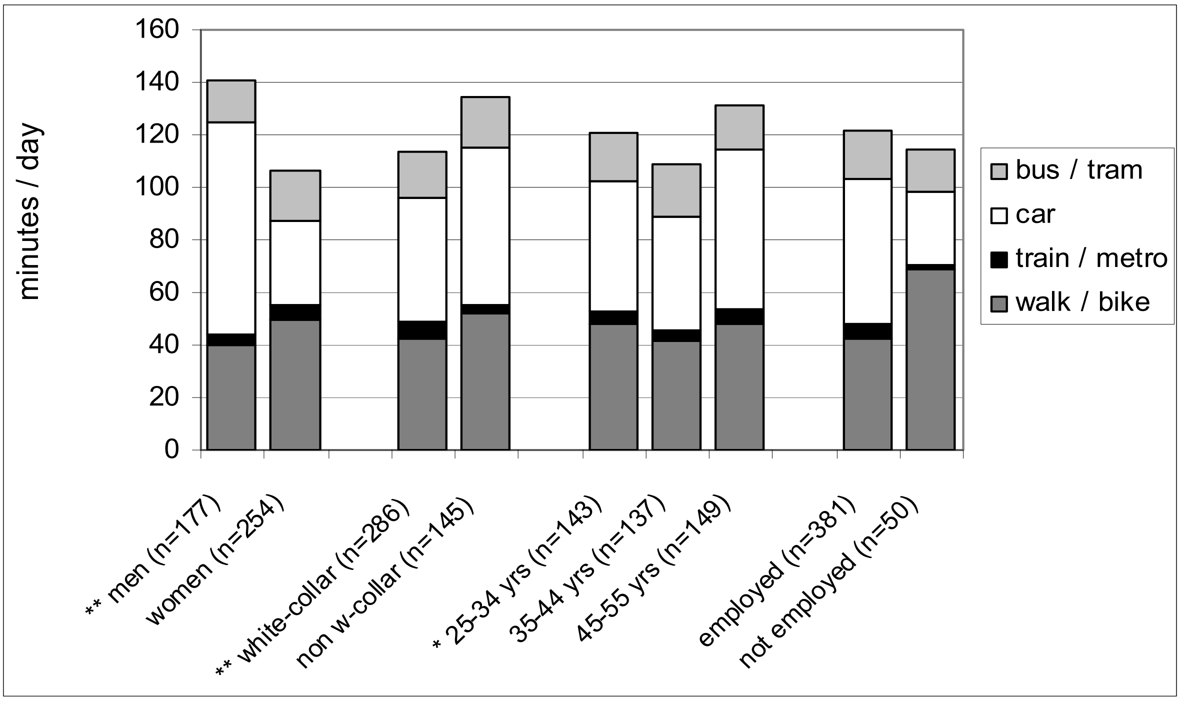


Figure 4.2.2. Minutes used in traffic per day (24h) on average by sociodemographic groups in *EXPOLIS*-Helsinki. (T-test significance * p<0.05, ** p<0.01)

The *EXPOLIS* time-microenvironment-activity data on traffic exposures could be used to explain exposure differences between sociodemographic groups, but this should be a target of an own study and is not analysed further here. This short example of time-use patterns is included to remind the significance of time-use for exposures.

4.2.4. Discussion of air pollution exposure

Studying personal exposure and measured levels

Some personal air pollution exposure studies (which are time-consuming and costly) have been conducted, but the study populations were usually small and from selected sub-populations. Nitrogen dioxide exposure has been studied the most (e.g. Özkaynak et al. 1993; Spengler et al. 1994; Alm et al. 1998), because it is a common air pollutant with both indoor and outdoor sources and its personal monitoring is easy using cheap and non-invasive passive sampling tubes. In previous exposure studies indoor and outdoor samples have been collected as 12- or 24-hour or even longer time averages (Lebowitz et al. 1995; Özkaynak et al. 1996; Janssen et al. 1998). In the *EXPOLIS* study, indoor and outdoor samples of fine particles at home were collected according to individual schedules only while the subject was at home and work indoor samples only while the subject was at work. Personal exposure and microenvironmental concentrations can thus be better compared and the indoor and outdoor fine particle samples were not affected by events or concentrations which occurred when the subject was absent. Nitrogen dioxide samples, however, were collected as 48-hour averages in *EXPOLIS*, because the passive method sensitivity is not sufficient for shorter sampling times. This affects especially the work measurements of nitrogen dioxide, mostly lowering the average level, because the 48-hour measurements were also influenced by the non-working hours when the subject was not present and the concentrations were most probably lower.

Tobacco smoke is so strong single source of air pollution exposure that it easily masks exposure differences from all other sources. Twenty percent of women and 27% of men smoked daily in 1999 in Finland. Men have decreased their smoking since the middle of the 1980s, but the proportion of women smoking has remained unchanged. The proportion of smokers depends on educational level for both men and women. The more education, the smaller is the proportion of long-term daily smokers in Finland (Helakorpi et al. 1999). While smoking is associated with sociodemographic differences (Cavelaars et al. 1998; Helakorpi et al. 1999), it is also associated with air pollution exposure differences and must, therefore, be considered while analysing personal exposure to air pollution.

The average fine particle ($PM_{2.5}$) concentrations were quite low in Helsinki. For example, the magnitudes of $PM_{2.5}$ exposure in Toronto (Pellizzari et al. 1999) (arithmetic mean 28 $\mu g/m^3$) were double those observed in Helsinki. In *EXPOLIS*-Helsinki personal exposure and work concentration of fine particles were higher than home indoor and outdoor concentrations. Although some of the outdoor concentrations penetrate indoors, home indoor levels were higher than outdoor levels because of additional indoor sources. In Central European cities indoor sources like gas appliances, fireplaces or smoking and possibly poor ventilation may be more frequent than in Helsinki.

Average personal exposure to nitrogen dioxide among adults in Helsinki was 25 $\mu g/m^3$, similar to those measured in the SAPALDIA study, where the overall average personal exposure to NO_2 among adults in the eight study regions in Switzerland was 27 $\mu g/m^3$ (Monn et al. 1998). Levy et al. (1998) reported personal exposure to NO_2 in eighteen cities in fifteen countries, the lowest average exposure of 22 $\mu g/m^3$ (values converted from ppb to $\mu g/m^3$ (NTP)) being recorded in Geneva, Switzerland (n=32), and the highest exposure of 103 $\mu g/m^3$ in Sosnowiec, Poland (n=15). Work nitrogen dioxide concentrations and personal exposures were in average higher than home indoor NO_2 concentrations in Helsinki. The differences in personal exposure between European cities, however, are probably smaller than the differences in the microenvironmental concentrations. The concentrations of nitrogen dioxide in Helsinki were closer to the levels measured in the other European cities than those of fine particles.

Sociodemographic differences in air pollution exposure

More important than absolute exposure levels is knowledge about exposure determinants and exposure differences in population sub-groups, which seem to have similar patterns to morbidity and mortality differences (Valkonen et al. 1992; Notkola & Husman 1997). Exposure determinants were sought with the help of the *EXPOLIS* questionnaires, in which the most relevant questions were compiled from previous studies and literature. Like sociodemographic factors, other determinants might also be different between European cities (because of climate, industry, culture, traffic differences and the like). At least the unvented gas appliances common in Central and Southern Europe are definitely determinants of exposure and increased personal exposures compared to Helsinki. However, individual exposure determinants could also be identified in the low air pollution concentration levels in Helsinki.

Fine particles ($PM_{2.5}$)

Tobacco smoke (apart from outdoor air) is known to be the most important single source of indoor concentration in homes where people smoke (Özkaynak et al. 1996) and a dominating determinant of personal exposure (Koistinen et al. 2001) to fine particles. Exposure to tobacco smoke is also related to socioeconomic status, lower status groups tending to smoke more (Cavelaars et al. 1998; Helakorpi et al. 1999) and, as a result, greater exposure to environmental tobacco smoke. Analysis of those Helsinki participants, who were not exposed to environmental tobacco smoke, revealed no new determinants, only weaker impacts of the same sociodemographic factors already identified. This shows that different smoking habits did not explain all the differences in fine particle ($PM_{2.5}$) exposure between socioeconomic groups. Pope et al. (2002) reported that also the association between fine particulate ($PM_{2.5}$) pollution and mortality was stronger for participants with less education after adjusting for age, sex and smoking status.

The most important sociodemographic determinants of personal 48-hour fine particle exposure in Helsinki were occupational status and education level. In general the lower socioeconomic groups were more exposed than white-collar employees. While the white-collar employees had clearly lower workday $PM_{2.5}$ exposure and workplace concentrations than the other occupational groups, the socioeconomic differences were much smaller in the home. Interestingly, however, a lower education level was associated with a greater exposure in the home, but neither education nor occupational status was associated with $PM_{2.5}$ levels outside the home in Helsinki. Occupational health studies have shown that manual workers have higher risk of work disability and mortality, especially from respiratory diseases, than white-collar employees (Notkola & Husman 1997). Part of this disparity can be explained by life-style factors like smoking and exposure to environmental tobacco smoke, but the rest may be caused by exposure at work. This study shows that the elevated fine particle exposure of working class individuals relative to white-collar employees may be one of the causal factors in the increased morbidity and mortality among the lowest socioeconomic groups.

The younger participants (25-34) were exposed to higher fine particle ($PM_{2.5}$) levels than older participants (35-55) in Helsinki. This difference was pronounced in both personal workday and leisure time exposure and home indoor concentrations, but not in workplace or home outdoor concentrations. Koistinen et al. (2001) identified significant differences in $PM_{2.5}$ exposure between the downtown and suburban areas (neighbourhood type). However, since the age difference was not associated with home outdoor concentration, the 'neighbourhood type' did not account for this difference. The younger age groups live more often in small and old downtown apartments with natural ventilation systems. A considerable fraction of the greater exposure of the younger age groups was probably related to lifestyle and behavioural factors such as greater mobility and activity during work-day and leisure times. Exposure to environmental tobacco smoke (ETS) did not explain the age difference (Rotko et al. 2000b).

No significant gender differences could be seen in personal 48-hour fine particle exposure in Helsinki, although men smoked more and used cars more often than women. However, men were more exposed to fine particles ($PM_{2.5}$) than women at work (including commuting). Quite surprisingly, unemployment strongly increased the exposure of men, but decreased that of women in comparison to the employed in Helsinki. The difference in personal exposure of the unemployed men did not result from experiencing higher home indoor or outdoor concentrations than women. Since the total numbers are small; however, these findings should be viewed with caution. Separate analysis for gender showed that men experience much larger exposure differences between the sociodemographic groups than women. Interestingly, differences in mortality (especially respiratory mortality) for occupational status groups are also greater among men than among women in Finland (Notkola & Husman 1997).

In addition to microenvironmental concentration levels, the other main determinants of fine particle personal exposure in Helsinki were smoking, the heating season, keeping windows open, the summer season and city living (Koistinen et al. 2001). Multiple regression analysis showed that the most important sociodemographic factors and determinants of personal $PM_{2.5}$ exposure in Helsinki were environmental tobacco smoke, home location (downtown), age (25-34 years old), education (<14 years), and keeping windows open (>20h/48h).

Nitrogen dioxide (NO_2)

The factors that increase average exposure to nitrogen dioxide in Helsinki relate to living downtown (small residences with gas stoves, in old high-rise buildings surrounded by heavy traffic). Also the association between the number of adults in the household and personal exposure to NO_2 indicates differences in living conditions. Single adults live more often in smaller apartments in older high-rise buildings close to main streets, and are more exposed on average than those living in larger households, usually in the suburbs and more distant from main streets and traffic arteries. The mean nitrogen dioxide concentration for single living adults was even greater inside home measurements than home outdoors.

The multiple regression model showed that the most important nitrogen dioxide personal exposure determinants in Helsinki were using a gas stove, keeping windows open (>20h/48h), summer (April-September), work location (downtown), education (<14 years), and residence built before 1970.

No gender differences in exposure to nitrogen dioxide were noticed in Helsinki. Age group differences in nitrogen dioxide could be seen in workplace concentrations, the younger having greater concentrations than the older. Unlike fine particles ($PM_{2.5}$), exposure to nitrogen dioxide (NO_2) was not associated with occupational status. Alm (1999) reported that mother's or father's education did not affect the exposure of preschool children to NO_2. Neas et al. (1991), however, reported that in the United States NO_2 concentrations were higher in homes with lower parental education and single parent family status. Adult inhabitants in Helsinki educated for less than 14 years were also more exposed to NO_2 than individuals educated for 14 years or more. The nitrogen dioxide workplace measurement was not optimal, because concentrations were averaged over the whole 48-hour sampling period, and therefore some sociodemographic differences in daytime workplace exposures may have been masked by sample collected during the off hours.

Unemployment was associated with reduced personal exposure to NO_2, especially for men, as those who were employed (especially those with less than 14 years of education) were more likely to be exposed while commuting to work and also to higher ambient NO_2 levels in workplaces than those not employed. Thus work outside of home appeared to increase NO_2 exposure for all.

Summary

In many US studies associations between air pollution and socioeconomic differences have been reported. However, these environmental equity/justice studies are usually based on ambient concentrations and socioeconomic differences between housing areas in a city. In Helsinki Metropolitan Area sociodemographic segregation is not strong, ethnic minorities are small and distributed within native inhabitation and the gap between the rich and the poor is relatively small compared to many urban areas in Europe or in the USA. Sociodemographic differences were not observed in home outdoor fine particle concentrations in Helsinki. Home location and housing characteristics affected nitrogen dioxide exposures, but were not associated with sociodemographic factors.

In conclusion, there are similarities and differences between the exposures to fine particles ($PM_{2.5}$) and nitrogen dioxide (NO_2) concerning exposure determinants and sociodemographic factors. Differences in fine particle exposures are apparent between the occupational status and education groups. The lower groups are more exposed, which seem to be caused mostly by workplace concentrations. In addition, the younger were more exposed to fine particles than the older, probably due to lifestyle. Nitrogen dioxide exposure is strongly related to work location and living conditions. Especially those living in small and old downtown appartments (with gas stove) were more exposed. Also the less educated (< 14 years) were more exposed to nitrogen dioxide than those with more education.

Both fine particles and nitrogen dioxide exposures also depend on individual behaviour, like smoking, and the time-use patterns. Keeping windows open and use of gas stove increase exposure to fine particles and nitrogen dioxide, but these hardly depend on sociodemographic status. Exposure to environmental tobacco smoke, however, increases sociodemographic differences of fine particle exposures, although it does not explain all of them. Total time used in traffic and selection of the means of transportation lead to different exposures to air pollutants between the different sociodemographic groups. Men, the oldest group (45-55 years) and non white-collar workers spent significantly more time in traffic than women, the younger and white-collar employees. In addition, the employed spent two times more time in cars than the non-employed and were therefore also more exposed to fine particles in Helsinki.

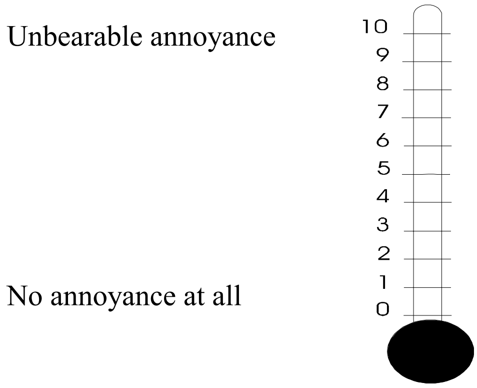
4.3. Annoyance caused by air pollution

Introduction

Air pollution may have psychological as well as physiological effects on humans. The psychological effects of air pollution may often be of greater importance to well-being than the biophysical effects to those people who are not exposed to high air pollution concentrations. “Moreover, it is argued that since psychological research reveals more and more results that indicate clinically relevant effects of psychological processes on somatic functioning and health-related behaviour, air pollution might affect human somatic functioning both by psychological and somatic means” (Meertens & Swaen 1997).

Air pollution is a mixture of various air pollutants. Perceived annoyance concerns the whole ambient air and not its individual components. Identifiable sources (e.g. traffic, smoking) of air pollution influence the perceived annoyance. The *EXPOLIS* and Environmental Attitude Questionnaire -respondents were asked to assess the personal perceived annoyance and not the concentration levels. Perceived annoyance is an individual sensation about air pollution influenced by sensibility, concern, knowledge, social and media impacts as well as current mood of the respondent. Some individuals are more sensitive to air pollution and low concentrations might annoy them, while others do not get annoyed even with quite smoky and thick air. Therefore the annoying concentrations of a specific compound depend on the observer. In addition, perceived annoyance might have an influence independent of pollution levels on health and quality of life. Many air pollution components are difficult to sense at low concentrations. However, even low concentrations sometimes have perceptible effects on sensitive individuals like asthmatics.

In the *EXPOLIS* study perceived annoyance from air pollution was reported in the end of the 48-hour participation period. Annoyance data was collected from the *Exposure* and *Diary* samples plus Environmental Attitude Questionnaire participants in Helsinki (n=199+229+242=670). Perceived annoyance from air pollution was surveyed by the following three questions (separately for home, work and traffic): "Please mark on the thermometer scale the degree to which you feel annoyed by air pollution at home / at work / when commuting/in the streets during the 48 hours that you participated in the study." (See Appendix 3)



Perceived annoyance from air pollution

Levels

The average perceived air pollution annoyance levels were lowest at home, followed by annoyance in the workplace and highest in traffic in Helsinki (Table 4.3.1). Compared to the other *EXPOLIS* cities the average annoyance was clearly lower while commuting in Helsinki, but at home the levels were almost the same (Rotko et al. 2002a). Air pollution at home annoyed 19% of the adult inhabitants in Helsinki (>3 on the annoyance scale). The most annoying factor at home was identified as ‘dust’ in Helsinki (67%). In the workplaces 38% of respondents were annoyed by air pollution (>3 on the annoyance scale). Also at work the most annoying factor was ‘dust’. Half the Helsinki respondents were annoyed by air pollution in traffic. The most annoying factor in traffic was ‘exhaust gases’ (70% in Helsinki).

Table 4.3.1. Average level of perceived air pollution annoyance and percentage distribution of perceived annoyance in the different microenvironments in *EXPOLIS*-Helsinki (and comparison to two other *EXPOLIS* cities).

Annoyance from air pollution	**Helsinki** N=670 % of those responding	**Basel** N=330	**Milan** N=299
Average level at home	**1.8**	**2.0**	**2.0**
Low (0-3)[1]	81	76	76
Medium (4-7)[1]	16	23	22
High (8-10)[1]	3	1	2
Average level at workplace	**2.6**	**2.6**	**3.8**
Low (0-3)[1]	62	66	47
Medium (4-7)[1]	30	28	43
High (8-10)[1]	8	6	10
Average level while commuting	**3.7**	**5.0**	**5.9**
Low (0-3)[1]	52	28	19
Medium (4-7)[1]	38	48	49
High (8-10)[1]	10	24	32

[1] score on 0-10 annoyance scale

Sociodemographic differences in air pollution annoyance at home

Significant differences in annoyance from air pollution at home between the population subgroups were tested by Chi-square (χ^2) -test comparing those who scored more than three on the annoyance scale to those annoyed ≤ 3. Women reported annoyance from air pollution at home 36% more often than men, workers and the group 'other' (students, retirees, housewives, the unemployed) 40% more often than white-collar employees, those sensitive to air pollution 56% more often than those not sensitive and those living downtown 41% more often than those living in suburban areas (Table 4.3.2). No significant differences in perceived annoyance from air pollution at home were noticed between the groups formed by age, smoking status or ETS exposure, allergic symptoms, or keeping windows open in Helsinki.

Table 4.3.2. Percentage of those annoyed by air pollution at home (>3 on annoyance scale) by sociodemographic and personal characteristics in *EXPOLIS*-Helsinki.

		Helsinki N=663	%	χ2 signif.
Gender	Men	301	14	**0.008**
	Women	362	22	
Age class	25-34 years	217	15	0.395
	35-44 years	202	20	
	45-55 years	242	19	
Education	≤9 years	72	27	0.116
	10-13 years	159	17	
	≥14 years	411	18	
Occupation class	White-collar	418	15	**0.024**
	Worker	108	25	
	Other	129	24	
Employment	Employed, entrepreneur	592	13	0.083
	Not employed	67	26	
Sensitivity	Noise	68	22	**0.000**
	Air pollution	115	32	
	Not sensitive	460	14	
Home location	Downtown, industrial	133	27	**0.006**
	Suburban	528	16	
Smoker	Yes	171	18	0.372
	No	490	21	
ETS exposure	No	299	17	0.933
	Yes	129	17	
Allergic symptoms	No	176	13	0.183
	Yes	124	19	
Windows open	≤ 20h /48h	293	16	0.355
	> 20h /48h	132	19	

$\chi 2$ -test compares to those annoyed ≤ 3 on annoyance scale,
ETS = environmental tobacco smoke

Discussion of the air pollution annoyance

Perceived annoyance from environmental factors, noise, odour and air pollution, have been studied recently and compared to levels of environmental noise (Klaeboe et al. 2000; Miedema and Vos 1998; Lercher and Kofler 1996), odours (Danuser 2001; Miedema et al. 2000) and air pollution (Klaeboe et al. 2000; Oglesby et al. 2000a; Forsberg et al. 1997; Lercher et al. 1995; Evans et al. 1988). A similar eleven-point “thermometer” as in the *EXPOLIS* study was used in a few earlier studies to measure perceived annoyance from air pollution (Oglesby et al. 2000a) and noise (Wallenius 1999).

Level of perceived annoyance from air pollution

Average air pollution annoyance score level in eight Swiss cities in the SAPALDIA study in the Alpine Regions was 3.2 in total (Montana 1.1, Davos 2.4; rural areas: Wald 1.9, Payerne 3.1; and urban areas: Aarau 2.6, Basel 4.4, Geneva 4.1, Lugano 4.9)(Oglesby et al. 2000a). With a smaller sample the average home indoor annoyance score in *EXPOLIS*–Helsinki was 1.8, which shows lower annoyance levels than in the SAPALDIA study. Average annoyance from air pollution in *EXPOLIS*–Helsinki was largest in traffic followed by workplace annoyance. Air pollution in the home did not annoy adult inhabitants much in Helsinki.

On average 3% of respondents in the *EXPOLIS*-Helsinki were highly annoyed (>7 at annoyance scale) by air pollution at home, 8% at workplace and 10% in traffic. In Switzerland the average proportion of those highly annoyed (>7 at annoyance scale) by ambient air pollution at home was 18% in eight Swiss cities (Oglesby et al. 2000a). In Sweden (Forsberg et al. 1997) the proportion of adults that were daily or almost daily annoyed by air pollution varied from 5% to 17% in the selected 55 urban areas. In Austria 40% of the respondents were annoyed by car fumes and 27% by visible dust/soot (Lercher et al. 1995).

Sociodemographic differences in perceived annoyance caused by environmental factors

Like in the previous studies, female gender (Oglesby et al. 2000a, Klaeboe et al. 2000; Forsberg et al. 1997) and downtown living indicating high neighbourhood traffic (Forsberg et al. 1997) were shown to be determinants of perceived air pollution annoyance also in the present study. In addition, non-white-collar workers were more annoyed by air pollution than white-collar employees. Also self-reported sensitivity to air pollution, as well as sensitivity to noise and odours (Lercher et al. 1995), increased the probability of being highly annoyed. In some earlier studies also current smoking status (Oglesby et al. 2000a; Lercher et al. 1995), older age and low education level (Klaeboe et al. 2000) were found to be determinants of perceived annoyance from air pollution. However, in the present study current smoking status (as in Forsberg et al. 1997), older age within the age range of 25-55 years (as in Oglesby et al.

2000a) or low education level (although a clear difference) were not significant determinants of perceived air pollution annoyance.

At least two factors might contribute to these perceived annoyance differences: 1) some sub-populations are more exposed to some air pollutants than others and therefore more annoyed about the pollution, and 2) some sub-populations are more sensitive to air pollution than others without higher exposure levels. This sensitivity is based on the personal characteristics and adaptation, e.g. smokers are adapted to high levels of voluntarily inhaled smoke that mask other pollutants and might therefore be not sensitive to air pollution. The effect of female gender, respiratory symptoms and self-reported sensitivity to air pollution on high annoyance in traffic in adjusted model decreased somewhat, but remained significant, compared to the unadjusted estimates (Rotko et al. 2002a). This indicates that women may be more sensitive to air pollution than men, but the annoyance difference is not explained totally by the sensitivity. However, annoyance from environmental factors itself might reduce the quality of life of certain more sensitive population groups without a relation to high exposure. In conclusion women and non-white-collar workers indicated more annoyance from air pollution than men and white-collar employees.

5 Concern about air pollution and the environment

5.1. Introduction

In addition to the *EXPOLIS* study questionnaires, an Environmental Attitude Questionnaire (EAQ) was applied in the Helsinki Metropolitan Area. Some of the questions were similar to the previous Finnish questionnaires on environmental attitudes and can therefore be compared to them. The purpose of this questionnaire was to study the concerns about and attitudes to environmental problems and particularly about air pollution. Concern about air pollution and environmental problems in general are partly based on the information received from the news and public discussion in the media. To what extent these concerns correspond with the measured exposure is discussed in chapter 6. However, the actual air pollution exposure, which people do not always even sense, and concerns about air pollution have different influences on everyday life.

In this chapter answers to the following questions are sought. How much are the adult inhabitants of the Helsinki region concerned about air pollution among other environmental and social problems? What are the differences in concern about air pollution between sub-populations?

5.2. Materials and methods of the Environmental Attitude Questionnaire

The Environmental Attitude Questionnaire (EAQ) (Appendix 5) was mailed with the *EXPOLIS* results to those who participated in the *EXPOLIS* study (N=383) and had provided their addresses for this purpose[1]. Not all the *EXPOLIS* participants (*Exposure* sample n=9, *Diary* sample n=43) had requested for their personal results and we did not have their addresses anymore to mail them the EAQ. The EAQ was also mailed to another random sample of the Finnish speaking population (25-60 years old) (similar to the *EXPOLIS Base* sample) of the Helsinki Metropolitan area (N=600). This questionnaire was mailed on January 1999, in other words more than a year after the *EXPOLIS* measurements were finished. No reminders were sent. Eight questionnaires were returned as being wrongly addressed (the respondent had moved), four invalid questionnaires had to be excluded and eventually 428 valid Environmental Attitude Questionnaires were analysed. The response rate was 44% (Table 5.1).

Table 5.1. Response rate of the Environmental Attitude Questionnaire (EAQ).

Group of respondents	Questionnaires sent	Number of responses	%
Expolis, Exposure group	192* /201	90	47
Expolis, Diary group	191* /234	96	50
EAQ only	600	242	41
Total	**983**	**428**	**44**

* Those who wanted their *EXPOLIS* results

Selection bias of the Environmental Attitude Questionnaire

Those who had participated in the *EXPOLIS* study (the *Exposure* and *Diary* samples) answered the Environmental Attitude Questionnaire somewhat more actively than those who only got the mailed Environmental Attitude Questionnaire to answer (Table 5.1). Owing to the low response rate (44%) of the mailed Environmental Attitude Questionnaire, the responding sub-samples differed somewhat from the overall population (Table 5.2) according to the background variables selected. The older, white-collar employees and married or cohabiting subjects were somewhat over-represented among the EAQ respondents compared to the same-age population in the Helsinki metropolitan area. However, significant differences were noticed only in education and number of children, by respondents of the EAQ being more educated and less frequently having children than the *Respondents* to the *EXPOLIS* Short Questionnaire. In addition, the EAQ respondents of the *EXPOLIS Exposure* and *Diary* samples were significantly more often women and white-collar employees than the EAQ only respondents.

1 For privacy protection all information identifying individual *EXPOLIS*-study participants had been deleted from the database as soos as the exposure and questionnaire data for each individual had been confirmed.

Table 5.2. Respondents of the Environmental Attitude Questionnaire versus *EXPOLIS* Short Questionnaire Respondents and the 25-54 year-old city population in Helsinki.

	Helsinki region (25-54 yr.) population (N=449 515) %	Respondents to *EXPOLIS* Short Questionnaire (N=1871) %	Respondents to Environmental Attitude quest. (N=428) %	*EXPOLIS* Exposure & Diary (N=186) %	EAQ only (N=242) %
GENDER					
Men	48	44	45	37	52**
Women	52	56	55	63	48
AGE					
25-34 years	36	32	29	27	31
35-44 years	31	32	31	34	29
45-55 years	33	36	40	39	40
CIVIL STATUS					
Married / cohabiting	58	68	72	74	70
Single, divorced or widow	42	32	28	26	30
EDUCATION					
Mandatory school (≤9 years)	37	25	15**	16	15
Apprenticeship (10-12 years)	14	18	19	13	22
A-levels/university (≥13 years)	49	57	66	67	64
OCCUPATIONAL STATUS					
White-collar	46	59	60	66	55*
Worker	19	19	16	16	17
Other (includes entrepreneur, unemployed, student, retiree)	35	22	24	19	28
NUMBER OF CHILDREN					
No children	Na	55	62*	62	62
Children	Na	45	38	38	38

* = Chi2 test p-value<0.05, ** = Chi2 test p-value<0.01 (comparing all EAQ respondents to the *EXPOLIS* respondents and comparing the *EXPOLIS* participants responding to EAQ to the EAQ only respondents), Na = not applicable

Methods

Most of the questions in the Environmental Attitude Questionnaire were structured (with set alternatives), but each question also provided the opportunity to give a free format answer. The frequencies of the environmental and air pollution questions are presented by gender. Sociodemographic (gender, age and education/occupation) differences within the environmental concerns were also identified among selected questions (one variable at a time) and tested by the chi-square (χ^2) -test for the significance of this difference. In addition logistic regression models (Hosmer & Lemeshow 1989) were applied to analyse the influence of gender, age and education/occupation simultaneously. The Odds Ratios and 95% confidence intervals of the adjusted models are presented in tables IIa-c (Appendix 1).

To be able to compare these results with two earlier studies, a similar environmental attitude index was computed (Tables 5.17 and 5.18). The values of the environmental attitude index can vary between 0 and 2. The alternative “very important” was weighted by 2, “important” by 1 and “not important” by zero. Missing values by each alternative were excluded.

5.3. Results of the Environmental Attitude Questionnaire

5.3.1. Air pollution

Levels

Concern about local environment was surveyed by the question "What is the most serious local environmental problem (in your opinion)?" When the respondent had to choose only one alternative, the most serious local environmental problems were pollution from traffic and environmental pollution in general (Table IIIa in Appendix 1). Four per cent of the respondents answered that there are no local environmental problems. Half the respondents were worried about local air pollution from various sources.

The respondents were also asked to evaluate separately (not to put in rank order) how concerned they were about the set alternatives of local environmental problems. The question was phrased "How much are you worried/concerned about the following environmental problems in the Helsinki Metropolitan area?" (eight alternatives). Almost half the respondents were very concerned about ‘littering in public spaces and in the wild’ and ‘the quality of sea water’, while 40% were very concerned about ‘air quality’. ‘Excessive building’, ‘noise from traffic’, ‘building roads and motorways’ and ‘waste processing’ greatly concerned only 10-20% of respondents (Table IIIb in Appendix 1).

Observations of pollution in the environment in general were asked by question: "Have you noticed any changes in the environment which might be caused by pollution or overloading during last ten years?" (circle the most important change). Most of the respondents had noticed such changes (Table IIIc in Appendix 1). ‘People have more allergies’, ‘water systems were polluted’ and ‘pollution in general’ were the most important change that were noticed. Nine percent altogether reported air quality worsening and climatic changes being the most important changes caused by pollution. However, two percent of the respondents had not noticed any pollution in the environment and one in five, more often women than men, could not specify it or did not want to answer the question.

The question then focused on observations of air quality changes only: "Have you noticed air quality worsening in your neighbourhood during the past ten years?" One in ten respondents answered that it had worsened considerably and 42% answered that it had worsened somewhat (Table IIId in Appendix 1). A quarter answered that air quality had not worsened at all and 4%, mostly men, reported that air quality had improved. Many of the respondents (21%) could not give an answer to this question.

Respondents' assumptions about their own ability to influence air pollution was tested by the claim "One cannot do much to prevent air pollution". Half the respondents disagreed with the statement (Table IIIe in Appendix 1). Avoiding the use of a car is one way to reduce air pollution. "How often do you avoid using a car for environmental reasons?" was the question used to evaluate the frequency of subjects actively preventing air pollution. More than half the respondents who had a car or driver's licence reported avoiding using a car for environmental reasons at least sometimes (Table IIIf in Appendix 1). However, every third respondent reported that they never avoid driving for environmental reasons.

Assumptions about the ability to influence one's own air pollution exposure was tested by the statement " I can, through my own actions, strongly influence my exposure to air pollutants." Only every fourth respondent thought that they had the ability to influence their exposure to air pollution (Table IIIg in Appendix 1). Almost one in five did not know how to prevent exposure. To avoid going out during air pollution episodes was given as one example of reducing one's own exposure to ambient air pollution. The willingness of respondents to do this was captured by "How often do you avoid going out when air pollution concentrations are high (e.g. according to the air quality index in the newspaper or your own opinion)?" Almost every fourth respondent reported that they avoid going out at least sometimes when air pollution concentrations were high (Table IIIh in Appendix 1). Significantly more those who reported suffering allergic symptoms (27%) avoided going out when pollution levels were high than the other sub-populations (18%).

Sociodemographic differences

Half of the respondents were worried about air pollution (traffic pollution, air pollution in general, emissions from industry/power plants and air pollution coming from the east) as the most serious local environmental problem (Table 5.3). No differences were noted between the genders. However, significant differences were noted between some other sociodemographic subgroups. Almost two-thirds of the youngest age group (25-34 years) reported air pollution as the most serious local environmental problem, but only every third of the oldest. Those having higher social status (upper white-collar employees and those educated for more than 17 years) were almost twice as likely to report air pollution being the most serious local environmental problem than the social group 'other' and those educated less than 10 years.

Table 5.3. The most serious local environmental problem: the proportion (%) of those reporting air pollution (=traffic pollution, air pollution, emissions from industry/power plants, air pollution coming from the east) versus other environmental problems. (Note. Missing values excluded)

		Total N	%	Chi2 test signif.	OR	95% CI
ALL		428	49			
GENDER	Men	195	52	0.645	1.00	(reference)
	Women	233	49		1.00	(0.64; 1.55)
AGE	25-34 years old	110	62	**0.006**	2.20	(0.99; 4.92)
	35-44 years old	126	46		1.18	(0.55; 2.55)
	45-54 years old	139	52		1.66	(0.79; 3.49)
	55-60 years old	52	33		1.00	(reference)
OCCUPATIONAL STATUS	Upper white-collar	107	61	**0.030**	2.17	(1.00; 4.68)
	Lower white-collar	153	48		1.36	(0.67; 2.79)
	Entrepreneur	42	51		1.78	(0.71; 4.46)
	Worker	59	49		2.06	(0.86; 4.90)
	Other	57	34		1.00	(reference)
EDUCATION	≤ 9 years	60	35	**0.005**	1.00	(reference)
	10-12 years	76	41		1.23	(0.58; 2.59)
	13-16 years	156	56		2.16	(1.05; 4.44)
	≥ 17 years	115	58		2.28	(1.05; 4.99)

The respondents were also asked to evaluate separately how concerned they were about the set alternatives of local environmental problems. More women were concerned about air quality and sea-water quality than men (Table 5.4). The oldest (55-60 years old) were almost twice as often concerned about littering in public spaces and in the wild than the youngest. Fresh water quality concerned the less educated more than the more educated. After adjusting for the other sociodemographic variables, the differences remained the same.

Table 5.4. The proportion (%) of those who were very concerned about the matter, chi²-test p-value for difference between population sub-groups and logistic regression models of Environmental Attitude Questions: OR's (odds ratios) and 95% confidence interval (CI) while adjusting for the other sociodemographic variables.

		Fresh water quality				Sea water quality				Air quality				Littering			
	N	%	Chi^2	OR	95% CI	%	Chi^2	OR	95% CI	%	Chi^2	OR	95% CI	%	Chi^2	OR	95% CI
ALL	**428**	**33**				**48**				**44**				**48**			
Gender			0.198				**0.014**				**0.000**				0.055		
Men	195	30		1.00	(reference)	41		1.00	(reference)	30		1.00	(reference)	42		1.00	(reference)
Women	233	36		1.30	(0.81; 2.09)	53		1.82	(1.17; 2.83)	55		2.55	(1.61; 4.03)	52		1.46	(0.94; 2.26)
Age			0.826				0.582				0.460				**0.024**		
25-34 years	110	33		1.00	(0.44; 2.29)	42		0.71	(0.32; 1.57)	40		1.08	(0.48; 2.42)	37		0.38	(0.17; 0.83)
35-44 years	126	32		0.93	(0.42; 2.05)	50		0.98	(0.46; 2.08)	41		1.03	(0.47; 2.26)	48		0.61	(0.29; 1.31)
45-54 years	139	31		0.78	(0.36; 1.72)	50		1.08	(0.52; 2.26)	45		1.24	(0.58; 2.66)	51		0.64	(0.30; 1.34)
55-60 years	52	39		1.00	(reference)	46		1.00	(reference)	53		1.00	(reference)	62		1.00	(reference)
Occup. Status			0.164				0.465				0.100				0.233		
Upper white-collar	107	24		0.69	(0.31; 1.54)	41		0.92	(0.44; 1.94)	41		0.68	(0.32; 1.47)	38		0.59	(0.28; 1.25)
Lower white-collar	153	38		1.23	(0.60; 2.54)	50		1.19	(0.60; 2.36)	45		0.53	(0.26; 1.09)	49		0.95	(0.48; 1.88)
Entrepreneur	42	32		1.09	(0.42; 2.87)	54		1.92	(0.79; 4.68)	36		0.57	(0.22; 1.46)	54		1.27	(0.52; 3.10)
Worker	59	39		1.07	(0.45; 2.59)	49		1.52	(0.65; 3.58)	37		0.41	(0.17; 1.00)	52		1.03	(0.45; 2.36)
Other	57	33		1.00	(reference)	42		1.00	(reference)	60		1.00	(reference)	52		1.00	(reference)
Education			**0.003**				0.202				0.110				0.088		
≤ 9 years	60	56		1.00	(reference)	57		1.00	(reference)	57		1.00	(reference)	61		1.00	(reference)
10-12 years	76	33		0.40	(0.19; 0.84)	39		0.56	(0.27; 1.16)	38		0.47	(0.22; 1.01)	49		0.73	(0.35; 1.51)
13-16 years	156	29		0.30	(0.14; 0.64)	50		0.87	(0.43; 1.77)	43		0.45	(0.21; 0.94)	41		0.61	(0.30; 1.24)
≥ 17 years	115	28		0.35	(0.16; 0.78)	46		0.84	(0.39; 1.79)	39		0.37	(0.17; 0.83)	47		0.88	(0.41; 1.88)

* Those very concerned about the matter as against those somewhat concerned or not concerned about it.

Table 5.5. The proportion (%) of those who were very concerned about the matter, chi^2-test p-value for difference between population sub-groups and logistic regression models of Environmental Attitude Questions: OR's (odds ratios) and 95% confidence interval (CI) while adjusting for the other sociodemographic variables.

		Noticed air quality worsen				**Own abilities to prevent air pollution**				**At least sometimes avoiding using a car**				**At least sometimes avoiding going out**			
	N	%	Chi^2	OR	95% CI	%	Chi^2	OR	95% CI	%	Chi^2	OR	95% CI	%	Chi^2	OR	95% CI
ALL	**428**	**53**				**51**				**54**				**23**			
Gender			**0.000**				**0.017**				**0.001**				**0.000**		
Men	195	43		1.00	(reference)	44		1.00	(reference)	45		1.00	(reference)	13		1.00	(reference)
Women	233	61		2.37	(1.52; 3.69)	56		1.81	(1.17; 2.80)	63		2.07	(1.27; 3.38)	32		3.13	(1.80; 5.46)
Age			**0.008**				0.116				0.783				0.293		
25-34 years	110	45		0.69	(0.32; 1.48)	54		1.04	(0.48; 2.23)	57		0.79	(0.33; 1.94)	18		0.66	(0.27; 1.61)
35-44 years	126	47		0.73	(0.35; 1.52)	57		1.16	(0.56; 2.42)	51		0.56	(0.24; 1.31)	22		0.78	(0.34; 1.81)
45-54 years	139	64		1.61	(0.79; 3.31)	43		0.72	(0.35; 1.47)	54		0.84	(0.37; 1.90)	25		0.97	(0.44; 2.16)
55-60 years	52	52		1.00	(reference)	50		1.00	(reference)	60		1.00	(reference)	31		1.00	(reference)
Occup. Status			0.852				0.776				0.392				**0.015**		
Upper white-collar	107	48		0.86	(0.41; 1.79)	54		1.63	(0.77; 3.45)	52		0.51	(0.21; 1.27)	14		0.34	(0.15; 0.81)
Lower white-collar	153	54		0.85	(0.43; 1.69)	50		1.26	(0.63; 2.51)	57		0.68	(0.29; 1.60)	27		0.55	(0.27; 1.14)
Entrepreneur	42	55		1.22	(0.51; 2.92)	50		1.78	(0.73; 4.32)	52		0.72	(0.27; 1.94)	19		0.58	(0.21; 1.59)
Worker	59	53		0.89	(0.39; 2.05)	55		2.45	(1.05; 5.73)	44		0.59	(0.21; 1.66)	24		0.50	(0.20; 1.26)
Other	57	54		1.00	(reference)	44		1.00	(reference)	65		1.00	(reference)	37		1.00	(reference)
Education			0.233				0.422				0.102				0.116		
≤ 9 years	60	63		1.00	(reference)	50		1.00	(reference)	47		1.00	(reference)	34		1.00	(reference)
10-12 years	76	51		0.77	(0.37; 1.59)	43		0.81	(0.40; 1.68)	48		1.29	(0.58; 2.86)	26		0.88	(0.40; 1.95)
13-16 years	156	52		0.75	(0.37; 1.53)	55		1.33	(0.66; 2.68)	53		1.44	(0.65; 3.19)	22		0.62	(0.28; 1.35)
≥ 17 years	115	47		0.66	(0.31; 1.42)	54		1.13	(0.53; 2.41)	65		2.66	(1.12; 6.35)	18		0.57	(0.24; 1.36)

* Those very concerned about the matter as against those somewhat concerned or not concerned about it.

Table 5.5 focuses on observations of air quality changes, believing in own abilities to prevent air pollution, avoidance of driving for environmental reasons, and avoidance of going out during high air pollution concentration. Significantly more women and 45-54 year-olds reported that they had observed air quality worsening during the past ten years than men and the younger. More women believed that they could prevent air pollution than men. Significant differences were not noticed between age, occupational or education sub-group in assumptions about one's own potential to influence air pollution. Clearly and significantly more women reported to avoid driving for environmental reasons than men. In addition a greater proportion of the more educated reported avoiding driving for environmental reasons than the less educated, but this difference was not significant. Significantly more women, students, retirees and housewives reported that they avoided going out during high air pollution concentration than men or other occupational status groups, especially upper white-collar employees. Adjustment for the other sociodemographic variables did not change the reported differences between the attitudes of the population sub-groups.

Almost one in five, more men than women, did not know how to prevent being exposed to air pollution. A significantly greater proportion of the oldest (55-60 years old) and the less educated believed that they could influence their own air pollution exposure than the other population sub-groups (Table 5.6).

Table 5.6. The proportion (%) of those believing in their own abilities to prevent being exposed to air pollution. (Note. Missing values excluded)

		Total N	%	Chi2 test signif.	OR	95% CI
ALL		428	25			
GENDER	Men	195	20	0.055	1.00	(reference)
	Women	233	28		1.91	(1.13; 3.24)
AGE	25-34 years old	110	16	**0.041**	0.41	(0.17; 1.01)
	35-44 years old	126	27		0.78	(0.36; 1.73)
	45-54 years old	139	26		0.68	(0.32; 1.48)
	55-60 years old	52	35		1.00	(reference)
OCCUPATIONAL STATUS	Upper white-collar	107	17	0.118	1.35	(0.52; 3.51)
	Lower white-collar	153	28		2.06	(0.87; 4.87)
	Entrepreneur	42	33		3.13	(1.12; 8.74)
	Worker	59	28		1.76	(0.65; 4.79)
	Other	57	20		1.00	(reference)
EDUCATION	≤ 9 years	60	41	**0.004**	1.00	(reference)
	10-12 years	76	30		0.72	(0.34; 1.53)
	13-16 years	156	22		0.46	(0.22; 0.98)
	≥ 17 years	115	17		0.37	(0.16; 0.86)

5.3.2. Environment

Levels

Concern about environmental problems

Air pollution concerns were also evaluated by indirect questions about environment and compared to concerns about other environmental problems. Environmental problems at national level were covered by "What is the most serious environmental problem in Finland (in your opinion)?" These were considered to be ‘environmental pollution in general’, ‘nuclear power plants in the east (Russia/former Soviet states)’ and ‘water pollution’ (Table IIIi in Appendix 1). Nobody said that there were no environmental problems in Finland, but 5% could not say what the most serious one was. Fourteen percent of respondents found air pollution from various sources to be the most serious environmental problem in Finland.

Observations of decreasing pollution in the environment were elicited by "Have you noticed any positive changes in the environment lately?" (assign one). Half the respondents had not noticed any improvement in their environment recently and every fifth answered 'Don't know' (Table IIIj in Appendix 1). The positive changes in the environment that were mentioned were ‘water systems becoming cleaner’, ‘waste sorting and recycling becoming more common’, ‘better air quality’ and ‘flora, fauna and forest recovery’.

The level of concern about two major air polluters were surveyed by the following questions: "How worried are you about the increase in traffic and its effects on environment?" and "How worried are you about the environmental impact of industry?" The environmental impact of industry concerned the respondents somewhat more than that of traffic (Table IIIk Appendix 1). Further, the level of concern about health effects of environmental pollution was assessed by "I often think how environmental pollution affects my health." More than half the respondents often thought about this (Table IIIl in Appendix 1). Fourteen percent could not answer this question. More than half of the respondents indicated that they themselves or their families had respiratory symptoms, allergies or asthma-like symptoms.

The importance of environmental problems among other social problems

The relative importance of social problems at global level was assessed by: "What are the most serious, second most serious and third most serious social problems at the moment in your opinion?" Environmental pollution emerged as the most serious social problem (Table IIIm in Appendix 1), every fourth respondent putting environmental pollution in first place. In addition, 15% of the respondents chose one of the more specific alternatives which concerned the environment (pollution of the atmosphere, nuclear power plants or water pollution) as the most serious problem in society. Among the eleven given alternatives and the possibility to provide one's own answer, pollution of the atmosphere specificly was the most serious social problem according to every tenth respondent. Furthermore, pollution of the atmosphere was the second in the second most serious social problems right after environmental pollution. More than a tenth put political unrest, unemployment and over-population first among the most serious problems in society. Some respondents (8%) could not rank the alternatives or indicate which one of them they considered the most important. Only a few respondents (n=8) gave their own alternative for the most serious social problem, like drugs, inequality, the global economy, climate change and immorality.

A combined variable was formed from the questions about the three most serious social problems concerning the number of environmental problems mentioned in these three questions. Four classes were created: zero mentions of the environment, and one, two and three mentions of environmental problems. Every tenth respondent chose environmental problems as the three most serious and 15% did not choose any environmental problems among the three most serious (Table IIIn in Appendix 1). Eighty percent of the respondents chose at least one of the environmental problems among the three most serious. Altogether 34% of the respondents were worried about atmospheric pollution among the three most serious social problems. Fourty-five percent of the respondents mentioned environmental problems two or three times among the three most serious social problems.

The importance of environmental protection was evaluated along with three other social aims (also used in some earlier surveys) by the following questions: "How important are the following social aims in Finland (in your opinion)?". Among the four given social aims in Finland the respondents found 'environmental protection' a very important aim most often (Table IIIo in Appendix 1). 'Decreasing unemployment' was also considered a very important aim. Fewer people chose ‘decreasing consumption differences between the poor and the wealthy people’ and ‘increase in the citizen’s consumption opportunities’ as very important social aims. Hardly any of the respondents indicated that 'environmental protection' and 'unemployment' were unimportant social aims in Finland.

Sociodemographic differences

Women were more often concerned about environmental pollution in general and men about nuclear power plants in the east. Fourteen percent of respondents found air pollution from various sources (stratospheric ozone depletion, emissions from industry, air pollution coming from the east, traffic pollution and pollution of the atmosphere) to be the most serious environmental problem in Finland (Table 5.7). Among this group the most educated (≥17 years) were significantly less concerned about air pollution at national level than the less educated. Men had noticed improvement in their environment more often than women, especially better water and air quality.

Women were more concerned about the environmental effects of both traffic and industry than men. In addition, the youngest (25-34 years) and the lower occupational groups were more often concerned about the environmental impact of industry than the older groups and the upper white-collar employees or entrepreneurs. After adjusting for the other sociodemographic variables the differences remained the same (Table 5.7). Women, the older age groups (45-60 years old), lower occupational groups and especially the least educated were clearly and significantly more concerned about the health impact of pollution than the other population subgroups (Table 5.8).

Table 5.8. The proportion (%) of those often thinking about how environmental pollution affects their health. (Note. Missing values excluded)

		Total N	%	Chi2 test signif.	OR	95% CI
ALL		428	57			
GENDER	Men	195	47	**0.000**	1.00	(reference)
	Women	233	66		2.51	(1.58; 4.01)
AGE	25-34 years old	110	43	**0.001**	0.62	(0.28; 1.41)
	35-44 years old	126	55		1.19	(0.55; 2.61)
	45-54 years old	139	69		1.90	(0.88; 4.10)
	55-60 years old	52	60		1.00	(reference)
OCCUPATIONAL STATUS	Upper white-collar	107	38	**0.000**	0.45	(0.21; 0.96)
	Lower white-collar	153	64		0.95	(0.46; 1.94)
	Entrepreneur	42	62		1.33	(0.53; 3.30)
	Worker	59	69		1.39	(0.57; 3.39)
	Other	57	61		1.00	(reference)
EDUCATION	≤ 9 years	60	80	**0.000**	1.00	(reference)
	10-12 years	76	55		0.39	(0.17; 0.88)
	13-16 years	156	59		0.56	(0.25; 1.26)
	≥ 17 years	115	44		0.34	(0.14; 0.79)

More women than men preferred environmental pollution in general as the most serious social problem at the moment. Fourty-five percent of the respondents mentioned environmental problems two or three times among the three most serious social problems (Table 5.7). The 45-54 age group were most concerned about the environment among the serious social problems and the oldest the least. Significantly more workers were concerned about environmental issues than upper white-collar employees. Further, more women considered ‘environmental protection’ to be a very important social aim than men.

Table 5.7. The proportion (%) of those who were very concerned about the matter, chi²-test p-value for difference between population sub-groups and logistic regression models of Environmental Attitude Questions: OR's (odds ratios) and 95% confidence interval (CI) while adjusting for the other sociodemographic variables.

		Air pollution as the most serious environmental problem in Finland				Increase of traffic and its impact				Environmental impact of industry				Environment mentioned at least twice among the three most serious social problems			
	N	%	Chi²	OR	95% CI	%	Chi²	OR	95% CI	%	Chi²	OR	95% CI	%	Chi²	OR	95% CI
ALL	**428**	**14**				**30**				**41**				**46**			
Gender			0.713				**0.000**				**0.000**				0.101		
Men	195	14		1.00	(reference)	21		1.00	(reference)	30		1.00	(reference)	41		1.00	(reference)
Women	233	15		1.53	(0.80; 2.96)	38		2.29	(1.40; 3.76)	51		2.38	(1.51; 3.74)	49		1.31	(0.84; 2.05)
Age			0.181				0.335				**0.015**				**0.011**		
25-34 years	110	10		0.63	(0.20; 2.01)	28		1.41	(0.58; 3.45)	54		2.26	(1.01; 5.07)	45		1.31	(0.62; 3.08)
35-44 years	126	12		0.89	(0.32; 2.49)	28		1.58	(0.67; 3.72)	39		1.34	(0.62; 2.93)	39		1.09	(0.51; 2.36)
45-54 years	139	19		1.27	(0.48; 3.35)	35		1.98	(0.87; 4.53)	36		1.16	(0.54; 2.47)	56		2.11	(1.00; 4.42)
55-60 years	52	14		1.00	(reference)	24		1.00	(reference)	33		1.00	(reference)	33		1.00	(reference)
Occup. Status			0.413				0.091				**0.025**				**0.009**		
Upper white-collar	107	11		1.32	(0.41; 4.30)	26		0.38	(0.17; 0.82)	31		0.41	(0.19; 0.89)	32		0.71	(0.33; 1.52)
Lower white-collar	153	14		1.34	(0.46; 3.94)	30		0.35	(0.17; 0.72)	46		0.64	(0.32; 1.27)	53		1.44	(0.72; 2.89)
Entrepreneur	42	20		1.95	(0.54; 7.02)	19		0.32	(0.12; 0.86)	31		0.54	(0.22; 1.35)	49		1.38	(0.57; 3.35)
Worker	59	19		1.89	(0.57; 6.27)	38		0.59	(0.25; 1.42)	48		1.10	(0.48; 2.55)	54		1.43	(0.61; 3.38)
Other	57	9		1.00	(reference)	41		1.00	(reference)	49		1.00	(reference)	40		1.00	(reference)
Education			**0.027**				0.077				0.278				0.427		
≤ 9 years	60	15		1.00	(reference)	43		1.00	(reference)	42		1.00	(reference)	48		1.00	(reference)
10-12 years	76	24		2.05	(0.81; 5.23)	24		0.46	(0.21; 1.01)	38		0.88	(0.42; 1.84)	47		1.09	(0.51; 2.33)
13-16 years	156	13		1.07	(0.40; 2.86)	27		0.53	(0.25; 1.11)	47		1.21	(0.59; 2.46)	48		1.14	(0.54; 2.39)
≥ 17 years	115	8		0.63	(0.20; 1.99)	31		0.67	(0.30; 1.49)	35		0.83	(0.38; 1.82)	39		0.94	(0.42; 2.08)

* Those very concerned about the matter as against those somewhat concerned or not concerned about it.

5.4. Discussion of concern about air pollution and the environment

Response rates and quality of data

The reason for the low response rate of the mailed Environmental Attitude Questionnaire in Helsinki (44%) was that no reminders were sent, as the potential of reminders to increase the response rates of mailed surveys is well documented in the literature (Bostrom et al. 1993; Etter & Perneger 1997; Holt et al. 1997; Sheikh 1998). It is possible that the subject's own interest in air pollution might have increased the response activity. Those who participated in the *EXPOLIS* study before were also more motivated to respond than those answering only the Environment Attitude Questionnaire. A promise to get information and results about one's own exposure might also work as a reward (Helm et al. 2000) as in the *EXPOLIS* study, but the attitude questionnaire itself was not attractive enough to generate more responses without any compensation. In another study in spring 2000 Helsinki adult citizens were asked for their opinions on the environment and the response rate after the first mailing was 40% and after one reminder the final response rate rose to 61% (Lankinen & Sairinen 2000). A mailed questionnaire in Sweden about risk perception after the Chernobyl nuclear accident with three reminders returned only 61% (Drottz-Sjöberg & Sjöberg 1990), although the accident was widely discussed in the media and concerned almost everybody. In addition, however, another 15% of the non-responders gave reasons why they did not complete the questionnaire in this Swedish study.

The Environment Attitude Questionnaire respondents were considered to represent both genders satisfactorily. However, those with high education and the older were over-represented among the EAQ respondents compared to the same age city population. This means that the EAQ-results cannot be generalised to the total same age population. However, since the results seem similar to the earlier (environmental) studies (e.g. Tanskanen 1997; Tulokas 1998), it can be assumed that there is no major bias in concerns about environment, after all. In addition, as in the previous studies about environmental attitudes and behaviour (Lankinen 1995; Tulokas 1998), a letter introducing the Environmental Attitude Questionnaire leads the respondent to think particularly of environmental problems and environmental attitudes may therefore be emphasized relative to other social problems in these answers. Moreover, the EAQ respondents who participated in the *EXPOLIS* study were already oriented toward air pollution rather than other environmental problems.

In the questions about the most serious social problems twelve alternatives similar to those in the previous studies were given, but an opportunity to write a free answer was also available. However, it is easier to pick up an alternative from the list than think one up. No major new alternatives emerged among the self-written answers. Two of the set alternatives referred to the economic depression and joining the European Union and these were no more acute issues like when they were first asked about (Kaila-Kangas et al. 1994). For example, a recent study conducted in Turku (Kouvo 2000) also had crime, inequality between the rich and the poor, the next depression and the threat of a global economy as alternatives for the most serious social problems.

Interpretations of some questions in the EAQ are difficult, because the aswers might have been focused to different points of view. For example, the question "How worried are you about the increase in traffic and its effects on environment?" connects the increase in traffic and environmental effects. Dangerousness of environmental problems is usually connected to perceived health risks. In addition, dangerousness of traffic includes assessment of air pollution, noise and accident caused by traffic and therefore worry about impacts of traffic may be influenced also by irritation about noise or accidents and not solely air pollution. Besides, indicating that a matter is dangerous is a stronger attitude than just being concerned about it. In other words, it is easier to express being very concerned about e.g. air pollution than indicate it to be dangerous (Tanskanen 1997).

Another example, respondents' assumptions about their own ability to influence air pollution was tested by the claim "One cannot do much to prevent air pollution", which is problematic, because the statement is negative and encouraging to agree with it. Furthermore, no examples were given for preventing air pollution. In addition word ‘much’ in the sentence makes the respondent think what is much. It is reasonable, however, to assume that those disagreeing with the statement do believe that they can influence air pollution by themselves.

In the Environmental Attitude Questionnaire similar questions were used as in some previous studies (Haavisto & Lankinen 1991; Kaila-Kangas et al. 1994; Lankinen 1995; Tulokas 1998) for the purposes of comparison, and questions concerning air pollution especially were derived from these. The actual questions concerning knowledge of air pollution were not included in the EAQ, which is an unfortunate absence. Instead those answering the Environmental Attitude Questionnaire only were compared to those participated earlier on the *Exposure* or *Diary* samples of the *EXPOLIS* study assuming that the later have more (or at least not less) knowledge about air pollution than the EAQ-only group. This superficial comparison gave only few significant differences and the *Exposure* and *Diary* samples differed more from each other than from the EAQ-only group. Therefore this comparison could not be used for further conclusions. However, the impact of knowledge on concerns is a very difficult issue to interpret, because the knowledge is filtered thru the attitudinal aspects connected to the problem. Correct knowledge about environmental problems may increase or decrease the expression of dangerousness of environmental problems (Tanskanen 1997). Cognitive and value-based (attitudinal, emotional) factors are very difficult to separate in survey-studies.

Local versus national and global environment and air quality

Attitudes about local and global environmental problems, their importance and priority, and assessment of their seriousness, are affected by the local or global viewpoint of individuals (Burningham & O'Brien 1994). The Commission of the European Communities has collected information on concerns and assumptions related to environment in EU countries (Europeans and Environment 1982, 1986, 1988, 1992). In these studies questions are focused on how concerned people are about global, regional and local environmental problems. Based on these surveys Europeans are more concerned about global and national environmental problems than local ones (Tanskanen 1997). Suhonen (1994) suggests reason being that media report mostly global and national catastrophes and problems and not small scale local environmental problems. Another explanation could be that the environmental policies that actively improve the local state of the environment decrease the local environmental concerns by fostering the feeling that these problems can be managed (Tanskanen 1997).

In 1999 the two most important environmental problems in Finland were considered to be 'environmental pollution in general' and 'nuclear power plants in the east'; followed by 'water pollution' and 'atmospheric pollution' in third and fourth place according to the EAQ-respondents in the Helsinki region. Similar results were reported by Tanskanen (1997) as the proportion of those reporting the issue being very dangerous in general in Finland: nuclear power plants (65%), greenhouse effect (56%), pesticides and chemicals (56%), health effects of car traffic (51%), pollution of water systems (46%), air pollution caused by industry (45%), and air pollution caused by cars (35%). In addition, the environmental effects of industry bothered the respondents somewhat more often than those of traffic at national level. More women, the youngest, and lower occupational status groups were concerned about the environmental effects of industry than other population sub-groups. More environment articles were written in Helsingin Sanomat about industry (19%) than about traffic (13%) (Suhonen 1994).

More of the EAQ-respondents were concerned about ‘pollution of the water systems’ and ‘the environment in general’ at national level than about their local environment, while ‘littering in public spaces and in the wild’, traffic pollution and noise seemed to be important local environmental problems. Assessments about the local environment are strongly based on one's own experiences (Tulokas 1990).

'Traffic pollution', 'environmental pollution in general', 'air pollution' and 'noise' were seen as the most serious local environmental problems among the EAQ-respondents in 1999. However, when questions about local environmental problems were set so that the importance of all the alternatives could be evaluated, the rank order of environmental concerns was (Table IIIp in Appendix 1): 'Sea-water quality', 'littering in public spaces and in the wild' and 'air quality'. A similar question was asked five years earlier (1994) from 17-74 years old inhabitants of Helsinki Metropolitan area and then the rank order was 'littering', 'air quality' and 'excessive building' (Tulokas 1998).

In comparing two types of questions about local environmental issues: 1) the concern of all the alternatives were assessed and 2) the most serious alternative was chosen, the rank order changed somewhat. Although 'traffic pollution' was chosen as the most serious local environmental problem, 'sea-water quality' and 'littering' concerned a larger number of respondents than 'air quality' or 'traffic noise'. The most serious local environmental problem may have national or even global impacts and is also therefore assessed differently from the local environmental concern based on own experiences.

These two questions about air pollution (1) concern about local air quality and 2) air pollution as the most serious local environmental problem) relate to different aspects of the worry. Suhonen (1994) classified the dimensions of environmental assumptions as cognitive and value based. The younger and more educated were more often found on average to have cognitive concern, while women, the older and less educated made value-based assumptions about the environment (Kaila-Kangas et al. 1994). Those choosing ‘air pollution’ as the most serious local environmental problem seemed to have sociodemographic characteristics similar to those who prioritised cognitive concern and those worried about ‘air quality’ similar to those making value-based assumptions. However, since the actual questions concerning knowledge were not included, this cannot be verified.

Another explanation is based on the social and cultural risk assessment. Assessment of the concern of the local environmental problems is done individually on psychological basis (perceived risk). Though some of the respondents judged the most serious environmental problem differently on social and cultural basis. They assessed air pollution as a social risk, but not as their own concern. Besides, women answered the question of the most serious local environmental problem less specificly than men as “environmental pollution” in general which could include air pollution, but was not classified as an air pollution concern. The women’s concern about air quality was stronger than that of men and ca. 90% of both men and women were at least somewhat concerned about local air quality.

Half of the EAQ-respondents considered 'air pollution' from various sources as the most serious local environmental problem, but only 14% reported air pollution as the most serious national environmental matter. Fourty-four percent of the respondents were very concerned about air pollution at local level. This is understandable because air is more polluted in the Helsinki region than in the other parts of the country. According to the Eurobarometer 20% of all the Finns were very concerned about air pollution at local and 61% at national level (Tanskanen 1997). Also Helsingin Sanomat reported more about local air pollution (42%) than national (14%), European (11%) or global (12%) air pollution problems between 1996-2000.

The state of the environment and environment among other social problems

The state of the environment is usually seen as better in the past and worse in the future than at the moment of evaluation (Tulokas 1998). According to Suhonen (1991) evaluation of the past and future is more tightly based on the common knowledge about the direction of the development than on one's own experience or evaluation of the state of the environment. This study canvassed personal experience of the state of environment, the present being seen as more polluted than the past. Although water systems have become cleaner lately and industries have clearly reduced their emissions (Hallanaro et al. 2000), hardly any improvement in the environment was noticed. Only four percent of the respondents had noticed the fact that air quality had improved in the Helsinki region during the past ten years. However, one in five of the respondents were uncertain and could not answer this question. Air pollution exposure is hard to observe, let alone quantity, and the attitudes to these matters may reflect the information gathered from the media. Half of the air pollution articles in Helsingin Sanomat between 1996-2000 were reports on how man had destroyed or damaged nature and only one third were articles about how man tried to solve problems.

Concern over global environmental problems increased substantially during the 1990s in Finland (Tulokas 1998). According to Tanskanen (1997) global and national problems concern typically more than the local environmental problems and the state of local environment is assessed to be much better than global environment in the Western countries (also Suhonen 1994). However, since in the Eastern European countries and developing countries local environmental problems concern the most, concern seem to be based on the perceived poor state of the local environment and distrust on the environmental policy. It is assumed that when the state of the environment improves in the Eastern European countries and developing countries the overall concern will not decrease, but remove from local problems towards global environmental problems.

As in this study, unemployment and environmental protection have both been very important social aims for at least 10 years according to the inhabitants of the Helsinki region (Haavisto & Lankinen 1991; Lankinen 1995; Tulokas 1998; Lankinen & Sairinen 2000) (Table IIIq in Appendix 1). The study by Lankinen and Sairinen (2000) reported that 'decreasing unemployment' and 'protection of the environment' were placed first by all social status groups among the four given social aims. Of all population subgroups women, the youngest and, according to Tulokas (1998), the more educated inhabitants of the Helsinki area gave the highest preference to the protection of the environment. The most serious social problem according to the EAQ-respondents was environmental pollution (in general), followed by political unrest, unemployment, overpopulation and atmospheric pollution. More women, 45-54 year olds and workers mentioned environmental problems among the most serious social problems than other population subgroups. The quality of the environment is an important factor in welfare.

Own abilities, behaviour and health concerns

In this study more than one in three believed that they could not do much to prevent air pollution, but women believed in their own ability to prevent air pollution more often than men. However, more than half of the respondents, educated women in particular, claimed that they avoided driving for environmental reasons at least sometimes. One reason may be the excellent public transportation in the Helsinki region. It is also possible that in reality not so many do avoid driving, but that this is their good intention. Besides, not all can choose to avoid driving. The earlier studies (Uusitalo 1986, 1991; Allardt 1991; Lahti & Saarela 1991) have shown that although attitudes may be environmentally friendly, behaviour does not change easily. According to Kouvo (2000) the more educated people seem to think more often than the less educated that their own life style reflects responsiblity for the environment.

Only a quarter of the respondents thought that they could mostly prevent exposure to air pollution. If the question was not frased the way that it was diffucult to agree with it totally, probably larger share of the respondents could have thought of some ways of reducing their own exposure. More of the oldest age group and the least educated believed in their own ability to prevent exposure to air pollution than the other population sub-groups. Almost one in four claimed that they avoid going out during air pollution episodes, especially women and the socioeconomic group ‘other’ (including retirees, students, housewives and the unemployed). In addition, those with allergic symptoms seemed to have knowledge or sensation of high pollution levels and so avoided going out during such episodes when possible.

More than half of the EAQ-respondents in the Helsinki region were worried about environmental pollution impacting their health. In an earlier study (Suhonen 1994) only every fifth respondent in Finland was concerned about environmental pollution impacting his or her own health. The personal health concerns usually relate to poor state of local environment or local environmental concerns (Tanskanen 1997). Therefore the health concerns of inhabitants in the Helsinki region are understandably higher than those of all Finns, because the air quality in Helsinki region is more polluted than in most other parts of Finland (Anttila, Alaviippola and Salmi 2003). Moreover, the different means of collecting the information (different questions in different order and different context) in these two studies have probably influenced the results.

In addtion, human health was mentioned in every third article about air pollution as a risk in Helsingin Sanomat between 1996-2000. Health was mentioned more than twice as often in the articles in which man had caused the problem compared to those in which man tried to resolve them. Women, the oldest age group (55-65), workers and the least educated were particularly worried about their health being affected by environmental pollution. Women have also in previous studies been reported to be more concerned about the health implications of pollution than men (Van Liere & Dunlap 1981; Suhonen 1994).

Summary by sociodemographic factors

In general women, 45-54 year olds and those with lower socioeconomic status seemed to be more concerned about air pollution and environmental issues than men, the younger and the more educated. When the importance of various environmental problems is canvassed, however, women and men usually end up with the same rank order. Assessment of the concern about air quality in Helsinki was based on perceived risk by women, the older, the less educated and the socio-economic group ‘other’ being more worried than other sub-groups. Air pollution as the most serious local environmental problem was probably assessed from more general perspective, as a social risk, and the younger, upper white-collar employees and the more educated agreed with it more often than other sub-populations.

A greater proportion of women than men believed in their own ability to prevent air pollution, and educated women in particular avoided driving for environmental reasons at least sometimes. Especially the oldest age group and the less educated believed in their own ability to prevent exposure to air pollution. More women and the occupational group 'other', however, avoided going out during air pollution episodes than other population sub-groups. In addition, women, the older, workers and the less educated were particularly worried about their health being affected by environmental pollution.

6 Association between exposure, perceived annoyance and concern about air pollution

6.1. Introduction

Perceived annoyances can be compared to the measured fine particle (n=201) and nitrogen dioxide (n=176) concentrations of the *EXPOLIS Exposure* sample. At the end of the *Exposure* sample's 48-hour measurement period, when the fine particle ($PM_{2.5}$) and nitrogen dioxide (NO_2) concentrations were measured in each participant's home, they also reported their level of annoyance caused by air pollution at home. Only a few analyses have been conducted previously on the association between annoyance from air pollution and air pollution exposure (Forsberg et al. 1997; Klaeboe et al. 2000; Oglesby et al. 2000a).

Methods

The associations between the individual annoyance scores and the measured $PM_{2.5}$ and NO_2 exposures and concentrations were tested by Pearson correlation (Table 6.1)(Rotko et al. 2002a). Means of the personal leisure time fine particle ($PM_{2.5}$) exposure and home indoor nitrogen dioxide (NO_2) concentration by three classes of perceived annoyance at home were tested by analysis of variance (Anova)(Table 6.2). Association between the perceived annoyance at home and the concerns about air pollution were analysed with crosstables and chi-square (χ^2) -tests (Table 6.3). All statistical tests were done by a STATA (version 5.0, STATA 1997) or SPSS (version 9.0, SPSS 1998) statistical package.

To find the differences of interest and to compare sub-populations with each other, the population samples were divided into two groups by each descriptive factor separately (one by one) and the mean values of each subgroup were then plotted on the same figure. The scales of the figure were set to cross each other at the mean/median values. This fourfold field (Figure 6.1) was created with median personal leisure time exposure ($PM_{2.5}$) and median home indoor (NO_2) concentration on the x-axis and the mean annoyance scores at home on the y-axis (Figures 6.2 and 6.3). Statistically significant differences between the subpopulations are presented in the footnote of the figures; for the perceived annoyance differences the chi-square (χ^2) -test was carried out and the exposure differences between the subpopulations were tested with Kolmogorov-Smirnov -test.

		Measured air pollution concentration Low	 High
Perceived annoyance	High	1) “over-sensitive” individuals	2) high concentration, annoyance "dose-responsive"
	Low	3) low concentrations, no annoyance "dose-responsive"	4) “unconcerned” individuals

Figure 6.1. Key to Figures 6.2 and 6.3: Interpretation scheme for (four-part field) comparing perceived annoyance to measured air pollution concentrations. 1) Annoyed by air pollution without high concentrations, 2) Annoyed by air pollution because of high concentrations, 3) Not annoyed by air pollution; low concentrations measured, and 4) Not annoyed by air pollution regardless of high concentrations.

The annoyance scores can be compared to the air pollution concentrations, keeping in mind that:

1) personal perceived annoyance was asked about, and not evaluation of the level of air quality at home (work, etc). In other words, subjects were not asked to assess the concentration levels because even low concentrations, e.g. detection of tobacco smoke, might annoy some population groups while others do not get annoyed even with smoky and thick air. Sensory air quality evaluation (on a comparable scale) is very difficult - if not impossible - especially for layman. While sensory evaluation of pollutant concentration by untrained individuals would include a lot of guesswork and contain unaccountable sources of error, "personal perceived annoyance" is a clear-cut measure. In addition, perceived annoyance might have an influence on health and quality of life independently of pollution levels.
2) Air pollution is a mixture of various air pollutants. Perceived annoyance concerns the ambient air and not an individual component of it. However, by comparing the

annoyance levels and concentrations of a single pollutant at a time, one can identify which pollutants annoy the most and are easiest to sense.

3) Many air pollution components might be hard to perceive at low concentrations. However, even low concentrations sometimes have perceptible effects on sensitive individuals like asthmatics.

6.2. Associations

Air pollution exposure and perceived annoyance comparison

Individual scores and average annoyances versus measured exposure

Perceived annoyance variation was large and individual annoyance scores did not correlate with fine particle or nitrogen dioxide concentrations in Helsinki (Rotko et al 2002a). Pearson correlation between perceived annoyance and personal exposure to fine particles ($PM_{2.5}$) and nitrogen dioxide (NO_2) as well as the measured microenvironmental concentrations are presented in Table 6.1.

Table 6.1. Pearson correlation between individual perceived air pollution annoyance scores and measured fine particle ($PM_{2.5}$) and nitrogen dioxide (NO_2) exposures and concentrations in different microenvironments in *EXPOLIS*-Helsinki.

		Annoyance from air pollution	
	N	At home	At workplace
Fine particles ($PM_{2.5}$)			
Personal leisure time	195	0.14	
Home indoor	190	0.20	
Home outdoor	169	-0.05	
Personal 48-hour	193, 174	0.04	0.07
Personal workday	174		0.08
Workplace	137		0.21
Nitrogen dioxide (NO_2)			
Home indoor	173	0.27	
Home outdoor	159	0.20	
Personal 48-hour	174, 155	0.11	0.22
Workplace	121		0.29

Average values of personal leisure time fine particle ($PM_{2.5}$) exposure and home indoor nitrogen dioxide (NO_2) concentration by three classes of perceived annoyance at home are presented in Table 6.2. In average the annoyance at home increased with indoor nitrogen dioxide concentration. The average leisure time fine particle exposure was almost three times higher for those who were highly (scored 8-10) annoyed by air pollution at home than those expressing low annoyance (scoring 0-3). The exposure differences between the high and low annoyance classes were close to significant. Although the individual perceived air pollution annoyance scores at home or at work did not correlate with the corresponding individual *EXPOLIS* concentrations of $PM_{2.5}$ and NO_2, the population level average values (annoyance classes) appeared to be useful in exposure-annoyance assessments.

Table 6.2. Statistics of personal leisure time fine particle ($PM_{2.5}$) exposure and home indoor nitrogen dioxide (NO_2) concentration by average perceived air pollution annoyance at home in *EXPOLIS*-Helsinki.

Annoyance from air pollution at home	Personal leisure time $PM_{2.5}$					Home indoor NO_2				
	N	Md[2]	Avg[2]	Std[2]	Anova[2]	N	Md[2]	Avg[2]	Std[2]	Anova[2]
Total	195	7.8	12.7	15.3		173	15.4	17.7	11.1	
Low (0-3)[1]	167	7.8	12.4	15.3	0.054	149	14.5	16.8	10.1	0.075
Medium (4-7)[1]	24	7.7	11.8	10.6		20	18.1	22.9	14.6	
High (8-10)[1]	4	31.0	30.9	30.3		4	24.7	26.3	17.4	

[1] score on 0-10 annoyance scale
[2] Md=median, Avg=average, Std=standard deviation and Anova=Analysis of Variance p-value

Sociodemographic differences in exposure and annoyance comparisons

Annoyance from air pollution at home and personal leisure time fine particle ($PM_{2.5}$) exposures between population subgroups were compared separately and interesting differences arose. Mean annoyance scores in Helsinki varied between 1 and 2.4 (Figure 6.2). Smokers and those exposed to environmental tobacco smoke were "unconcerned" and those not exposed to environmental tobacco smoke were somewhat "oversensitive" to air pollution compared to their measured exposure to fine particles. Those living downtown were more annoyed by air pollution and had also higher fine particle exposure than the rest. Those who kept their windows open a lot (>20h/48h) were greatly annoyed by air pollution and were also exposed to high fine particle levels. Those reporting to be sensitive to air pollution were eager to report high annoyance scores compared to their average fine particle exposure.

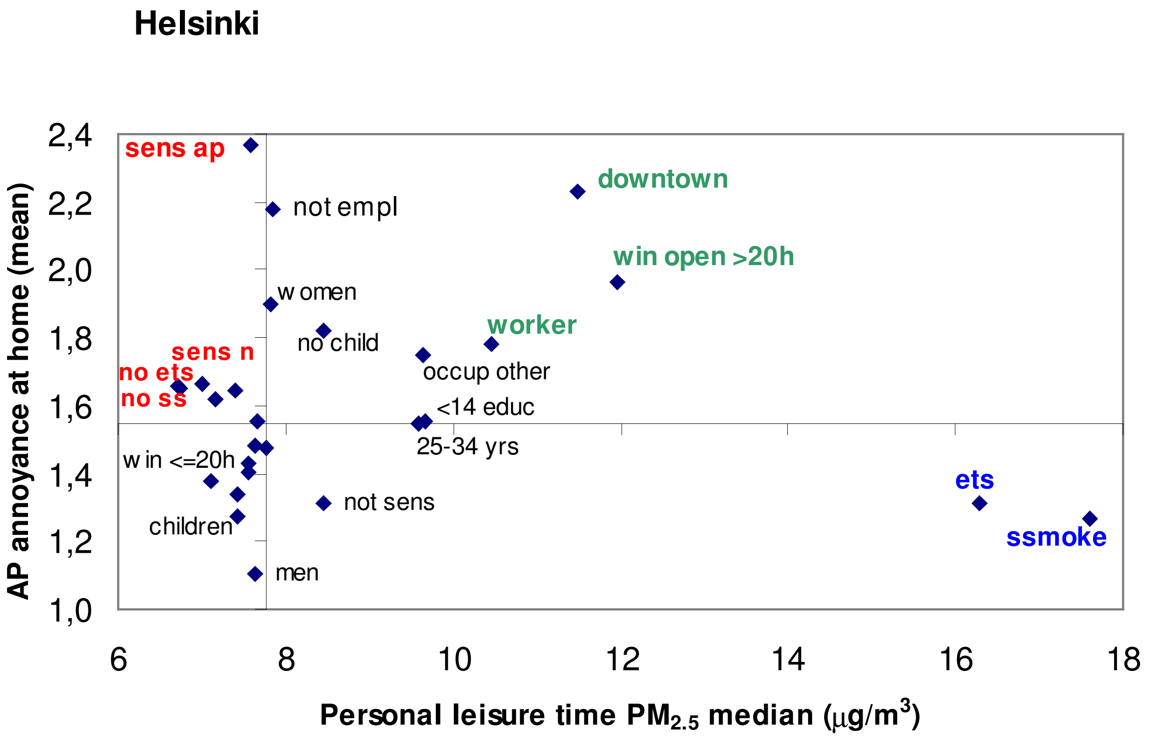


Figure 6.2. Personal leisure time fine particle ($PM_{2.5}$) exposure median versus home annoyance mean by population subgroup. Red: ”over-sensitive” annoyance compared to the fine particle exposure, Green: dose-responsive annoyance reaction, Blue: ”unconserned” annoyance compared to the fine particle exposure.

Factor	*Classific.*	*Mark in fig.*	*N*	*sig. annoy*	*sig. expo*
Gender:	men		88	*	
	women		113		
Age class:	25-34 yrs		62		*
	35-44 yrs		71		
	45-55 yrs		66		
Education years:	≤9		20		*
	10-13	(<14 educ)	49		
	≥14	(≥14 educ)	125		
Self smoker:	smoker	(ssmoke)	52		*
	non smoker	(no ss)	149		
Having children:	children		99		
	no children	(no child)	101		
Employment status:	employed		177		
	not employed	(not empl)	24		
Self reported sensitivity:	to noise	(sens n)	10	*	
	to air pollution	(sens ap)	39		
	not sensitive	(not sens)	140		
Home location:	downtown		48	*	*
	sub-urban area	(subu)	153		
Keeping windows open at home:	≤20hours/48h	(win <=20h)	139		*
	>20hours/48h	(win open >20h)	60		
Exposure to environmental tobacco smoke:	ets		62		*
	no ets		139		
Self reported allergic symptoms:	symptoms		76		
	no symptoms		100		
Occupational status:	white-collar employee		125	*	
	worker		39		
	other	(occup other)	36		

Mean annoyance from air pollution at home was also compared to median home indoor nitrogen dioxide (NO_2) levels in Helsinki (Figure 6.3). Those living in the city area, those reporting sensitivity to air pollution, those keeping their windows open a lot (>20h/48h) and those not employed at the moment were on average more annoyed by air pollution than other population subgroups, but were also in average more exposed to nitrogen dioxide. Those exposed to environmental tobacco smoke and self-smokers were "unconcerned" about air pollution relative to their exposure to nitrogen dioxide. In addition, among Helsinki respondents women, those sensitive to noise and the more educated (≥14 years) were "over-sensitive" to air pollution compared to their exposure to nitrogen dioxide relative to other subpopulations.

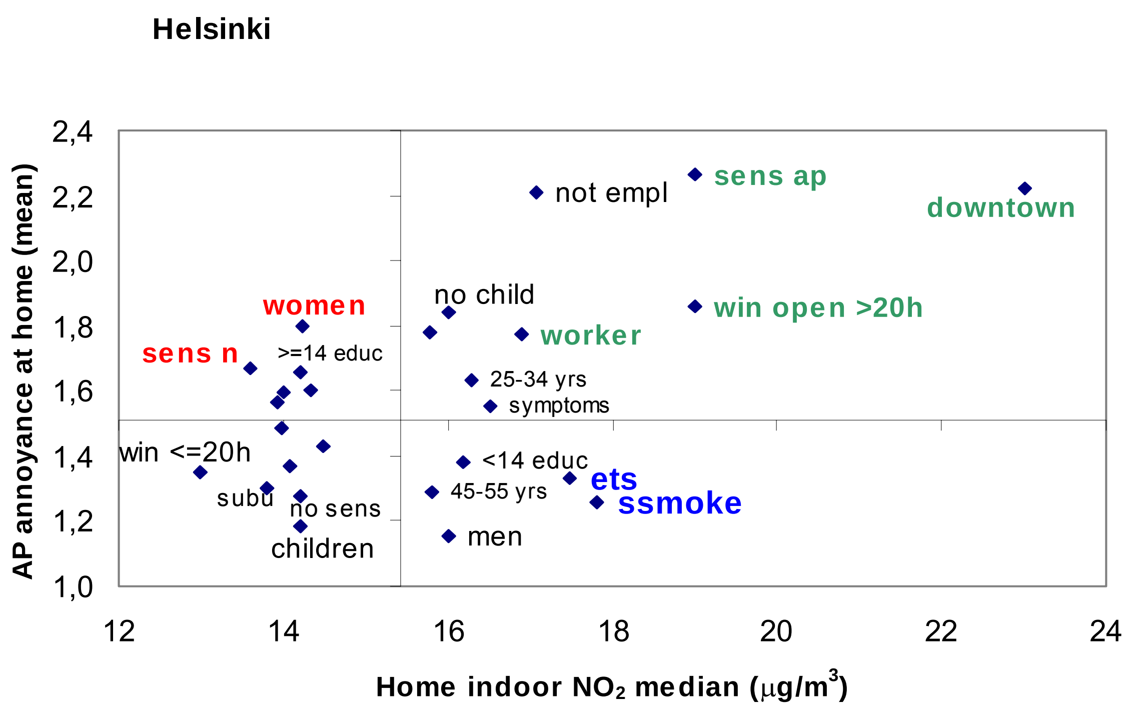


Figure 6.3. Home indoor nitrogen dioxide (NO_2) concentration median versus home annoyance mean by population subgroup. Red: ”over-sensitive” annoyance compared to the nitrogen dioxide exposure, Green: dose-responsive annoyance reaction, Blue: ”unconserned” annoyance compared to the nitrogen dioxide exposure.

Factor	*Classific.*	*Mark in fig.*	*N*	*sig. annoy*	*sig. expo*
Gender:	men		78	*	
	women		99		
Age class:	25-34 yrs		54		
	35-44 yrs		64		
	45-55 yrs		57		
Education years:	≤9		14		
	10-13	(<14 educ)	46		
	≥14	(≥14 educ)	110		
Self smoker:	smoker	(ssmoke)	46		*
	non smoker	(no ss)	131		
Having children:	children		88		
	no children	(no child)	88		
Employment status:	employed		156		
	not employed	(not empl)	21		
Self reported sensitivity:	to noise	(sens n)	10	*	
	to air pollution	(sens ap)	35		
	not sensitive	(not sens)	120		
Home location:	downtown		41	*	*
	sub-urban area	(subu)	136		
Keeping windows open at home:	≤20hours/48h	(win <=20h)	118		*
	>20hours/48h	(win open >20h)		57	
Exposure to environmental tobacco smoke:	ets		55		*
	no ets		122		
Self reported allergic symptoms:	symptoms		76		
	no symptoms		100		
Occupational status:	white-collar employee		111	*	
	worker		33		
	other	(occup other)	32		

Exposure, annoyance and concern comparison

Perceived annoyance at home was compared to various expressions of concerns about air pollution with crosstables (Table 6.3). Compared to those experiencing low annoyance (< 4), those experiencing a high (≥ 4) annoyance of air pollution at home were also more concerned (63% vs. 38%) about air quality in the Helsinki region, and they thought more often (86% vs. 61%) that environmental pollution affects their own health. Perceived annoyance of air pollution at home, however, did not influence the personal judgement about whether air pollution or something else was the most serious local environmental problem.

Table 6.3. Crosstables between perceived annoyance from air pollution at home and three air pollution concern questions in Helsinki (percentages and chi2-test).

Concern questions		Perceived annoyance at home		
		0 - 3 in annoyance scale	4 - 10 in annoyance scale	Chi^2 p-value
The most serious local environmental problem (n=404)	Air pollution	50.3	52.3	0.808
	Something else	49.7	47.7	
Concern about air quality in the Helsinki region (n=401)	Very concerned	38.0	62.5	**0.000**
	Somewhat concerned	62.0	37.5	
Often thinking that environmental pollution affect my health (n=359)	Agree	60.5	85.9	**0.000**
	Disagree	39.5	14.1	

Summary of the agreements and disagreements between the sociodemographic differences in exposures, perceived annoyances and concern about air pollution are presented in Table 6.4. Women were more annoyed by air pollution and concerned about environmental health impacts and local air quality than men. However, men were more exposed at least to one air pollution component, fine particles (non-significant difference). The younger (25-34 years) were more exposed to fine particles, more concerned about local air pollutioning, but less concerned about health impacts than the older. The more educated were less exposed to fine particles and nitrogen dioxide, less annoyed from air pollution, less concerned about health impacts and air pollution as a national environmental problem, but more concerned about local air pollution than the less educated.

Table 6.4. Summary of the sociodemographic impacts in personal exposure to $PM_{2.5}$ and NO_2, perceived annoyance from air pollution and concern about air pollution.

	Exposure		**Annoyance from air poll.**	**Concern**			
	$PM_{2.5}$ 48h	NO_2 48h	At home	AP 1st local env. probl.	Env. poll. affect health	AP 1st env. probl. FIN	Very concerned AQ in Hki
Gender	⇡	–	⬇	–	⬇	–	⬇
Men							
Women							
Age	↑	–	⇣	⬆	⬇	⇣	⇣
25-34 years							
35-55 years							
Occupational status	↓	–	↓	↑	⬇	⇣	⇡
White-collar							
Non-white-collar							
Education years	↑	↑	⇡	⬇	⬆	↑	⇡
< 14 years							
≥ 14 years							

⇡ Non-significant difference, ↑ significant difference ($p<0.05$), ⬆ significant difference ($p<0.01$), -- no difference

6.3. Discussion of air pollution exposure, annoyance and concern comparison

Air pollution exposure versus perceived annoyance

A large variation between individual's annoyances from air pollution was noticed. Similar results have been reported also earlier (Oglesby et al. 2000a). Some adults are sensitive to air pollution, while even high levels do not annoy others. Air pollution is a complex issue, since it consists of many compounds in numerous mixtures. Some air pollution compounds smell or irritate, others do not; some of them may cause immediate health symptoms. It is also possible that some components of air pollution might annoy people more than others, but the annoying compounds and concentrations appear to depend on the observer. At population level, however, an association can be seen between increasing exposure and annoyance. This finding is consistent for both fine particles and nitrogen dioxide. Also at the population level average values between European cities appeared to have exposure-annoyance correlation (Rotko et al. 2002a).

When comparing the mean annual ambient PM_{10} and NO_2 concentrations in eight Swiss cities with the average air pollution annoyance assessments of their inhabitants, the correlation was high (r=0.85) (Oglesby et al. 2000a). Population level correlations between the average perceived annoyances and 6-month average fixed site NO_2 levels ranged from r=0.52 (smelly outdoor air in the residential area daily or almost daily) to r=0.66 (irritating outdoor air in the town centre) in 55 Swedish cities (Forsberg et al. 1997). Evans et al. (1988) noted modest but significant relationships between ambient ozone concentrations and anxiety symptoms in a large representative sample of Los Angeles residents.

Between the *EXPOLIS* cities the average perceived annoyance levels at home correlated highly with the average measured personal 48-hour fine particle ($PM_{2.5}$)(r=0.63) and nitrogen dioxide (NO_2)(r=0.95) exposures (Rotko et al. 2002a). In addition, the average perceived annoyance levels at home correlated highly with the measured home indoor NO_2 concentration, annoyance at work correlated with personal workday exposure and workplace $PM_{2.5}$ concentrations, and annoyance in traffic with home outdoor NO_2 concentration (Rotko et al. 2002a). These results, however, are based on a small number of cities ($PM_{2.5}$ n=6, NO_2 n=4).

The created fourfield figures for comparison of sub-population's annoyance scores and the observed air pollution exposures turned out to be a convenient tool. This could be used also for comparing data of different cities with each other, since the scales are set to cross each other at the mean/median values of each city. It is important to keep in mind that the comparisons relate to just two air pollutants and therefore does not comprise the entity of air pollution annoyance. Therefore the terms "over-sensitive" and "unconcerned" should be seen as labels, not judgements.

Comparing the association between fine particle ($PM_{2.5}$) and nitrogen dioxide (NO_2) exposure and annoyance at home between the population subgroups revealed some "over-sensitive" and some "unconcerned" groups. In Helsinki relative to fine particle exposure the "over-sensitive" tended to be those reporting sensitivity to air pollution or to noise. Relative to their nitrogen dioxide concentration at home, the "over-sensitive" included women, those sensitive to noise and those educated for more than 14 years. Those "unconcerned" about air pollution included smokers and those exposed to environmental tobacco smoke in Helsinki compared to their exposure to fine particles and nitrogen dioxide. One reason why smokers did not pay much attention to annoyance from other air pollutants maybe that they inhale the major part of air pollutants voluntarily. Some population sub-groups which were either less exposed and reported low annoyance or more exposed and highly annoyed by air pollution could be identified as well. Those living downtown and keeping windows open a lot were very much annoyed by air pollution at home and also exposed to high fine particle and nitorgen dioxide levels. In addition, those not employed at the moment and those sensitive to air pollution were very annoyed by air pollution and had in average high nitrogen dioxide concentration at home.

Air pollution exposure, annoyance and concern comparison

Concerns about local air quality and own health affected by pollution seemed to increase the perceived annoyance from air pollution. However, the concern about air pollution as against other environmental problems as the most serious local environmental problem did not influence the perceived annoyance from air pollution. (See discussion about differences between these two questions in more detail in section 5.4.) Especially women, the older (35-55 years) and those having less education were more annoyed and concerned about air pollution than the other sociodemographic groups.

In conclusion concern about air pollution and it's health effects influence the perceived annoyance from air impurities. It seems in general that different population groups are exposed to air pollution (fine particles and nitrogen dioxide) and annoyed by it. While men, the younger and less educated were in average more exposed, women, the older and less educated people were more annoyed by and concerned about air pollution. Only the less educated were both exposed to higher than average concentrations and annoyed above average by air pollution. In other words, air pollution affects well-being in two ways: the exposure of some population groups is high, yet air pollution concerns other population groups even when they are not exposed to high levels of air pollution.

7 Discussion and conclusions

Environmental risks and air pollution

The natural sciences have been crucial to ecological awakening. Environmental problems, however, cannot be solved simply by knowledge of the natural sciences. Because environmental problems concern the relationship between nature and society, they always include the aspects of both natural and social sciences (Järvelä & Wilenius 1996; Haila 2001c). The facts and probabilities computed by the natural sciences and the knowledge produced by the social sciences are all essential to risk management and political decision-making. Perceived health factors have not, however, often been taken into account in decision-making so far as, for example, the evaluation by the National Research and Development Centre for Welfare and Health of the quality of Environmental Impact Assessment and Social and Health Impact Assessment in Finland pointed out (STAKES 1999). If social impact data was collected, it was regarded as too subjective and was not taken into account. Social risks and actions to diminish deleterious social effects were not mentioned in the final reports at all.

Environmental effects on human health have traditionally been evaluated by the number of deaths, injuries or morbidity rates or by assessing the concentrations of chemicals in the environment which may increase morbidity. The broader view of a health-promoting environment includes also social environment and perceived safety, which have indirect health effects. In addition to environmental health risk assessment this study presents other relevant issues and sociodemographic backgrounds of exposures, perceived risks and social and cultural dimensions of risk that should be taken into account in decision-making.

Public information programs can affect risk perceptions (Smith Merry 1990), and these perceptions in turn can affect public policy (Moore 1990). Even well-intended, scientifically accurate messages can have unintended consequences due to the role of risk perceptions. Risk is a combination of the assessed hazard and outrage. The public responds more to outrage than to assessed hazards. Activists and media amplify outrage, but they do not create it. If a risk had no outrage associated with it, there would be less attraction of activists and media. Therefore, concern and outrage of risks can be reduced by considering outrage factors and attending the way how a risk analysis is being released to the public.

Air pollution is a complex issue, since it consists of many different compounds which are emitted from many different sources. Air pollution, however, has features of the risks of the modern reflexive society. Some air pollution compounds are invisible and difficult to perceive at least in low concentrations. Science is needed to observe air pollution with well-developed measurement and analysis equipment and the special knowledge to understand these methods (Haila 2001b). This means that people depend on expert system. The consequences of the collectively created danger (e.g. traffic, industrial emissions) remain to individual's concern about health. All air pollution cannot be temporally, locally or socially controlled or restricted totally which is typical for the hazards of the risk society. Ambient air pollution is an ever-present global threat which concerns everybody. Since the individual cannot avoid all exposure, air pollution is not a voluntary risk. There is no exact knowledge of the impact on health of all air pollution compounds, which is typical of the uncertainty of reflexive modernization. Uncertainty, characteristic of late modernity, is created by man (Beck 1992, 1990; Bauman 1993; Giddens 1994).

Air pollution is not considered here as a single environmental disaster, but as a continuing threat to human health which may cause more uncertainty than a short-term air pollution episode. Uncertainty (e.g. invisible/non-detectable chemicals in air) is usually felt to be even more stressful than definite bad news (Couch & Kroll-Smith 1991, 1994). Here air pollution was studied in a broad social context.

Benefits and restrictions of the study materials

The traditions, needs and requirements of various scientific disciplines caused some problems in the *EXPOLIS* study. At the outset the study was designed for the needs of the natural sciences with careful preparation for exact measurement procedures. In an expensive, time-consuming and demanding exposure study large random population sample was not the most important aim. However, social sciences usually require large random population samples for quantitave analysis. This could have been solved by sending the Environmental Attitude Questionnaire to the Base samples of the *EXPOLIS* study, but this was not possible.

The carefully collected personal exposure measurements of the *EXPOLIS* study gave the possibility to observe exposure differences between sub-populations. In the present analyses air pollution compounds are restricted to the mass concentrations of fine particles ($PM_{2.5}$) and nitrogen dioxide (NO_2) and the exposure concentrations relate only to these two compounds. Most questions of the *EXPOLIS* questionnaires were exposure related and were used in the present analyses selectively. The basic sociodemographic variables, however, were useful and practical. Personal exposure depends the time used in different microenvironments. However, the *EXPOLIS* time-activity data was only scratched and was not analysed further here to limit the already various study material.

Since exposure-relevant selection bias occurred, it is likely that the most exposed individuals were not reached by the *EXPOLIS* study. Those with low socio-economic status and the younger are under-represented, but probably highly exposed because of dirtier workplaces, more traffic near home, living conditions, mobility, smoking, etc. The actual exposure differences within the adult Helsinki inhabitants are thus probably larger than those presented and the actual average personal exposure levels are probably higher. Despite low air pollution concentrations in Helsinki and selection bias, significant differences in exposures to fine particles and nitrogen dioxide between sociodemographic groups could still be observed. Data on sociodemographic exposure differences is scarce in the literature.

It was also possible to gather new information on the relations between the observed exposure data and perceived annoyance from air pollution. However, both fine particles and nitrogen dioxide come from different sources like smoking, traffic emissions and heat and power generation. On the other hand, from the perceived annoyance and concern about air pollution point of view the identifiable sources (e.g. traffic, smoking) include many other air pollution compounds as well. Therefore perceived annoyance and concern does not relate solely to fine particles or nitrogen dioxide. Visible, detectable and perceptible parts of air pollution (e.g. spring dust, smoke) might end easily in annoyance and concern estimations, but at the same time invisible chemicals (e.g. radiation, fine particles) might frighten and cause more concern than visible/detectable ones.

The ‘thermometer’ was an attempt to measure perceived annoyance and it turned out to be useful. Perceived annoyance is an individual feeling including also sensibility, concern, knowledge, social and media impacts as well as the current mood of the respondents as the background assumptions, and therefore individual differences are large in perceived annoyances. One possibility to manage this variation is to use analysis techniques to eliminate or reduce the impact of the variation. In addition, the created fourfield graphics for comparisons of sub-populations averages between the perceived annoyance scores and the observed air pollution exposures turned out to be a convenient tool. This could be used also for comparing data of different cities with each other, since the scales are set to cross each other at the mean/median values of each city.

In addition season may influence the perceived annoyance from air pollution, since both temperature and ambient concentrations vary in time. In this study *EXPOLIS* data and perceived annoyance assessments were collected around the year, therefore it is not assumed that the temporal variation would influence sociodemographic differences. Environmental Attitude Questionnaire was mailed during winter when air pollution concentrations in Helsinki are usually not high (except during inversion). However, cold air may increase perceived impacts of air pollution. In winter people spend more time indoors and the indoor sources of air pollutants may be emphasised in annoyance assessments of the EAQ-respondents.

The response rate of the Environmental Attitude Questionnaire was low and the more educated and the older were over-represented compared to the overall population. This means that the EAQ-results cannot be generalised to the same age population of Helsinki region. However, since the results seem similar to the earlier (environmental) studies, it can be assumed that no major bias in concerns about environment was reported. However, the main aim to assess the importance of the air pollution concern among the other environmental and social problems was achieved and the differences in concern between the sociodemographic groups could be analysed. Questions of knowledge about environmental problems were not included in the EAQ. The impact of knowledge to concerns is a very difficult issue to interpret, because the knowledge seem to be filtered thru the attitudinal aspects connected to the problem. This was not the main aim of this study, besides it has been studied earlier (e.g. Tanskanen 1997).

The aim of Helsingin Sanomat air pollution search was to describe the picture of air pollution conveyed by the leading Finnish newspaper. Since media influences peoples concerns about air pollution, this background information helped in making conclusions about

Environmental Attitude Questionnaire data. Media also reflects indirectly the knowledge that people are supposed to have. This description of air pollution articles was very brief and the direct impacts on concerns cannot be drawn. Unfortunately 'the letters to the editor' were not available at the time when the first air pollution search was made. The purpose of the small extra search was to give a hint what matters connected to air pollution made Helsinki inhabitants express their opinions. It was focused to the year before the Environmental Attitude Questionnaire was mailed to illustrate the "opinion climate" toward air pollution at the time.

Although especially the 'perceived annoyance' and 'concern about air pollution' -analyses were not comprehensive, these matters have been studied earlier, and the main benefit of the three different kind of data sets was the possibility to analyse the associations between these issues. And completely new results were produced.

Exposure to fine particles and nitrogen dioxide

Measured personal air pollution exposure levels (especially for fine particles) were in average low in Helsinki compared to the previous international studies (Levy et al. 1998; Pellizzari et al. 1999). However, also low air pollution concentrations are reported to increase early deaths (WHO 2000). As a great number of people are exposed to relatively low concentrations of air pollution every day, even a small increase in relative death risk will materially increase early deaths. In addition, since air pollutants behave differently depending on their major sources and specific exposure conditions, population sub-groups are exposed to different levels of these air pollutants. However, in addition to the exposure levels also the sociodemographic differences in exposure may differ between the European cities.

In Helsinki the largest sociodemographic difference in exposure to fine particles ($PM_{2.5}$) was assessed between occupational groups with workers having double the exposure of white-collar employees. Fine particle exposure differences were greater between the socioeconomic groups among men than among women. Differences between social status groups were mostly caused by work exposure. Smoking and exposure to environmental tobacco smoke increased exposure differences between socioeconomic groups, but did not explain all of it. One reason for the sociodemographic differences is the time use differences. For example men and non white-collars spent more time in traffic and were therefore exposed to higher traffic related concentrations than women and white-collar employees.

The younger (25-34 years old) were more exposed to fine particles than the older. Age differences could be seen in the home indoor concentration and personal exposure, but not in home outdoor or workplace concentrations of fine particles ($PM_{2.5}$). Probably the main reason for this age difference is in time use patterns; the younger have more active life-style, e.g. spending lots of leisure time outside home in differing air pollution concentrations.

Nitrogen dioxide (NO_2) exposure is strongly related to living conditions. Especially single living adults are more exposed in small and old downtown appartments with high traffic volumes near home and sometimes also a gas-stove in use. Personal exposure differences to nitrogen dioxide were also noticed between education groups, but not for occupational status. Those having less than 14 years of education were more exposed to nitrogen dioxide than those having more education in the model adjusted with the other major determinants of NO_2 (use of a gas stove, keeping windows open, summer season, downtown home/work location, home characteristics and exposure to tobacco smoke). Nitrogen dioxide exposure at work and the time use differences may be reasons for this exposure difference between education groups. However, these factors could not be identified from the 48-hour average measurements of nitrogen dioxide in the *EXPOLIS*-study.

Perceived air pollution annoyance and associations with exposure and concern

The perceived annoyance level caused by air pollution at home in Helsinki was almost the same as measured in Sweden, but lower than in Swizerland. Women, lower socioeconomic groups, those reporting sensitivity to air pollution, and those living downtown were more annoyed by air pollution than other population groups. Concerns about regional air quality and own health seemed to increase the perceived annoyance from air pollution. Perceived annoyance from air pollution may be more important for the physical and psychological well-being of people than the measured concentrations. A large variation between the individual assessments of annoyance from air pollution was noticed. However, the population level average values appeared to be useful in the assessments of exposure-annoyance relationships.

Some 'over-sensitive' (high annoyance without high exposure) and 'unconcerned' (high exposure but low annoyance level) groups were found in comparing the association between fine particle ($PM_{2.5}$) and nitrogen dioxide (NO_2) exposure and annoyance at home between population subgroups. However, air pollution is a mixture of air pollutants. Since perceived annoyance concerns the ambient air and not some individual component of it, comparisons between annoyance levels and concentrations of a single pollutant are challenging. Besides many air pollution components are imperceptible in low concentrations. Those not employed at the moment seemed to be 'over-sensitive' (annoyed highly) compared to their nitrogen dioxide exposure in Helsinki, but more in line with their exposure to fine particles. Those sensitive to air pollution, however, were highly annoyed and more exposed to nitrogen dioxide than to fine particles. Thus it seems that both high exposure to fine particles and to nitrogen dioxide increase perceived annoyance. Those 'unconcerned' about air pollution exposure were smokers in Helsinki, who inhaled the major part of their air pollutants voluntarily. Perceived annoyance from air pollution is clearly greater concerning possible exposure that one cannot control than voluntary exposure. Dose-responsive groups were also identified, who were either less exposed and therefore less annoyed or greatly exposed and also very annoyed by air pollution, such as many of those living downtown.

Concern about air pollution and impact of media

Littering in public spaces and in the wild seemed to be the main local environmental problem for the adult Helsinki inhabitants. Assumptions about the local environment are strongly based on one's own experiences (Tulokas 1990; Suhonen 1994). Half of the Environmental Attitude Questionnaire respondents considered air pollution as the most serious local environmental problem; especially nuclear power and air pollution from traffic worried people. Women believed in their own ability to prevent air pollution more often than men and educated women in particular avoided at least sometimes driving for environmental reasons. In addition, only a quarter of the respondents thought that they could prevent being exposed to air pollution; the oldest and the less educated more often than other population sub-groups. However, every third woman and those who reported having allergic symptoms from air pollution reported avoiding going out during air pollution episodes. Those most concerned about air pollution, environmental issues in general, and their health implications seemed to be women, the older and less educated respondents in the Helsinki region.

Despite the fact that air quality in the Helsinki area has improved over the recent years mostly because emissions of industry have decreased (Hämekoski ed. 1998), surprisingly many people, especially women and the older (45-65 years old) age groups, reported noticing worsened air quality. Evaluation of the past and future is more tightly based on common knowledge of the direction of the trend than on one's own experiences and the past is usually seen as better and the future as worse than at the moment of evaluation (Suhonen 1991; Tulokas 1998). The less experience somebody has of a matter the more he or she has to rely on the information supplied by the media (Zucker 1978). Besides, the media often increase the awareness of risk (Drottz-Sjöberg & Sjöberg 1990). Observing changes in air quality is difficult, but perhaps the increased number of articles about air pollution as a local problem in Helsingin Sanomat has influenced these answers. For many readers the increased number of air pollution articles indicates the worsening of the problems rather than increased interest toward air pollution.

The news about air pollution has a greater impact on the consciousness of laymen than experts, especially women, the older and less educated, who tend to be more annoyed from and concerned about air pollution. However, based on the letters to the editor Helsinki inhabitants seem to focus their interest to the relevant issues concerning air pollution. Traffic concerned most often and after smoking it is indeed the major local ambient air pollution source that impacts our health. In addition, traffic emissions can be reduced by influencing the social decisions and regulations.

General conclusions and recommendations

More environmental social science studies and cooperation between the natural, medical and social sciences and technology is needed in environmental health studies to be able to diminish sociodemoraphic differences. While the objectives of this study were achieved for the most part, cooperation with the natural and social sciences in similar future studies should be designed from the outset also for the needs of the social sciences. Based on the results of this study, in addition to taking risk perceptions, psychological, social and cultural dimensions of risks into account in risk analysis (in communication and management steps), environmental risk assessment could provide also information of sociodemographic differences in exposures and annoyances. Since the consequences of environmental risks are not divided equally between the sociodemographic groups, this information would help in identifying its causes and focusing on risk groups.

The concern about air pollution and its health effects increased the perceived annoyance from air pollution. Exposure to air pollution (fine particles and nitrogen dioxide) does not necessarily coincide with annoyance and concern about it. While men, the younger and less educated were in average more exposed to these air pollutants, older women and less educated people were more annoyed by air pollution and concerned about it. Only the less educated were both exposed to high concentrations and very annoyed by air pollution. In other words, air pollution affects their well-being in two ways; the exposure of certain population groups is high, yet air pollution concerns other population groups even when they are not highly exposed. However, whether the sociodemographic differences in exposures to other air pollution components are similar to fine particles and nitrogen dioxide and whether the findings of sociodemographic differences in other European cities are similar to Helsinki should be studied.

Although air pollution exposure levels could be decreased in the future by new information, regulations, technological innovations, etc., it is unclear whether the sociodemographic differences would diminish. The health implications of perceived threats are unknown. This means that although exposure could be reduced, this may not reduce the impact of perceived annoyance and concern. However, further studies should concentrate on the possibilities to measure the health effects caused by perceived annoyance and concern about air pollution. Instead of the traditional division to risk assessment and risk management as separate issues, the need for deliberation has been emphasised recently, meaning the interplay between researchers, politics and public, concerning environmental risks. Only by developing a holistic view of the different dimensions of perceived risks and linking this view to traditonal risk assessment a proper risk management (policy options) is possible.

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Table I. A Comparison of Major Assumptions in the Dominant Western Worldview (DWW), Sociology's Human Exemptionalism Paradigm (HEP), and the Proposed New Ecological Paradigm (NEP). (Catton & Dunlap 1980)

	DWW	HEP	NEP
I Assumptions about the nature of human beings	People are fundamentally different from all other creatures on Earth, over which they have dominion.	Humans have a cultural heritage in addition to (and distinct from) their genetic inheritance, and thus are quite unlike all other animal species.	While humans have exceptional characteristics (culture, technology, etc.), they remain one among many species that are interdependently involved in the global ecosystem.
II Assumptions about social causation	People are masters of their destiny; they can choose their goals and learn to do whatever is necessary to achieve them.	Social and cultural factors (including technology) are the major determinants of human affairs.	Human affairs are influenced not only by social and cultural factors, but also by intricate linkages of cause, effect, and feedback in the web of nature; thus purposive human actions have many unintended consequences.
III Assumptions about the context of human society	The world is vast, and thus provides unlimited opportunities for humans.	Social and cultural environments are the crucial context for human affairs, and the biophysical environment is largely irrelevant.	Humans live in and are dependent upon a finite biophysical environment, which imposes potent physical and biological restraints on human affairs.
IV Assumptions about constraints on human society	The history of humanity is one of progress; for every problem there is a solution, and thus progress need never cease.	Culture is cumulative; thus technological and social progress can continue indefinitely, making all social problems ultimately soluble.	Although the inventiveness of humans and the powers derived therefrom may seem for a while to extend carrying capacity limits, ecological laws cannot be repealed.

Table IIa. Number of air pollution articles among articles on environmental problems in Helsingin Sanomat headline news 1951-1990 (evaluated by Heiskala's data ed. 1993).

Years	All environ. news N	Air pollution N	Proportion of air poll. %
1951-1960	101	0	0
1961-1970	116	2	1.7
1971-1980	202	2	1.0
1981-1990	272	26	9.6
Total	691	30	4.3

Table IIb. Three examples of classification of air pollution articles from Helsingin Sanomat www pages.

1) Kova tuuli sekoitti ja laimensi ilman epäpuhtaudet 05.02.1999 Kaupunki

Kova tuuli sekoitti ja laimensi tammikuussa Helsingin ilman epäpuhtaudet. Suuria saastepitoisuuksia ei muodostunut, vaikka pakkanen paukkuikin muutaman kerran kireästi. Korkeimmat ilmansaastearvot mitattiin aamuyöllä sunnuntaina 31. tammikuuta. Helsingin yhteistyövaltuuskunnan YTV:n mukaan pitoisuudet nousivat, kun kova pakkanen lauhtui nopeasti ja lämpötila kohosi lähelle nollaa. Vuosi sitten tammikuussa ilmanlaatu kävi muutaman kerran välttävän puolella. Nyt kuun lopun vaikea jakso osui viikonloppuun, jolloin liikenne on tavanomaista hiljaisempaa.

CLASSIFICATION: Article type: main air pollution**, Location in the paper:** city**, Viewpoint on the issue:** other**, Scientific orientation:** natural scientific**, Health:** not mentioned**, Geographical perspective:** local (in Finland)**, Object of the article:** man & nature**, no compounds mentioned**

2) EU:n vaatimukset ilmanlaadusta pakottavat kaupungit töihin 07.05.1998 Kotimaa
KAARINA JÄRVENTAUS

Raja-arvot tulevat voimaan 2005

BRYSSEL-Puhdas ilma on kaikille mieleen, mutta kuka pystyy haltioitumaan ilmanlaatua ohjaavista direktiiveistä? Ainakin EU:n komissiossa kaupunkiympäristöyksikköä johtava espanjalainen virkamies **Prudencio Perera**. Hän kertoo kamppailleensa vuosia saadakseen huomion tehtaiden piippujen päistä lopputulokseen, paikalliseen ilman laatuun. Kamppailun hedelmät, ilmanlaadun tytärdirektiivit ovat nyt tulossa nopeaan tahtiin ympäristöministerien käsiteltäväksi. Tänä keväänä on tarkoitus nuijia läpi rikkidioksidi, typpidioksidi, hiukkaset ja lyijy. Seuraavaksi hoidellaan otsoni, bentseeni, häkä ja pah-yhdisteet. Kahden vuoden kuluessa on selvitetty jo kadmium, arseeni, nikkeli ja elohopeakin. Ensimmäiset raja-arvot tulevat voimaan 2005. Vuosien mittaan niitä tiukennetaan asteittain. "Perustamme ehdotuksemme tuliteriin YK:n terveysjärjestön WHO:n suosituksiin", Perera selittää silmät loistaen. Tosin juuri Suomelle ongelmallisista pienistä pölyhiukkasista ei ole suositusta, koska WHO ei ole pystynyt määrittämään turvallista alarajaa. "Ei ole järkeä yrittää ratkaista kaikkia ongelmia EU:n tasolla, vaan valtion, kuntien ja kansalaisten on itse löydettävä ratkaisuja." Oleellinen osa asiaa on tiedottaminen, johon direktiivit viranomaisia patistavat. Etenkin ilmansaasteiden terveyshaitoista tuleva tieto saa kansalaiset liikkeelle, Perera uskoo. Pereran mieleen on 1994 voimaan tullut direktiivi, joka pakottaa antamaan kaupunkilaisille saastehälytyksiä tai -varoituksia otsonimäärien noustessa korkeiksi.

CLASSIFICATION: Article type: main air pollution**, Location in the paper:** national**, Viewpoint on the issue:** Man solving problems**, Scientific orientation:** social scientific**, Health:** not mentioned**, Geographical perspective:** Europe**, Object of the article:** man**, Number of compounds mentioned:** 8 (including NO2,PM)

3) Globalisaatio ja internet lisäävät köyhien tuskaa 27.5.2000 Talous
ANNUKKA OKSANEN

Amerikkalaistutkija: vauraus kasvaa, samoin saasteet ja tuloerotkin

Leikitään, että käteen jäävä kuukausipalkkasi on 10 000 markkaa. Maksat summasta vuokran, ruuan ja muut pakolliset menot. Niiden jälkeen käteen jää ehkä 3 000 markkaa. Haluat ostaa farkut. Tarkemmin sanottuna haluat dieselit tai levikset, koska olet mainoksista huomannut, että kaikilla viileillä tyypeillä on jommatkummat. Lähdetään etsimään housuja vaikka Itäkeskuksesta. Siellähän niitä on, mutta hinta on 20 000 markkaa. Höpöhöpö. Eivät farkut maksa oikeasti 20 000 markkaa. Eivät maksakaan, mutta suurimmalle osalle maailman ihmisistä merkkifarkkujen suhteellinen on hinta on 20 000 markkaa. Kun kuukausipalkka on esimerkiksi 200 markkaa, 400 markan farkut ovat tavoittamattomissa. Kuitenkin mainokset kauppaavat niitä koko ajan.

Rikkaudet eivät ole koskaan jakautuneet maailmassa tasan, mutta nykymeno eroaa entisajoista teknologian takia. Internetin ja muiden viestimien ansiosta entistä useammille köyhille on paljastunut, kuinka rikkaita rikkaat eli teollisuusmaiden asukkaat ja kehitysmaiden eliitti ovat. "Meneillään on perustavaa laatua oleva muutos", globalisaatioasiantuntija ja konsultti **Paul Laudicina** uskoo. Amerikkalaisen Laudicinan mukaan Maailman kauppajärjestön ja Kansainvälisen valuuttarahaston kokousten yhteydessä viime aikoina pidetyt mielenosoitukset kielivät laajalle levinneestä levottomuudesta. Mukana on myös huuhaa-porukkaa, mutta niitä ei voi sen takia mitätöidä. Laudicinan mukaan mielenosoituksissa tiivistyy globalisaation eli talouden maailmanlaajuistumisen paradoksi: kansa nousee barrikadeille maailmantalouden vääristymien takia, mutta se ei olisi kuullut vääristymistä ilman uutta teknologiaa ja globalisaatiota. Perjantaina Suomessa piipahtaneen Laudicinan mukaan globaalitalous on näin kylvänyt oman tuhonsa siemenet. Kansainvälisen A. T. Kearney-konsulttitoimiston globalisaatioasiantuntija kuitenkin uskoo globalisaatioon. Hyvä onkin uskoa, kun työkseen kiertää saarnaamassa aiheesta maailman bisnesjohtajille.

Globalisaation tilinpäätös jää A. T. Kearneyn tekemän selvityksen mukaan plussalle. Avoimet taloudet kasvavat suljettuja nopeammin. Lisäksi lapsikuolleisuus on vähentynyt, keskimääräinen elinikä noussut, poliittinen vapaus kasvanut ja julkiset sosiaalimeno ovat kasvaneet nopeammin kuin suljetuissa talouksissa. Haittojakin on. **Ilmansaasteet**, korruptio sekä rikkaiden ja köyhien välinen kuilu ovat kasvussa. Korruptiota seuraavan Transparency Internationalin mukaan korruptio on lisääntynyt keskimäärin 70 prosenttia maailman nopeimmin kasvavissa talouksista. Laudicina maalaa tuttua kuvaa, jossa maailmaan syntyy pieni, erittäin liikkuvainen eliitti. Siihen kuuluvat esimerkiksi intialaiset tietotyöläiset, jotka ovat nousseet amerikkalaisfirmojen johtoon. Enemmistö väestöstä jää paikoilleen ja seuraa eliitin hurjaa menoa kateellisena. Laudicinan mukaan globalisaatio on kuitenkin vähentänyt köyhyyttä maailmasta. Vuonna 1980 maailman asukkaista 1,3 miljardia ansaitsi alle kaksi dollaria päivässä. Kaksi dollaria eli noin 13 markkaa on Maailmanpankin köyhyysraja. Vuonna 1990 köyhiä oli enää 727 miljoonaa.

CLASSIFICATION: Article type: air pollution only mentioned**, Location in the paper:** the economy**, Viewpoint on the issue:** Man causing problems**, Scientific orientation:** social scientific**, Health:** not mentioned**, Geographical perspective:** global

Table IIc. Air pollution articles from Helsingin Sanomat www pages between May 1996 and July 2000.

Classification	About air pollution N=108 %	Air pollution only mentioned N=34 %	Total N=142 %
Location in the paper			
Now	5	21	8
City	35	6	28
National	18	21	18
Culture	0	9	2
International	19	9	16
The economy	8	24	12
Special pages	16	12	15
Viewpoint on the issue			
Man solving problems	36	6	29
Man causing problems	50	21	43
Natural disasters	2	0	1
Other	12	74	27
Scientific orientation			
Natural scientific	65	26	56
Social scientific	17	15	16
Other	19	59	28
Health (human effects)			
Health not mentioned	71	91	76
Health mentioned	29	9	24
Geographical perspective			
Local in Finland	42	26	38
The whole of Finland	14	24	16
Local outside of Finland	19	21	19
Europe	11	3	9
Global	12	12	12
Missing	3	15	6
Object of the article			
Man	27	na	27
Nature	19	na	19
Man & nature	28	na	28
Other	26	na	26
Number of compounds mentioned			
0	24	na	24
1-2	43	na	43
3 or more	33	na	33
Nitrogen oxides (NOx) mentioned	48	na	48
Particulate matter (PM) mentioned	37	na	37

na = not applicable

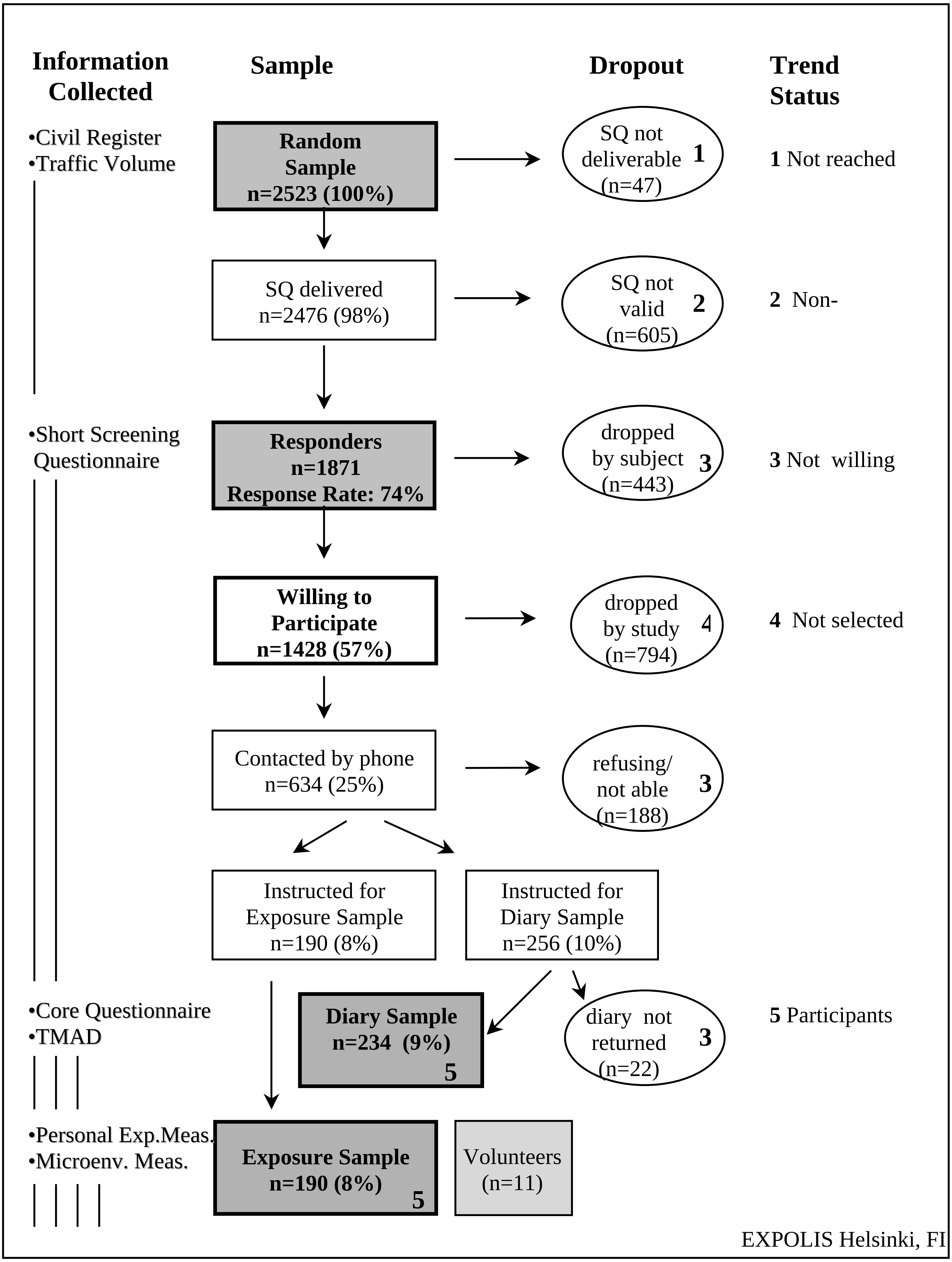


Figure I *EXPOLIS*-Helsinki – Multistage sampling process. Collected information, dropouts, resulting sizes of (sub-)samples and trend status are indicated (SQ= short screening questionnaire; TMAD= time-microenvironment-activity diary) (Oglesby et al. 2000b).

Helsinki Environmental Attitude Questionnaire: frequencies by gender

Table IIIa. What is the most serious local environmental problem (in your opinion)?

	All (N=428) %	Men (N=195) %	Women (N=233) %
No problems	4	6	3
Emissions from industry/power plants	2	1	2
Noise	7	8	5
Traffic pollution	36	38	35
Utilisation and cultivation of nature	3	3	3
Water pollution	3	3	3
Air pollution coming from the east	3	5	1
Environmental pollution	26	20	29
Air pollution	7	5	9
Pollution of a particular water system	2	2	3
Dumping areas, waste, garbage	1	2	1
Something else	1	1	2
Don't know	3	4	2
Missing	2	2	2
Total	100	100	100

Table IIIb. How much are you worried/concerned about the following environmental problems in the Helsinki Metropolitan area?

	Very concerned %	Somewhat concerned %	Not concerned %	Don't know %	Missing %	Total %
All (N=428)						
Water quality in rivers and lakes	32	58	6	0	4	100
Sea-water quality	46	48	3	1	2	100
Traffic noise	16	59	21	1	3	100
Air quality	42	49	4	1	4	100
Waste processing	9	51	34	2	4	100
Excessive building	17	42	33	3	5	100
Building of roads and motorways	14	32	47	3	4	100
Littering in public places and in the wild	46	47	5	0	2	100
Men (N=195)						
Water quality in rivers and lakes	28	56	11	1	4	100
Sea-water quality	40	52	5	0	3	100
Traffic noise	13	56	27	0	4	100
Air quality	29	59	8	1	3	100
Waste processing	6	44	44	2	4	100
Excessive building	15	36	42	2	5	100
Building of roads and motorways	7	24	62	3	4	100
Littering in public places and in the wild	41	50	6	0	3	100
Women (N=233)						
Water quality in rivers and lakes	34	59	3	0	4	100
Sea-water quality	52	44	1	1	2	100
Traffic noise	19	61	16	1	3	100
Air quality	51	41	2	0	6	100
Waste processing	12	56	25	2	5	100
Excessive building	19	48	25	4	4	100
Building of roads and motorways	19	39	34	3	5	100
Littering in public places and in the wild	51	44	4	0	1	100

Table IIIc. Have you noticed any changes in the environment which might be caused by pollution or overloading during last ten years? (circle the most important change)

	All (N=428) %	Men (N=195) %	Women (N=233) %
None	2	3	2
Pollution in general	10	12	8
Forest degradation	3	4	3
Waste in the wild	8	7	9
Polluted water systems	16	19	14
People having allergies more often	29	30	28
Changes in flora	1	1	1
Poor air quality	3	2	4
Changes in climate	6	5	6
Disappearance of animal species	1	0	1
Reduced fish population	1	0	1
Don't know	2	3	2
Missing	18	14	21
Total	100	100	100

Table IIId. Have you noticed air quality worsen in your neighbourhood during the last ten years?

	All (N=428) %	Men (N=195) %	Women (N=233) %
Yes, greatly	10	9	11
Somewhat	42	34	49
Not at all	23	32	16
Air quality improved	4	7	1
Don't know	21	18	23
Total	100	100	100

Table IIIe. One cannot do much to prevent air pollution

	All (N=428) %	Men (N=195) %	Women (N=233) %
Fully agree	6	7	5
I agree somewhat	32	36	28
Neither agree nor disagree	11	12	10
I disagree somewhat	40	39	42
I totally disagree	9	5	13
Don't know	1	1	1
Missing	1	0	1
Total	100	100	100

Table IIIf. How often do you avoid using a car for environmental reasons?

	All (N=428) %	Men (N=195) %	Women (N=233) %
Always	1	0	2
Often	10	6	13
Sometimes	32	34	31
Never	34	48	23
I do not have a car or a driver's licence	19	11	26
Don't know	3	1	4
Missing	1	0	1
Total	100	100	100

Table IIIg. I can mostly choose the way to prevent my being exposed to air pollution or not.

	All (N=428) %	Men (N=195) %	Women (N=233) %
I agree	24	20	28
I disagree	57	58	57
Don't know	18	21	14
Missing	1	1	1
Total	100	100	100

Table IIIh. How often do you avoid going out when air pollution concentrations are high (according to the air quality index in the newspaper or your own opinion)?

	All (N=428) %	Men (N=195) %	Women (N=233) %
Always	2	1	2
Often	4	2	7
Sometimes	17	11	22
Never	74	85	65
Don't know	3	1	4
Total	100	100	100

Table IIIi. What is the most serious environmental problem in Finland (in your opinion)?

	All (N=428) %	Men (N=195) %	Women (N=233) %
Environmental toxins, hazardous waste	2	1	3
Environmental pollution	37	33	41
Stratospheric ozone depletion	3	3	3
Emissions from industry	2	3	1
Dumping areas, waste, garbage	2	1	2
Air pollution coming from the east	4	4	4
Traffic pollution	1	0	2
Pollution of the atmosphere	4	4	5
Nuclear power plants, accident, waste	4	4	4
Water pollution	10	11	9
Forest degradation	1	1	1
Nuclear power plants in the east (Russia/former Soviet countries)	23	28	19
Utilisation and cultivation of nature	1	2	0
Something else	1	1	1
Don't know	2	0	3
Missing	3	4	2
Total	100	100	100

Table IIIj. Have you noticed any positive changes in the environment lately? (assign one)

	All (N=428) %	Men (N=195) %	Women (N=233) %
I have not noticed any	48	42	53
Cleaning of water systems	8	14	3
Industrial emissions decreased	2	1	2
Waste sorting, recycling	6	1	9
Better air quality	4	7	2
Environmental problems being discussed	2	1	3
Seasons changing	1	1	1
Flora, fauna, forest improved	4	6	3
Decreased noise	1	1	0
Cleaning of the environment	1	2	1
Other	2	3	1
Don't know	20	20	21
Missing	1	1	1
Total	100	100	100

Table IIIk. How worried are you about the following issues?

	The increase in traffic and its impact on the environment?			The environmental impact of industry?		
	All (N=428) %	Men (N=195) %	Women (N=233) %	All (N=428) %	Men (N=195) %	Women (N=233) %
Very dangerous for the environment	5	4	5	10	5	14
Dangerous for the environment	25	17	32	31	25	36
Somewhat dangerous for the environment	51	49	53	51	58	45
Not so dangerous for the environment	17	29	8	7	12	4
Not at all dangerous for the environment	1	1	1	0	0	0
Don't know	1	0	1	1	0	1
Total	100	100	100	100	100	100

Table IIIl. I often think how environmental pollution affects my health

	All (N=428) %	Men (N=195) %	Women (N=233) %
I agree	57	46	66
I disagree	29	39	20
Don't know	14	14	14
Missing	0	1	0
Total	100	100	100

Table IIIm. **What are the three most serious social problems at the moment in your opinion?**

	All (N=428)			Men (N=195)			Women (N=233)		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
	%	%	%	%	%	%	%	%	%
Political unrest	16	11	14	12	9	16	19	13	12
Environmental pollution	26	26	13	22	24	15	30	28	11
Unemployment	13	8	8	14	10	8	12	7	8
Government policy	1	2	4	1	2	2	0	1	5
Pollution of the atmosphere	10	12	12	12	12	8	9	12	15
Famine	4	4	7	4	3	7	4	4	7
The European Union	0	0	1	0	0	1	1	1	1
Nuclear power plants	1	5	6	0	6	4	1	4	9
The intellectual climate in Finland	2	4	5	3	3	6	2	5	4
Water pollution	4	10	9	5	10	8	3	10	9
Over population	12	8	11	14	10	12	11	7	10
Something else	2	1	3	3	1	4	1	1	2
Don't know	1	1	0	1	1	1	0	0	0
Missing	8	8	7	9	9	8	7	7	7
Total	100	100	100	100	100	100	100	100	100

Table IIIn. **Combined variable: environment mentioned among the three most serious social problems.**

	All (N=428) %	Men (N=195) %	Women (N=233) %
Environment not mentioned	15	18	13
Environment mentioned once	37	38	36
Environment mentioned twice	33	27	38
Environment mentioned three times	11	11	10
Missing	4	6	3
Total	100	100	100

Table IIIo. **How important are the following social aims in Finland (in your opinion)?**

	Very important %	Important %	Unim-portant %	Don't know %	Missing %	Total %
All (N=428)						
Increased consumption opportunities	5	27	56	6	6	100
Decreasing in consumption disparities between the poor and the wealthy	18	50	20	8	4	100
Environmental protection	63	33	1	0	3	100
Decreasing unemployment	59	38	1	0	2	100
Men (N=195)						
Increased consumption opportunities	6	33	51	6	4	100
Decreasing in consumption disparities between the poor and the wealthy	21	44	25	7	3	100
Environmental protection	53	43	2	0	2	100
Decreasing unemployment	59	39	1	0	1	100
Women (N=233)						
Increased consumption opportunities	4	22	60	7	7	100
Decreasing in consumption disparities between the poor and the wealthy	15	56	16	9	4	100
Environmental protection	71	26	0	0	3	100
Decreasing unemployment	59	38	1	0	2	100

Table IIIp. The rank order of concern about local environmental problems (in Helsinki region) (index) in 1999 and 1994.

	1999 [1] N=428	1994 [2] N=231
Sea-water quality	1. (1.45)	5. (0.89)
Littering in public places and in the wild	2. (1.43)	1. (1.48)
Air quality	3. (1.39)	2. (1.07)
Water quality in rivers and lakes	4. (1.26)	4. (0.95)
Noise from traffic	5. (0.95)	6. (0.86)
Excessive building	6. (0.83)	3. (1.03)
Waste processing	7. (0.74)	7. (0.80)
Building of roads and motorways	8. (0.64)	8. (0.74)

[1] EAQ = Environmental Attitude Questionnaire, [2] Statistics Finland, Helsinki region (Tulokas 1998)

Table IIIq. The rank order of the important social aims in Finland (index) in 2000, 1999, 1994 and 1989.

	2000[1] N=1220	1999[2] N=428	1994[3] N=820	1994[4] N=231	1989[5] N=648
Environmental protection	2. (1,51) *75%*	1. (1,64) *63%*	2. (1,58) *66%*	2. (1,64)	1. (1,70) *75%*
Decreasing unemployment	1. (1,54) *76%*	2. (1,59) *59%*	1. (1,90) *79%*	1. (1,92)	2. (1,51) *48%*
Decreasing consumption differences	3. (0,93) *40%*	3. (0,98) *18%*	3. (1,22) *30%*	3. (1,07)	3. (1,29) *29%*
Increased consumption opportunities	4. (0,75) *13%*	4. (0,42) *5%*	4. (0,79) *11%*	4. (0,82)	4. (0,51) *3%*

[1] (Lankinen & Sairinen 2000), [2] EAQ = Environmental Attitude Questionnaire, [3] (Lankinen 1995), [4] Statistics Finland, Helsinki region (Tulokas 1998), [5] (Haavisto & Lankinen 1991); percentage of those answering 'very important' in italics

APPENDIX 2

EXPOLIS
Exposure Distributions of Adult Urban Populations

KTL Ympäristöterveys

Mannerheimintie 166
FI-00300 HELSINKI
FINLAND

Tutkimusprofessori Matti Jantunen

puh. 90-458 4298
telekopio 90-4744 468

13. Toukokuuta 1996

Hyvä vastaanottaja

Teidät on valittu kansainvälisen EXPOLIS-tutkimusprojektin 2500:n henkilön otokseen. Tässä Teille kyselylomake, jonka pyydämme Teitä täyttämään ja palauttamaan. Vastauksenne on tutkimuksellemme erittäin arvokas, vaikka ette haluaisi osallistua varsinaiseen ilmansaastemittaukseen.

Expolis-hankkeessa selvitetään kuinka paljon Eurooppalaiset kaupunkiväestöt hengittävät ilmansaasteita päivittäin kotonaan, työssään, vapaa-aikanaan ja liikenteessä. Tutkimusta koordinoi Suomessa Kansanterveyslaitos. Muut mukana olevat keskukset ovat VTT-kemian tekniikka Helsingissä sekä yliopistot, kansalliset ja kansainväliset tutkimuslaitokset Kreikassa, Italiassa, Ranskassa, Sveitsissä, Alankomaissa ja Tsekin tasavallassa. (Artikkeli Helsingin Sanomissa torstaina 9.5.1996 sivu A5)

Tutkimusta tehdään elokuusta 1996 kesäkuuhun 1997. Suomessa tutkittavat on valittu satunnaisesti aikuisista Suur-Helsingin (Helsingin, Espoon, Vantaan ja Kauniaisten alueen) asukkaista. Satunnaisotoksesta (2500 henkeä) valitaan 250 henkilöä 48 tunnin ilmansaastemittaukseen ja 250 henkilöä täyttämään ajankäyttöpäiväkirjaa. Otamme erikseen yhteyttä kyseisiin 500 henkilöön jakamalla lisätietoa tutkimuksesta ja sopiaksemme 48 tunnin mittausajankohdan.

Seuraavilta sivuilta löydätte muutamia kysymyksiä kodistanne, työpaikastanne, liikkumisestanne ja joistakin muista tekijöistä. Vaikka Teitä ei valittaisi ilmansaastemittausryhmään, vastaamalla näihin muutamiin kysymyksiin parannatte tutkimuksemme laatua ja autatte meitä vähentämään ilmansaasteiden aiheuttamia terveysriskejä. Olkaa hyvä ja palauttakaa täytetty lomake maksutta oheisessa vastauskuoressa.

Kaikki antamanne tiedot käsitellään luottamuksellisesti. Henkilötietonne (nimi, osoite, puhelinnumero) hävitetään heti kun niitä ei tarvita enää mittaritutkimuksen henkilöiden valintaan ja viimeistään 31.12.1996.

Mahdollisiin tiedusteluihin vastaa Kansanterveyslaitoksen Expolis-tutkijaryhmä. Yhteyshenkilö on Tuulia Rotko p. 241 9628

Lämmintä kesää

Matti Jantunen, Tutkimusprofessori

Osoitelähde: Väestötietojärjestelmä, Väestörekisterikeskus, PL 7, 00521 HELSINKI

EXPOLIS Subject Code:
SHORT QUESTIONNAIRE

Date: ___ . ___ . ______ (dd,mm,yy)

Please circle the number of the right answer or most suitable alternative. If there are no alternatives in the question, please write the answer on the line. Write the specification as well, if asked for.

1. Marital status
   1 married or living together
   2 single
   3 divorced
   4 widowed

2. I am
   1 employed outside home
   2 entrepreneur/self-employed
   3 farmer
   4 unemployed
   5 housewife
   6 student
   7 pensioner
   8 other, what?

3. My occupation (job title) is

4. I smoke regularly (at least one cigarette, cigar, pipe per day during the last year)
   1 yes
   2 no

5. There is somebody else who smokes
   1 inside my home
   2 some other place
   3 no

6. The stove in my kitchen is heated with
   1 electricity
   2 gas
   3 wood/coal

7. Most of the time in winter when I go to work or to school/university, I spend roughly the following times covering the following distances one way by (please check everything that applies)
   1 walking or cycling ____ min ____ km
   2 motorbike or scooter ____ min ____ km
   3 car ____ min ____ km
   4 bus or tram ____ min ____ km
   5 train or metro ____ min ____ km

8. I work or study most of the time presently
   1 in my own home
   2 in one space in a building (e.g. office, service desk)
   3 in one building (e.g. school, hospital, warehouse)
   4 outdoors in one place at a time (e.g. construction site, garden, market square/street)
   5 moving in traffic (bus/lorry/taxi/delivery van driver, traffic police)
   6 I am not employed and I do not study
   7 none of the above, where?

9. The place where I work is located in a/an
   1 densely built town centre (with mixed functions)
   2 non-industrial business/service zone (offices, hospitals, educational)
   3 industrial /commercial zone
   4 high-rise suburb
   5 single family or detached housing suburb
   6 rural area (no urban zoning)
   7 mostly traffic dominated zone (streets, petrol station, airport)

10. I have strong reasons for not participating if selected in the EXPOLIS study
   1 I can probably participate
   2 I will probably not reside or work in the Helsinki area during next year
   3 I constantly travel around the country or abroad for my work
   4 I do not want to participate

11. I describe myself as a person who is particularly sensitive to
   1 noise (traffic, refrigerator, etc.)
   2 air pollution (asthma, allergy)
   3 I am not particularly sensitive

My home telephone number is
You may also call my workplace. The telephone number is

Thank you for answering these questions! You have been a great help to us.

APPENDIX 3

INSTRUCTIONS

Please read these instructions carefully before filling in the questionnaires:

1) You can fill in the Home, Commuting & Work Environment Questionnaire any time during the 48 hours of your participation in the study. However, please fill in the 48 Hour Exposure Questionnaire at the end of the study either by yourself or together with the EXPOLIS researcher when he or she visits your home.

2) Most questions are multiple choice, with a number next to each answer. Fill in the number of the correct answer in the small square provided next to the question.
e.g.:

When was your home built?___1-After 1989_______________ [2]
2-1980-1989
3-1970-1979
4-Before 1970
5-Don't know

3) Some questions include the option "*Other (please specify)*" as an answer. In such a case, fill in the number next to "*Other*" and write a brief explanation in the blank space.
e.g.:

How would you describe the building where you live?____1-A single family house [3]
2-An office/ apartment building
3-Other (please specify) [*A mobile home*]

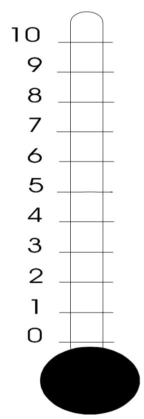
4) Some other questions ask you to "*please mark everything that applies*". Simply mark the small square provided next to each answer with an x or a ✓.
e.g.:

Does your bedroom have:_________- Wall-to-wall carpet_ [✓]
(please check everything that applies) - Other carpets/ rugs___________ [ ]
- Curtains__________ [✓]

5) In the questions that ask you to provide a number as an answer, please fill in one digit of the number in each of the squares provided.
e.g.:

What is the floor area of your home (in square metres)? [1] [1] [0]

6) Finally, in the "thermometer" questions, simply circle the number of your answer. Suppose that this is a measure of how much you are annoyed by air pollution. Zero means you are not annoyed at all and ten that you are annoyed unbearably.:



HOME, COMMUTING & WORK ENVIRONMENT QUESTIONNAIRE

I: HOME ENVIRONMENT

1) Where is your home located?_________________ 1-City/suburb centre or commercial district ______ ☐
2-Neighbourhood/suburb with mainly densely-built apartment buildings
3- Neighbourhood/suburb with mainly single family homes or apartment buildings with gardens
4- Industrial zone
5-Other (please specify) ☐

2) How would you describe the building where you live ?_________________ 1-A single family house, detached from any other house. ______________ ☐
2-A single family house, attached to one or more houses.
3-An office/ apartment building
4-A factory/industrial building
5-Other (please specify) ☐

3) Which floor is your home on? (mark 0 for ground floor) ☐☐

4) When was your home built?_________________ 1-After 1989 ________________________________ ☐
2-1980-1989
3-1970-1979
4-Before 1970
5-Don't know

5) What is the floor area of your home (in square metres)? (all rooms) ____ ☐☐☐

6) What is the height of the rooms in your home (in metres)?_______________________________ ☐,☐☐

7) What is the traffic volume in the street in front of your home during weekdays? _________ 1-Heavy/ a continuous flow of traffic ____________ ☐
2-Medium/ many cars passing by
3-Light/ a few cars every now and then

8) How often do heavy trucks and/ or buses (except trolley buses) pass along the street in front of your home during weekdays?_______ 1-Almost all the time ________________________ ☐
2-Often/ several times per day
3-Rarely/ a few times per day
4-Never

9) Does your home have a garage attached to it, leading directly inside the house? _______ 1-Yes____________________________________ ☐
2-No
3-Don't know

10) Does your home have:
(please mark everything that applies)

- Wall-to-wall carpet ☐
- Other carpets/ rugs ☐
- Curtains ☐
- Upholstered or soft furnishings ☐
- Double glazing ☐
- Linoleum floor ☐
- PVC (plastic) floor ☐
- Wood floor ☐
- Wood panelling on walls and/ or ceiling ☐
- Plasterboard walls and/ or ceiling ☐
- Chipboard walls ☐
- Wallpaper (any kind) ☐
- None of the above ☐

11) Have there been any of the following renovations/ repairs in your home in the last year?
(please mark everything that applies)

- Painting of walls/ new wallpaper ☐
- Floor repair/ polishing/ varnishing ☐
- Water/ sewage system repair ☐
- Window or door repair/ replacement ☐
- Insulation repair/ replacement ☐
- Wall construction/ removal ☐
- None of the above/ Don't know ☐

12) Have any of these renovations been caused by water damage ?

1-Yes ☐
2-No
3-Don't know

13) Is there any water damage in your home that has not been fixed ?
(signs such as scaled off paint, swollen panels, wet spots, etc.)

1-Yes ☐
2-No
3-Don't know

14) How many pets do you have at home?

- Cats ☐☐
- Dogs ☐☐
- Birds ☐☐
- Other ☐☐
(please specify) ☐

15) Including yourself, how many people in your household smoke inside your home? ☐☐

16) How much in total do the people in the previous question smoke inside the home?

- Cigarettes per day ☐☐
- Cigarillos per day ☐☐
- Cigars per week ☐☐
- Pipe tobacco (pipefuls per week) ☐☐

17) What kind of heating does your home have? (please mark everything that applies)
- District heating ☐
- Central heating (inside your building) ☐
- Single stoves/ heaters:
  - with electricity ☐
  - with gas ☐
  - with coal ☐
  - with wood ☐
  - with kerosene/ paraffin ☐
  - with fuel/ heating oil ☐
- Fire place ☐
- There is no heating
- Other (please specify) ☐

18) Does your home have? (please mark everything that applies)
- Air conditioning ☐
- A humidifier (including any humidifier built into your heating system or air-conditioning) ☐
- An electric air cleaner, ionizer or air filter ☐
- None of the above ☐

19) What do you use for cooking? (please mark everything that applies)
- Electricity (stove or microwave) ☐
- Gas ☐
- Solid fuel (coal, coke, wood, etc.) ☐
- Other (please specify) ☐
- I do not use anything for cooking at home ☐

20) Do you have a kitchen fan/ vent ?
1- Yes, a fan that filters the air and blows it back into the kitchen ☐
2- Yes, an extractor fan that I can turn on/off
3- Yes, an exhaust vent connected to the building ventilation system
4- No
5- Don't know

21) Do you use any naphthalene or other anti-moth products in your home?
1-Yes ☐
2-No ☐
3-Don't know

22) Do you use any air fresheners, such as "*local brand names*" in your home?
1-Yes ☐
2-No
3-Don't know

23) If you do use air fresheners, please give their brand names. ☐

III: WORK ENVIRONMENT

Do you presently work or study most of the time ____ ☐

1- In one room/space within a building (e.g. office, service desk, etc.)

Please go on to question 1 below

2- Moving around inside a building (e.g. school, hospital, etc.)

Please go on to question 6 on the next page

3- At home
4- Outdoors, in one place (construction worker, gardener, etc.)
5- Moving in the traffic (bus driver, delivery person, etc.)
6- Presently I am not employed/I do not study

If you answered 3, 4, 5 or 6, you have finished this questionnaire.
Do not forget to complete the 48 hour exposure questionnaire at the end of the study!

1) How many people, including yourself, ____ ☐☐
normally work in the same room/ space?

2) How many of the people in question 1, ____ ☐☐
including yourself, smoke inside this
room during working hours?

3) How much in total do the people _______________ in question 1 smoke inside this room during working hours?

- Cigarettes per day __________________ ☐☐
- Cigarillos per day __________________ ☐☐
- Cigars per week ____________________ ☐☐
- Pipe tobacco (in pipefuls per week) ____ ☐☐

4) What floor is your work space on? ☐☐
(mark 0 for ground floor)

5) Does the room/ space where you work have:
(please check everything that applies)

- Wall-to-wall carpet _______ ☐
- Other carpets/ rugs ________________________ ☐
- Curtains ___________________________________ ☐
- Upholstered or soft furnishings ______________ ☐
- Double glazing ____________________________ ☐
- Linoleum floor_____________________________ ☐
- PVC (plastic) floor__________________________ ☐
- Wood floor ________________________________ ☐
- Wood panelling on walls and/ or ceiling_______ ☐
- Plasterboard walls and/ or ceiling____________ ☐
- Chipboard walls ___________________________ ☐
- Wallpaper (any kind) _______________________ ☐
- None of the above _________________________ ☐

6) Where is your workplace located? ______________ ☐

1- City/suburb centre or commercial district
2- Neighbourhood/suburb with mainly densely

built apartment buildings
3- Neighbourhood/suburb with mainly single family homes, or apartment buildings with gardens
4- Industrial zone
5-Other (please specify) ☐

7) How would you describe the building where you work ? ☐
1-A single family house, detached from any other house.
2-A single family house, attached to one or more houses.
3-An office/ apartment building
4-A factory/industrial building
5-Other (please specify) ☐

8) What is the traffic volume in the street in front of your workplace during working hours? ☐
1-Heavy/ a continuous flow of traffic
2-Medium/ many cars passing by
3-Light/ a few cars every now and then

9) How often do heavy trucks and/ or buses (except trolley buses) pass in the street in front of your workplace during working hours? ☐
1-Almost all the time
2-Often/ several times per day
3-Rarely/ a few times per day
4-Never

10) When was the building where you work in built? ☐
1-After 1989
2-1980-1989
3-1970-1979
4-Before 1970
5-Don't know

11) Have there been any of the following renovations/ repairs in your workplace in the last year? (please mark everything that applies)
- Painting of walls/ new wallpaper ☐
- Floor repair/ polishing/ varnishing ☐
- Water/ sewage system ☐
- Window or door repair/ replacement ☐
- Insulation repair/ replacement ☐
- Wall construction/ removal ☐
- None of the above/ Don't know ☐

12) Have any of these renovations been caused by water damage ? ☐
1-Yes
2-No
3-Don't know

13) Is there any water damage in your workplace that has not been fixed ? (signs such as scaled off paint, swollen panels, wet spots, etc.) ☐
1-Yes
2-No
3-Don't know

14) What kind of heating does your workplace have?
- District heating ☐
- Central heating (inside your building) ☐

(please mark everything that applies)

- Single stoves/ heaters:
  - with electricity ☐
  - with gas ☐
  - with coal ☐
  - with wood ☐
  - with kerosene/ paraffin ☐
  - with fuel/ heating oil ☐
- Fire place ☐
- There is no heating ☐
- Other (please specify) ☐

15) Does your workplace have?
(please mark everything that applies)

- Air conditioning ☐
- A humidifier (including any humidifier built into the heating system or air-conditioning) ☐
- An electric air cleaner, ionizer of air filter ☐
- None of the above ☐

48 HOUR EXPOSURE QUESTIONNAIRE
TO BE COMPLETED AT THE END OF THE 48 HOURS OF YOUR PARTICIPATION IN THE STUDY

I: AT HOME

During the 48 hours that you participated in the study, and while you were at home:

1) How long were the following devices used ?
(please answer 0 if you do not have such a device or it was not used at all):

	Hours	Minutes
- A single stove with gas		
- A single stove with coal		
- A single stove with wood		
- A single stove with kerosene/ paraffin		
- A single stove with fuel/ heating oil		
- A fire place		
- The kitchen fan/ vent while cooking		
- The air conditioning		
- A humidifier (including any humidifier built into the heating system or air-conditioning		
- An electric air cleaner, ionizer or air filter		
- An unvented gas-fired water heater		
- An electric clothes dryer		
- An unvented gas-fired clothes dryer		
- A wood-heated sauna		
- An electric cooking stove/ microwave		
- A cooking stove with gas		
- A cooking stove with solid fuel (wood, coke, coal, etc.)		

2) Did you or someone else vacuum your home? _______________ 1-Myself ___________________________________ ☐
2-Someone else
3-Nobody did

3) Were there any cleaning/ polishing chemicals used in your home ?
(please give brand names)

4) How long were the windows open? _____ Hours ☐☐ Minutes ☐☐

II: At Your Workplace

During the 48 hours that you participated in the study, and while you were at your workplace:

1) How long were the following devices used ?
(please answer 0 if you do not have such a device or it was not used at all):

	Hours	Minutes
- A single stove with gas		
- A single stove with coal		
- A single stove with wood		
- A single stove with kerosene/ paraffin		
- A single stove with fuel/ heating oil		
- A fire place		
- The air conditioning		
- A humidifier (including any humidifier built into the heating system or air-conditioning		
- An electric air cleaner, ionizer or air filter		

2) How long were the windows open? ___________________________

3) How long did you or someone else use _______________________ a photocoping machine or a printer in the same room?

III: Various Activities

During the 48 hours that you participated in the study:

1) How long were you engaged in any of the following activities, at home, work or elsewhere?

	Hours	Minutes
- Developing/ printing photographs		
- Painting/ drawing		
- Using some kind of glue		
- Home workshop/ “do it your self”		
- Washing your car		
- At a gas station ________ filling the tank with petrol___ or diesel		
- Grilling		
- Inside a garage		
- Heavy outdoor work/ exercise (e.g. jogging, working in the garden)		
- Heavy indoor work/ exercise (e.g. being in the gym)		
- Staying inside an indoor ice hockey rink		

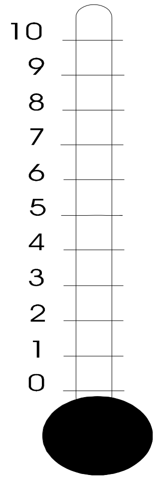
2) Did you use any deodorant, perfume, ______1-Yes ____________________________________ ☐
hair spray or after shave?
2-No
3-I don't remember

3) Did you use any clothes that have _________1-Yes ____________________________________ ☐
been dry cleaned?
2-No
3-I don't remember

IV: ANNOYANCE FROM AIR POLLUTION

1) Please mark on the thermometer scale the degree to which you felt annoyed by air pollution at home during the 48 hours that you participated in the study.

Unbearable annoyance

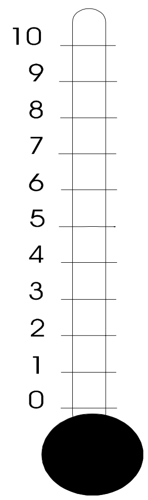


No annoyance at all

2) This annoyance consisted mostly of: ______________1-Dust _________________________________ ☐
2-Exhaust gases
3-Chemicals
4-Other
(please specify) [ ]

3) Please mark on the thermometer scale the degree to which you felt annoyed by air pollution at work during the 48 hours that you participated in the study.

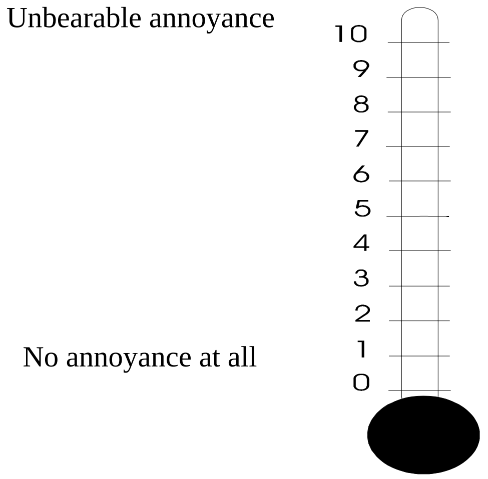
Unbearable annoyance



No annoyance at all

4) This annoyance consisted mostly of: ______________1-Dust _________________________________ ☐
2-Exhaust gases
3-Chemicals
4-Other
(please specify) [ ]

5) Please mark on the thermometer scale the degree to which you felt annoyed by air pollution <u>when commuting/ in the streets</u> during the 48 hours that you participated in the study.



6) This annoyance consisted mostly of: ______________1-Dust _________________________________ ☐
2-Exhaust gases
3-Chemicals
4-Other
(please specify) ☐

V: INSTRUMENT CASE

1) Was there any time during the 48 hours of measurement that the instrument case was not with you? ____________1-No, it was with me at all times ____________ ☐
2-Yes
From:

(date)	(time)

To:

(date)	(time)

3. How many years did you spend on your education (altogether)?
_______ years

10. Have you had wheezing or whistling when you did not have a cold in the last 12 months?
1 yes 2 no 3 don't know

11. Have you had an attack of asthma in the last 12 months?
1 yes 2 no 3 don't know

12. Do you have any nasal allergies, including hay fever?
1 yes 2 no 3 don't know

☺ Thank you for your participation in the EXPOLIS study ☺

EXPOLIS Exposure Distributions of Adult Urban Populations

Time-Location-Activity-Diary

Subject-Code: _________________

Begin:Date: ___ . ___ . ______ (dd, mm, yy) Time: ___. ___. (hh, min.)

End: Date: ___ . ___ . ______ (dd, mm, yy) Time: ___. ___. (hh, min.)

Definitions:

LOCATIONS:

Places you are staying at within a certain period of 15 minutes.

IN TRANSFER

When you move from one place to another, including going for a walk or making some roundtrip.

Walk/bike:	when you walk or bike from one place to another
Motorcycle:	when you go on a motorbike from one place to another
Car/Taxi:	when you drive or are driven from one place to another inside a private car, a taxi, a van or truck
Bus/Tram :	when you travel from one place to another using a public bus or tram
Metro/Train:	when you travel from one place to another using the metro or a train

NOT IN TRANSFER

When you stay for some time within the same place (including going around within this place)

Home:	**In(side):**	all rooms in the house or appartment where you live
	Out(side):	outdoor locations belonging to your home as garden/balcony/yard
Work:	**In(side):**	all closed indoor-spaces of work where you are usually working
	Out(side):	open air locations where you are usually working
Other:	**In(side):**	any closed indoor-spaces other than home or work, including shopping, cinema, restaurants, theaters, sport hall, staying at homes of friends etc.
	Out(side):	all stays in open air which are not a transfer and not outside at home or work, including staying in a park, at a sport ground, in a garden-café, etc.

ACTIVITIES:

If one of the following events happens during a certain period of 15 minutes.

Cooking:	when you are inside a kitchen and the stove is on, also if someone else is cooking
Smoking, self:	when you smoke a cigarette, cigar, pipe etc.
Smoking, same room:	when somebody near you, *inside a closed space*, smokes a cigarette, cigar, pipe etc.

INSTRUCTIONS

Please read attentively these instructions before you start filling in the diary!

- o fill in the diary 3 to 5 times per day, e.g. in the morning when you arrive at work, at noon, coming back home, before sleeping.
- o to remember the sequence of events, you can briefly describe your activities or the location you are staying at. However, this is not mandatory
- o cross the bubbles ☒
- o for each 15 minutes, cross *at least* one LOCATION. Cross the activity which applies.
- o if within 15 minutes you stay in several locations or if more than one activity applies, cross all of them
- o if you stay for more than 15 min. at the same location or activity, connect the bubbles with lines

EXAMPLE:

Date: ____________			**LOCATION**											**ACTIVITIES**		
Time		Briefly Describe Activity	IN TRANSFER					NOT IN TRANSFER						COOK-ING	SMOKING	
			walk bike	motor-cycle	car taxi	bus tram	metro train	home in	home out	work in	work out	other in	other out		self	same room
8	0		❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	X	❍	❍
	15		❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍	❍	❍
	30		❍	❍	X	❍	❍	X	X	❍	❍	❍	❍	❍	❍	❍
	45		❍	❍	X	❍	❍	❍	❍	❍	X	❍	❍	❍	❍	❍
9	0		❍	❍	❍	❍	❍	❍	❍	❍|	X	❍	❍	❍	❍	❍
	15		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	30		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	45		❍	❍	❍	❍	❍	❍	❍	❍|	X	❍	❍	❍	X	❍
10	0		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	15		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	30		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	45		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
11	0		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	15		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	30		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	45		❍	❍	❍	❍	❍	❍	❍	❍|	X	❍	❍	❍	❍	❍
12	0		❍	❍	❍	❍	❍	❍	❍	❍	❍	X	❍	❍	❍	X
	15		❍	❍	❍	❍	❍	❍	❍	❍	❍	X	❍	❍	❍	X
	30		❍	❍	❍	❍	❍	❍	❍	❍|	X	❍	❍	❍	❍	❍
	45		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
13	0		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	15		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	30		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	45		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
14	0		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	15		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	30		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍
	45		❍	❍	❍	❍	❍	❍	❍	❍|	❍	❍	❍	❍	❍	❍

EXPOLIS
Exposure
Distributions
of Adult Urban
Populations

Kansanterveyslaitos
Ympäristöterveys
PL 95
70701 KUOPIO

1. Joulukuuta 1998

Hyvä vastaanottaja

Kansanterveyslaitos tekee tutkimuksen, jossa kysytään kansalaisten mielipiteitä erilaisista ympäristöasioista. Tämä kyselytutkimus täydentää Expolis-ilmansaastetutkimuksen tuloksia. Expolis- hankkeessa selvitetään, kuinka paljon Eurooppalaiset kaupunkiväestöt hengittävät ilmansaasteita päivittäin kotonaan, työssään, vapaa-aikanaan ja liikenteessä.

Kyselytutkimus lähetetään noin 1000:lle pääkaupunkiseudun asukkaalle. Te olette yksi väestörekisteristä satunnaisesti poimittu henkilö. Vastauksenne on tärkeä, jotta erilaisista ympäristökäsityksistä saadaan riittävän laaja kuva. Tietoja käsitellään ehdottoman luottamuksellisesti, eivätkä yksittäiset vastaukset tule esille tuloksissa.

Seuraavilta sivuilta löydätte ympäristöasioihin liittyviä kysymyksiä. Vastaamalla näihin muutamiin kysymyksiin parannatte tutkimuksemme laatua ja autatte meitä vähentämään ilmansaasteiden aiheuttamia terveysriskejä. Olkaa hyvä ja palauttakaa täytetty lomake maksutta oheisessa vastauskuoressa mahdollisimman pian.

Mahdollisiin tiedusteluihin vastaa Kansanterveyslaitoksen Expolis-tutkijaryhmä. Yhteyshenkilö on Tuulia Rotko puh. 191 23884.

Yhteistyöstä etukäteen kiittäen

Tutkimuksen johtaja

Matti Jantunen

Osoitelähde: Väestötietojärjestelmä, Helsingin maistraatti, PL 309, 00181 HELSINKI

APPENDIX 5

EXPOLIS
Exposure
Distributions
of Adult Urban
Populations

Kansanterveyslaitos
Ympäristöterveys
PL 95
70701 KUOPIO

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11. Tammikuuta 1999

Hyvä vastaanottaja

Kansanterveyslaitos tekee tutkimuksen, jossa kysytään kansalaisten mielipiteitä erilaisista ympäristöasioista. Tämä kyselytutkimus täydentää Expolis-ilmansaastetutkimuksen tuloksia. Expolis- hankkeessa selvitetään, kuinka paljon Eurooppalaiset kaupunkiväestöt hengittävät ilmansaasteita päivittäin kotonaan, työssään, vapaa-aikanaan ja liikenteessä.

Kyselytutkimus lähetetään kaikille Expolis-tutkimuksessa mukana olleille suomalaisille ja lisäksi 600:lle pääkaupunkiseudun asukkaalle. Expolis-tutkimuksessa mukana olleena teidän vastauksenne on erityisen arvokas, jotta erilaisista ympäristökäsityksistä saadaan riittävän laaja kuva. Tietoja käsitellään ehdottoman luottamuksellisesti, eivätkä yksittäiset vastaukset tule esille tuloksissa.

Seuraavilta sivuilta löydätte ympäristöasioihin liittyviä kysymyksiä. Vastaamalla näihin muutamiin kysymyksiin parannatte tutkimuksemme laatua ja autatte meitä vähentämään ilmansaasteiden aiheuttamia terveysriskejä. Olkaa hyvä ja palauttakaa täytetty lomake maksutta oheisessa vastauskuoressa mahdollisimman pian.

Mahdollisiin tiedusteluihin vastaa Kansanterveyslaitoksen Expolis-tutkijaryhmä. Yhteyshenkilö on Tuulia Rotko puh. 191 23884.

Yhteistyöstä etukäteen kiittäen

Tutkimuksen johtaja

Matti Jantunen

Osoitelähde: Väestötietojärjestelmä, Helsingin maistraatti, PL 309, 00181 HELSINKI

Helsinki Environmental Attitude Questionnaire: questions and frequencies

ID-number	Identification number of the participant
Date	Date of answer

PART I:

A) Importance of environmental problems

1. What is the most serious, second most serious and third most serious social (societal) problem at the moment in your opinion?

	Most serious	2nd most serious	3rd most serious
0 none	1	2	3
1 political unrest	1	2	3
2 environmental pollution	1	2	3
3 unemployment	1	2	3
4 government policy	1	2	3
5 pollution of the atmosphere	1	2	3
6 famine	1	2	3
7 the European Union	1	2	3
8 Don't know	1	2	3
9 nuclear power plants	1	2	3
10 The intellectual climate in Finland	1	2	3
11 water pollution	1	2	3
12 over population	1	2	3
13 something else_______________________	1	2	3

2. How important are the following social aims in Finland (in your opinion)?

	very important	important	unimportant	don't know
Increased consumption opportunities	1	2	3	4
Decreased consumption disparities between the poor and the wealthy	1	2	3	4
Environmental protection	1	2	3	4
Decreasing unemployment	1	2	3	4

3. What is the most serious environmental problem in Finland (in your opinion)?
    - 0 none
    - 1 environmental toxins, hazardous waste
    - 2 environmental pollution
    - 3 stratospheric ozone depletion
    - 4 emissions from industry
    - 5 dumping areas, waste, garbage
    - 6 air pollution coming from the east
    - 7 traffic pollution
    - 8 pollution of the atmosphere
    - 9 nuclear power plants, nuclear accidents, nuclear waste
    - 10 water pollution
    - 11 forest degradation
    - 12 nuclear power plants in the east (Russia/former Soviet States)
    - 13 utilization and cultivation of nature
    - 14 something else____
    - 15 don't know

4. What is the most serious local environmental problem (in your opinion)?
   0 none
   1 emissions from industry/power plants
   2 noise
   3 traffic pollution
   4 utilization and cultivation of nature
   5 water pollution
   6 air pollution coming from the east
   7 environmental pollution
   8 air pollution
   9 pollution of a particular water system
   10 dumping areas, waste, garbage
   11 something else____
   12 don't know

B) Concern about the environment and air quality

5. How much are you worried/concerned about the following environmental problems in the Helsinki Metropolitan area?

	very concerned	somewhat concerned	not concerned	don't know
Water quality in rivers and lakes	1	2	3	4
Sea-water quality	1	2	3	4
Noise from traffic	1	2	3	4
Air quality	1	2	3	4
Waste processing (collecting, transportation, dumping areas, sewage)	1	2	3	4
Excessive building	1	2	3	4
Building of roads and motorways	1	2	3	4
Littering in public spaces and in the wild	1	2	3	4

6. I often think about how environmental pollution affects my health
   1 I agree
   2 I disagree
   3 don't know

7. How worried are you about the increase in traffic and its impact on the environment?
   1 very dangerous for the environment
   2 dangerous for the environment
   3 somewhat dangerous for the environment
   4 not so dangerous for the environment
   5 not at all dangerous for the environment
   6 don't know

8. How worried are you about the environmental impact of industry?
   1 very dangerous for the environment
   2 dangerous for the environment
   3 somewhat dangerous for the environment
   4 not so dangerous for the environment
   5 not at all dangerous for the environment
   6 don't know

C) Perceived changes in environment and in air quality

9. Have you noticed any changes in the environment which might be caused by pollution or overloading during the past ten years? (circle the most important change)
   0 none
   1 pollution in general
   2 forest degradation
   3 waste in the environment
   4 polluted water systems
   5 people having allergies more often
   6 changes in flora
   7 poor air quality
   8 climatic changes
   9 disappearance of animal species
   10 reduced fish population
   11 don't know

10. Have you noticed any positive changes in the environment lately? (assign one)
   0 none
   1 yes, please specify ____
   2 don't know

12. Have you noticed air quality worsening in your neighbourhood during the past ten years?
   1 yes, greatly
   2 somewhat
   3 not at all
   4 air quality has got better
   5 don't know

D) One’s own ability to influence air pollution

13. One cannot do much to prevent air pollution
   1 fully agree
   2 I agree somewhat
   3 neither agree nor disagree
   4 I disagree somewhat
   5 I completely disagree
   6 don't know

14. I can, through my own actions, strongly influence my exposure to air pollutants
   1 I agree
   2 I disagree
   3 don't know

E) Your own and your family's health

15. Do you or someone in your family have any respiratory disease, allergy, or asthma? (K15a)
    1 yes → (K15b)
    2 no
    3 don't know

    (K15b) 1 I have
    2 someone else
    3 I and someone else

16. Which one of the following alternatives best describes your current health?
    1 very good
    2 good
    3 moderate
    4 bad
    5 very bad
    6 don't know

17. Do you have a chronic disease, disability or handicap?
    1 yes
    2 no

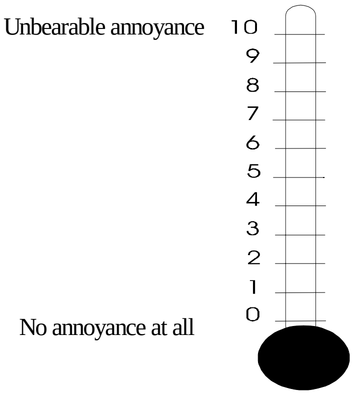
F) Behaviour

18. How often do you avoid going out when air pollution concentrations are high (according to the air quality index in the newspaper or your own opinion)?
    1 always
    2 often
    3 sometimes
    4 never
    5 don't know

19. How often do you avoid using a car for environmental reasons?
    1 always
    2 often
    3 sometimes
    4 never
    5 I do not have a car or a driver's licence
    6 don't know

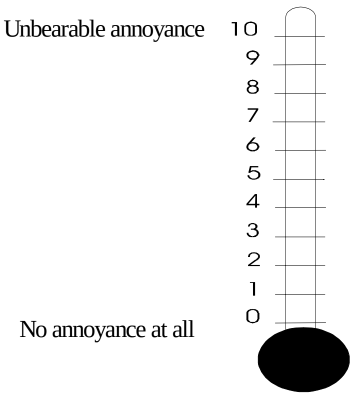
G) Annoyance from air pollution

20. To what degree did you feel annoyed by air pollution at home today?



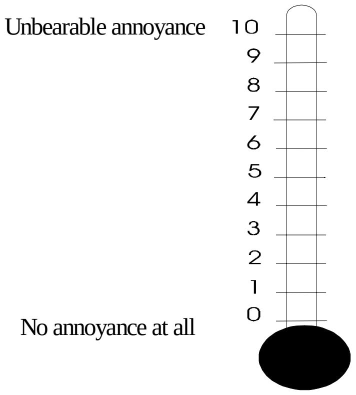
21. This annoyance consisted mostly of
    1 dust
    2 exhaust gases
    3 chemicals
    4 tobacco smoke
    5 other (please specify)

22. To what degree did you feel annoyed by air pollution at work?



23. This annoyance consisted mostly of
    1 dust
    2 exhaust gases
    3 chemicals
    4 tobacco smoke
    5 other (please specify)

24. To what degree did you feel annoyed by air pollution when commuting/ in the streets?



25. This annoyance consisted mostly of
    1 dust
    2 exhaust gases
    3 chemicals
    4 other (please specify)
    5 dust and exhaust gases

PART II: Background information (EXPOLIS SHORT QUESTIONNAIRE)

1. Where is your home located?
   1 City/suburban centre or commercial district
   2 Neighbourhood/suburban mainly with densely-built apartment buildings
   3 Neighbourhood/suburban mainly with single family homes or apartment buildings with gardens
   4 Industrial zone
   5 Other (please specify)

2. How would you describe the building where you live?
   1 Single family house, detached from any other house
   2 Single family house, attached to one or more houses
   3 Office/ Apartment building
   4 Other (please specify)

3. The household that I live in consists of (including myself)
   _______ adults (18 years or more) _______ children (less than 18 years)

4. The size of my residence is (m^2) ________

5. Marital status
   1 married or living together
   2 single
   3 divorced
   4 widowed

6. Occupational status
   1 employee
   2 self-employed
   3 farmer
   4 unemployed
   5 housewife/househusband
   6 student
   7 retiree

7. Occupation (job title) ____

8. How many years did you spend on your education (altogether)? _______ years

9. Are you a regular smoker (at least one cigarette or cigar per day for the last year)?
   1 yes
   2 no

10. Does someone else in your household smoke?
   1 yes, indoors
   2 yes, but not indoors
   3 no

11. Today (last working day) when I went to work or to school/university, I spent roughly the following time one way by (please mark everything that applies):

	from home to work (t)	from work to home (k)
1 walking or cycling	______ min ____km	______ min ____km
2 motorbike or scooter	______ min ____km	______ min ____km
3 car	______ min ____km	______ min ____km
4 bus or tram	______ min ____km	______ min ____km
5 train or metro	______ min ____km	______ min ____km

12. I work or study most of the time presently:

1 in one space in a building (e.g. office, service desk)
2 in one building (e.g. school, hospital, warehouse)
3 in my own home
4 outdoors in one place at the time (e.g. construction site, garden, market square/street)
5 moving in traffic (e.g. bus/lorry/taxi/delivery van driver, traffic police)
6 many places
7 I am not employed and do not study at the moment

13. Where is your workplace?

1 Centre of Helsinki
2 Commercial/service district
3 Industrial zone
4 Neighbourhood/suburban mainly with densely-built apartment buildings
5 Neighbourhood/suburban mainly with single family homes or apartment buildings with gardens
6 In the countryside
7 In a traffic-dominated area
8 I am not employed and do not study at the moment

14. I describe myself as someone who is sensitive to:

1 noise (traffic, refrigerator, etc.)
2 air pollution (asthma, allergy)
3 I am not particularly sensitive

Thank you very much for your collaboration!

EXPOLIS
Exposure Distributions of Adult Urban Populations

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____.____.____

Hyvä vastaanottaja

Kiitos lupauksestanne osallistua Expolis-tutkimuksen kahden vuorokauden ilmansaastemittaukseen. Kotiinne tuodaan sisään ja ulos (pihalle tai parvekkeelle) kiinteät mittalaitteet, jotka ovat noin stereokaiuttimen kokoisia laatikoita. Ne mittaavat ilman pienhiukkasia sekä haihtuvia orgaanisia yhdisteitä. Vastaavanlainen mittalaite asetetaan myös työpaikallenne, jos mahdollista. Nämä mittalaitteet toimivat automaattisesti, joten niihin ei tarvitse kiinnittää huomiota mittausjakson aikana. Toivomme, että mittalaitteiden pumppujen hurinasta ei ole Teille liikaa häiriötä.

Mittausjakson ajan teidän tulisi pitää mukananne henkilökohtaista mittauslaitteistoa, joka on pakattu alumiinisalkkuun. Laitteisto painaa n. 3,5 kg. Halutessanne saatte käyttöönne repun, jossa salkkua on helppo kantaa. Salkun mittalaitteistolla mitataan ilmasta samoja ilmansaasteita kuin kiinteilläkin mittalaitteilla. Lisäksi salkussa on häkämittari.

Tutkimuksessa kerätään Teidän avullanne tietoa siitä, mille ilmansaasteille pääkaupunkiseudun asukkaat altistuvat, ja missä ympäristöissä altistuminen tapahtuu. Tätä varten pyydämme Teitä täyttämään ajankäyttöä kuvaavaa lomaketta mittausjakson ajan, sekä mittausjakson lopuksi kyselylomakkeen, jossa on kysymyksiä liittyen ajankäyttöönne ja elinympäristönne mahdollisiin epäpuhtauslähteisiin.

Kaikki Teitä koskevat tiedot käsitellään luottamuksellisesti, ja henkilötietonne (nimi, osoite, puhelinnumero) hävitetään viimeistään kuukauden kuluttua mittauksesta.

Koska ilmansaastemittalaite on tarkoitus asettaa myös työpaikallenne, tulee myös työnantajanne olla tietoinen tutkimuksesta. Siksi pyydämmekin Teitä ystävällisesti toimittamaan oheisen kirjeen työnantajallenne mahdollisimman pian.

Kiitämme Teitä osallistumisestanne. Tällä kahden vuorokauden mittaisella vaivannäöllänne on suuri merkitys tutkimukselle, jolla pyritään vähentämään ilman saasteiden terveyshaittoja Euroopassa.

Sovittu mittausajankohtanne on ____, ja tapaamme siis kotonanne/työpaikallanne ______________________________________. Kerron tällöin tarkemmin ajankäyttöpäiväkirjan täyttämisestä, salkun kantamisesta ja muista mittaukseen liittyvistä tärkeistä asioista. Jos sitä ennen ilmenee jotain kysyttävää, voitte soittaa minulle numeroon 4744 778.

Terveisin

EXPOLIS
Exposure Distributions of Adult Urban Populations

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____.____.____

Hyvä vastaanottaja

Teidät on valittu Expolis-tutkimusprojektin 250 henkilön satunnaisotokseen täyttämään ajankäyttöpäiväkirjaa kahden vuorokauden ajaksi.

Aikaisemmissa ilmansaastetutkimuksissa on mittauksia tehty vain kiinteissä mittapisteissä. Ihmisten henkilökohtaista altistusta ilman epäpuhtauksille on tutkittu hyvin vähän. Arvioidessa väestön altistumista tarvitaan tietoa väestön ajankäytöstä. Ajankäyttöpäiväkirjojen avulla selvitämme pääkaupunkiseudun aikuisväestön ajankäyttöjakaumaa erilaisissa ympäristöissä eri vuorokaudenaikoina.

Pyydämme teitä siis täyttämään erityistä päiväkirjalomaketta muutamia kertoja päivässä kahden vuorokauden ajan. Ajankäyttöpäiväkirjojen avulla saamme tietoa esim. siitä, miten paljon ihmiset viettävät aikaa kotona, työssä tai liikenteessä. Mittausjakson lopuksi täytetään lisäksi kyselylomake, jossa on lyhyitä kysymyksiä ajankäyttöönne ja elinympäristönne mahdollisiin epäpuhtauslähteisiin liittyen.

Vaikka teiltä ei varsinaisesti mitata mitään, olette tärkeässä asemassa tutkimuksessamme, koska teidän täyttämänne ajankäyttöpäiväkirjan ja kyselylomakkeen avulla saamme riittävän edustavan otoksen aikuisväestön ajankäytöstä ja altistumisolosuhteista.

Kaikki Teitä koskevat tiedot käsitellään luottamuksellisesti, ja henkilötietonne (nimi, osoite, puhelinnumero) hävitetään viimeistään kuukauden kuluttua ajankäyttöpäiväkirjan täyttämisestä.

Tarvittavat kaavakkeet sekä yksityiskohtaiset ohjeet niiden täytöstä saatte sovitussa tapaamisessamme ____ kotonanne/ työpaikallanne.

Jos Teillä on sitä ennen jotain kysyttävää tutkimukseen liittyen, voitte soittaa minulle numeroon 4744 778.

Suuret kiitokset osallistumisestanne!

EXPOLIS-SALKUN KÄYTTÖOHJE

Salkun avulla mitataan ilman epäpuhtauksia siitä samasta ilmasta, jota hengitätte. Tällöin saamme mitattua henkilökohtaisen altistuksenne, josta ilman saasteiden aiheuttamat terveyshaitat nimenomaan johtuvat. Siksi on erittäin tärkeää, että pidätte salkun **aina mukananne**.

Salkussa olevilla mittareilla mitataan ilmasta häkäpitoisuutta, haihtuvien orgaanisien yhdisteiden pitoisuuksia, sekä pienhiukkaspitoisuutta. Hiukkasia kerätään salkussa kahdelle eri suodattimelle. Toista suodatinta käytetään työpäivän aikana, toista muuna aikana. Teidän tulee siis vaihtaa suodatinta kolme kertaa mittauksen aikana. Suodattimen vaihtojen ajankohdat kirjataan tarkoitukseen varattuun lomakkeeseen eli mittauspöytäkirjaan. Suodattimen vaihtaminen on nopea ja yksinkertainen toimenpide. Opetamme sen teille käyntimme aikana.

Sisätiloissa salkku tulisi pitää esim. pöydällä tai tuolilla samassa huoneessa, jossa oleskelette. Asettakaa salkku mahdollisimman lähelle itseänne. Lattialla salkkua ei tule säilyttää. Vaihtaessanne huonetta salkun tulisi seurata mukananne, esim. työpaikalla kokouksiin, kahvitauolle ja tupakkatauolle, kotona keittiöön, makuuhuoneeseen, parvekkeelle jne. Jos salkun ääni häiritsee yöuntanne, siirtäkää salkku yöksi viereiseen huoneeseen, ja mainitkaa asiasta ajankäyttöpäiväkirjassanne.
Salkkua ei tarvitse ottaa mukaan käydessä toisessa huoneessa pikaisesti, kuten mennessänne avaamaan ovea, kysyessänne viereisen huoneen työtoverilta lyhyttä kysymystä tai poiketessanne WC:hen tai kylpyhuoneeseen.

Liikkuessa salkkua tulisi kantaa kädessä, olkahihnan avulla tai salkun omassa repussa. Julkisissa kulkuneuvoissa salkkua voi kantaa kuten liikkuessa, tai pitää sitä sylissä tai viereisellä istuimella. Autolla ajaessa salkku tulee kiinnittää istuimelle turvavyön avulla, jotta se ei aiheuttaisi vahinkoa mahdollisessa äkkijarrutuksessa. Turvallisuussyistä salkkua ei missään tapauksessa saa asettaa auton takaikkunalle.

Erityisen tärkeää on pitää salkkua lähettyvillänne, kun saatatte erityisesti altistua ilmansaasteille esim. autoa tankatessa, ruokaa grillatessa, liimoja, maaleja ja muita liuottimia käsitellessä tai vaikkapa hiuslakkaa suihkuttaessa. Muistakaa pitää salkku mukananne myös vapaa-aikananne, esim. tenniskentällä (kentän laidalla), aerobic-tunnilla (seinän vierellä), hiihtolenkillä (repussa), ravintolassa (tuolilla tai pöydällä), elokuvissa (sylissänne) jne.

Jos salkku syystä tai toisesta ei kuitenkaan ole ollut aina mukananne ylläolevien ohjeiden mukaisesti, pyydämme teitä mainitsemaan asiasta ajankäyttöpäiväkirjassanne.

KTL/EXPOLIS/EU IV Environment and Climate contract No°ENV4-CT96-0202(DG12-DTEE)

Customer Procedure - Exposure Customers

Identification code: SOP Expolis / KTL-I-1.1	APPROVALS
❑ Full SOP ❑ Working SOP # pages____	Coordinator:__/__/__ _______________
Issue Date: ___/___. _________	QAU: __/__/__ ____________________
Revision No: Revision date: ___/___. _________ Revision description:	Coordinator: QAU:
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Revision No: Revision date: ___/___. _________ Revision description:	Coordinator: QAU:

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KTL Helsinki				
University of Athens				
University of Basel				
RIVM Bilthoven				
University of Grenoble				
VTT Helsinki				
University of Milan				
PIAS Prague				

CUSTOMER PROCEDURE - EXPOSURE CUSTOMERS

1.0 Purpose and Applicability

This SOP outlines the researcher's responsibilities in public contact and behavior with Exposure customers. The purpose of this SOP is also to describe basic pre- and post-field visit activities and standards which are expected of every researcher. The procedure applies to all Staff who interact with the customers of the Air Pollution Exposure Distributions within Adult Urban Populations in Europe (Expolis) European multicenter project consortia.

2.0 Definitions

Customer: A person participating in the Expolis study as a study subject.
Exposure customer: Customer participating in both exposure and TLAD measurement.

Customer file: All customer data sheets including all data collected from the customer during the measurement.

Customer ID: Each Customer is uniquely identified by Expolis identification code.

Measurement period: 48 hours customer measurement.

MEM sampler: Microenvironmental sampler used to collect $PM_{2.5}$ and VOC samples.
I-MEM sampler: MEM sampler positioned in customers home.
O-MEM sampler: MEM sampler positioned outside customers home.
W-MEM sampler: MEM sampler positioned in work place.

Paper database: Collection of all customer files.

PC database: The computerized Expolis database into which data is entered according to the Expolis Data Procedures.

PEM sampler: Personal exposure sampling case, carried by the customer.

Questionnaires: The Home, Commuting & Work Environment Questionnaire and the 48 Hour Exposure Questionnaire

Short Questionnaire: The mailed questionnaire (three different versions)

SOP: Standard Operating Procedure, which must be prepared revised, distributed and applied with full SOP formalities.

TLAD: Time Location Activity Diary

3.0 References

The development of this SOP is based on

3.1 SOP # UA-T-1.0 (February 1995) developed in University of Arizona for the U.S. EPA NHEXAS project

3.2 SOP # UA-T-3.0 (February 1995) developed in University of Arizona for the U.S. EPA NHEXAS project

3.3 SOP Expolis / KTL-G-1 (* (Preparation of Standard Operating Procedures)
3.4 SOP Expolis / KTL-F-1 (MEM Sampler Positioning & PEM Sampler Carrying)
3.5 SOP Expolis / KTL-F-2 ($PM_{2.5}$ PEM Sampling)
3.6 SOP Expolis / KTL-F-3 ($PM_{2.5}$ MEM Sampling)
3.7 SOP Expolis / VTT-F-4 (VOC sampling)
3.8 SOP Expolis / KTL-F-5 (CO Monitoring)
3.9 SOP Expolis / ETHZ-L-5 ($PM_{2.5}$ Teflon-Filter Analysis)
3.10 SOP Expolis / UoA-I-3 (Home, Commuting & Work Environment Questionnaire
Forty Eight Hour Exposure Questionnaire)
3.11 SOP Expolis / UoB-I-4 (Time-Location-Activity-Diary: Instructions for Field Workers)

3.12 Expolis Data Procedures

*) This statement refers to the latest SOP revision available. Make sure that you know and have it.

4.0 Discussion

This SOP outlines generalities in the training of researchers. Pre- and post-field visit activities and on-site data collection standards. The goal of field visit activities within the Expolis study is to collect accurate and comparable information regarding personal exposure to air pollutants from the customers in the study. Data retrieval and handling are the primary job responsibilities of all researchers. Researchers are expected to execute their responsibilities in an exhaustive and comprehensive fashion in accordance with the stated protocol. The researcher's methods of contact with the public is very important area of consideration in the gathering of good data.

Respect for Customers: The information sought is respectfully requested of the environment of the customer as a gift of time and information. Most respondents will recognize the occasion as an opportunity to contribute to the efforts being made to improve the environment in the community. This gift should be given and received in dignity; it must not be demanded nor obtained by coercion. Remember, a refusal to provide information is the prerogative of the Customer; it is not a personal affront, but the expression of a fundamental human right.

5.0 Responsibilities

5.1 The Coordinator is responsible for the final review and approval of this SOP.

5.2 Local Principal Investigator is responsible that any new version of this SOP will be made available to all members of the project team, according to the SOP Expolis / KTL-G-1 (Preparation of Standard Operating Procedures).

5.3 All members of the project team are responsible for working according to this SOP and reporting any local and/or temporal deviations and/or changes of it, according to the SOP Expolis / KTL-G-1 (Preparation of Standard Operating Procedures).

5.4 Tuulia Rotko from the Expolis Centre in Helsinki is responsible for the contents of this SOP.

6.0 Equipment and Materials

6.1 Equipment

- GSM Phone, Nokia 1610 (customer) and Nokia 2110 (researcher)
- PEM sampler
- MEM samplers
    - I-MEM sampler
    - O-MEM sampler
    - W-MEM sampler
- Pocket Hygro-Thermometer, Extech model 445922

6.2 Materials

- Card with contact information of the researcher and the customer ID for needs of further contact
- *Customer Information Sheet* (Name, phone number and address (home, workplace) of the customer)(Figure 3, page 13)
- Customer instructions for PEM sampler and GSM phone
- Extra Short Questionnaire, if needed (See 7.1.1 page 5)
- *MEM Location Description Sheet* (SOP Expolis / KTL-F-1; Figure 1)
- *MEM Sheet* (SOP Expolis / KTL-F-3; Figure 8)
- *PEM Sampling Times Sheet* (Figure 1, page 11)
- *PEM Sheet* (SOP Expolis / KTL-F-2; Appendix 2)
- Pen or pencil
- Questionnaires (SOP Expolis / UoA-I-3; Appendix 1)
- ‘Request of the results’ -paper (Figure 2, page 12)
- TLAD (SOP Expolis / UoB-I-4; Appendix 1)

7.0 Procedure

A) Pre-field standards expected of all researchers include punctuality, professionalism, safety and reliability. The nature of this research project requires flexibility and researchers must be prepared to respond to a variety of sampling environments.

B) In-field QC checks of data and method are the responsibility of all field researchers. Every form, questionnaire, sample and data item collected must be labeled with the customer ID, type of sample, date of collection, time of collection and researcher's initials at a minimum.

7.1 Preparation

7.1.1 Phoning

The customer will be contacted by telephone call at least one week before the assumed measurement period. The measurement period should be two consecutive weekdays. Before calling the customer check through the information about the customer from the mailed questionnaire (PC database). Print this information about the customer as a *Customer Information Sheet.* If there are some questions without an answer, ask them on the phone. If the customer is not employed, skip questions 4, 5 and 6. When reaching the eligible customer and after proper introduction, ask her/him the following questions and mark the answers into the blank space of the *Customer Information Sheet* and also into the PC database according to the Expolis Data Procedures:

1) Acceptance of the customer to participate the study.
2) Is the proposed measurement time suitable for the customer?
   If not, ask her/him a better suiting time.
3) Tell her/him that the visit at her/his home will take 30...45 minutes.
4) Ask if the customer or somebody else is smoking in her/his home and/or workplace.
   If yes, provide 47 mm, 3 µm poresize filters according to the SOP Expolis / ETHZ-L-5 ($PM_{2.5}$ Teflon-Filter Analysis).
5) Find out in what kind of working place does the customer work and what are her/his working hours for planning the work measurement.
6) The address and areal code of the workplace of the customer.
7) Is it possible to connect the MEM sampler to the mains current in the workplace?
8) Is there a balcony (or a stairway balcony of the building) or a yard in the home of the customer for outside MEM measurement?
   If yes, ask her/him if it is a safe place, if the O-MEM sampler can be connected to the mains current.
9) Make an appointment for visiting home and workplace of the customer.
10) Ask if customer's home address and/or workplace have changed from the earlier given information in mailed questionnaire (for example the customer has moved, she/he has gotten unemployed or changed her/his workplace)?
   If yes, take an extra short questionnaire with you, when visiting customer's home, to be filled in with the present information.
11) Give the customer your contact information.

7.1.2 Information Letter

Right after the telephone contact the customer should be approached with a letter reminding about this study, the fact that she/he has been selected for personal and microenvironmental monitoring, a brief description about what will be required from her/him and how this will interfere with her/his life and maybe others in the family. The inconvenience and interference should be described realistically, based on pilot experiences. The letter should also remind the customer of the date for actual sampling, and if she/he is employed, a request to take the letter for the employer to her/his employer for workplace monitoring permission, and finally giving the contact information of a specified researcher, and a suggestion to call the contact person as soon as possible for any questions or problems with the suggested dates.

7.1.3 Preparation for Field

Prepare the measurement equipment according to the following SOPs:

SOP Expolis / KTL-F-1 (MEM Sampler Positioning & PEM Sampler Carrying);
SOP Expolis / KTL-F-2 ($PM_{2.5}$ PEM Sampling);
SOP Expolis / KTL-F-3 ($PM_{2.5}$ MEM Sampling);
SOP Expolis / VTT-F-4 (VOC sampling);
SOP Expolis / KTL-F-5 (CO Monitoring) and
SOP Expolis / ETHZ-L-5 ($PM_{2.5}$ Teflon-Filter Analysis).

Study the location and environment of the customer's home (and workplace) with the help of a map and any other helpful material. Collect the needed paper material and **fill in the customer ID** to the TLAD, the Questionnaires, the 'Request of the results' -paper and all the *Sheets*. Prepare the questionnaires according to the SOP Expolis / UoA-I-3 (Questionnaires) and the TLAD according to the SOP Expolis / UoB-I-4 (TLAD). Check that you have all the needed equipment and material with you according to the following list:

Equipment:
- GSMs (1610 and 2110)
- MEM samplers
  - I-MEM sampler + extension cord
  - O-MEM sampler (Andersen PM10 inlet)
  - W-MEM sampler + extension cord
- PEM + Back bag
- Pocket Hygro-Thermometer

Material:
- Card with contact information of the researcher and the customer ID
- *Customer Information Sheet*
- Customer instructions for PEM sampler and GSM phone
- Extra Short Questionnaire, if needed
- *MEM Location Description Sheet*
- *MEM Sheet*
- *PEM Sampling Times Sheet*
- *PEM Sheet*
- Pen or pencil
- Questionnaires (additional copies to be used as needed)
- 'Request of the results' -paper
- TLAD (additional copies to be used as needed)

7.2 Field Procedures

7.2.1 First Visit at Customer's Home (Starting the measurement)

Get to the home of the customer at accurate time. Establish an initial friendly relationship with the Customer to enhance cooperation and to facilitate the collection of the needed information. Attempt to get the Customer positively involved by giving her/him the feeling that the Customer can contribute something worthwhile in this research effort.

Place the MEM samplers according to the SOP Expolis / KTL-F-1 (MEM Sampler Positioning and PEM Sampler Carrying) and connect them to mains current, if it is possible. Place also the Pocket Hygro-Thermometer stabilize in the same room with I-MEM sampler.

Hand the customer the TLAD, the questionnaires, the *PEM Sampling Times Sheet,* the instructions of the PEM sampler and the GSM phone and the 'Request of the results' -paper. Give the customer also an extra Short Questionnaire, if she/he have moved or her/his workplace have changed, and ask her/him to fill it in again according to present situation. Go through the instructions with the customer and the questionnaires according to the SOP Expolis / UoA-I-3 (Questionnaires) and the TLAD according to the SOP Expolis / UoB-I-4 (TLAD). Let then the customer try to use the PEM as described in the SOP Expolis / KTL-F-2 ($PM_{2.5}$ PEM Sampling) and to use the GSM and to fill in the TLAD. Start the PEM pump according to the SOP Expolis / KTL-F-2 ($PM_{2.5}$ PEM Sampling). Write down the start time of the PEM measurement according to customer's watch to the *PEM Sampling Times Sheet* and also to the *PEM Sheet*. Give her/him the bag back to help carrying the PEM-case. Ask if there is still anything unclear and answer the questions. Make sure that the customer has your contact information.

At the end of visit temperature and relative humidity are measured and recorded on the *MEM Sheet.* Take the Hygro-Thermometer and the *MEM Sheet* with you. Ask when it is suitable to take the equipment back after the measurement period. Be on call during the 48 hour measurement period.

7.2.2 First Visit to the Workplace

Take the work MEM sampler to the workplace of the customer at accurate time. This may happen before or after you visit the home of the customer but in any case you may not give the customer a ride after the measurement period has started. She/he should always follow her/his normal daily routines.

Place the W-MEM sampler according to the SOP Expolis / KTL-F-1 (MEM Sampler Positioning and PEM Sampler Carrying) and connect it to mains current, if it is possible. Place also the Pocket Hygro-Thermometer in the same room to stabilize. Ask if there is still anything unclear and answer the questions. At the end of visit temperature and relative humidity will be measured and recorded on the *MEM Sheet*. Take the Hygro-Thermometer and the *MEM Sheet* with you. Ask when it is suitable to take the W-MEM sampler back after the measurement period.

7.2.3 Second Visit at Customer's Home (Ending the measurement)

Go to the home of the customer at accurate time to take the equipment back. Place the Pocket Hygro-Thermometer in the same room where MEM samplers are. Ask if there has been any problems during the 48 hours and write them down on the *MEM Location Description Sheet*, if there has been any. Check that you have marked the positioning of the MEM samplers into the *MEM Location Description Sheet.* Ask where she/he has placed the PEM case over night and record it into the *MEM Location Description Sheet.*

Stop the PEM pump according to the SOP Expolis / KTL-F-2 ($PM_{2.5}$ PEM Sampling) and write down the end time of the PEM measurement according to customer's watch to the *PEM Sampling Times Sheet* and to the *PEM Sheet*. Stop also the MEM samplers, if they are still runnig according to the SOP Expolis / KTL-F-3 ($PM_{2.5}$ MEM Sampling). Check through all the paper material - the TLAD according to the SOP Expolis / UoB-I-4 (TLAD), the questionnaires according to the SOP Expolis / UoA-I-3 (Questionnaires) and the *PEM Sampling Times Sheet* - ask all unanswered questions and other discrepancies that come to mind and make the corrections which are needed. Check also that the extra Short Questionnaire is filled in, if it was needed. Thank the customer for participating in the study. At the end of visit temperature and relative humidity are measured and recorded on the *MEM Sheet*. Check that you have all the equipment and material with you according to the following list:

Equipment:
- GSM (1610)
- MEM samplers
  - I-MEM sampler + extension cord
  - O-MEM sampler (Andersen PM10 inlet)
- PEM + Back bag
- Pocket Hygro-Thermometer

Material:
- Questionnaires
- Sheets:
  - *MEM Location Description Sheet*
  - *MEM Sheet*
  - *PEM Sheet*
  - *PEM Sampling Times Sheet*
- TLAD
(- Extra Short Questionnaire, if it was needed)
(- 'Request of the Results' -paper, if the customer gives it to you)

7.2.4 Second Visit to the Workplace

Go to the workplace of the customer at accurate time to take the work MEM sampler back. Place the Pocket Hygro-Thermometer stabilize in the same room with W-MEM sampler. Stop also the W-MEM sampler, if it is still runnig according to the SOP Expolis / KTL-F-3 ($PM_{2.5}$ MEM Sampling). Ask if there has been any problems during the 48 hours and write them down on the background of the *MEM Sheet*, if there has been any. At the end of visit temperature and relative humidity will be measured and recorded on the *MEM Sheet*. Check that you have all the equipment and material with you according to the following list:

- *MEM Sheet*
- Pocket Hygro-Thermometer
- W-MEM sampler + extension cord

7.3 After Fieldwork

All equipment should be handled according to the following SOPs:
- SOP Expolis / KTL-F-2 ($PM_{2.5}$ PEM Sampling);
- SOP Expolis / KTL-F-3 ($PM_{2.5}$ MEM Sampling);
- SOP Expolis / VTT-F-4 (VOC sampling);
- SOP Expolis / KTL-F-5 (CO Monitoring) and
- SOP Expolis / ETHZ-L-5 ($PM_{2.5}$ Teflon-Filter Analysis).

The GSM phone is connected to mains current to be charged.

The results of the measurements will be prepared and mailed to the customers, who have asked for their own results, and the employers, who have asked for the results of the workplace.

7.4 Quality Control

7.4.1 Tolerance Limits

Tolerance limits concerning measurements (equipment) are checked from the following SOPs:
- SOP Expolis / KTL-F-2 ($PM_{2.5}$ PEM Sampling);
- SOP Expolis / KTL-F-3 ($PM_{2.5}$ MEM Sampling);
- SOP Expolis / VTT-F-4 (VOC sampling);
- SOP Expolis / KTL-F-5 (CO Monitoring) and
- SOP Expolis / ETHZ-L-5 ($PM_{2.5}$ Teflon-Filter Analysis).

The questionnaires and the TLAD are 100 % QC checked for completeness and comprehensiveness by the researcher in the field with the customer and again upon return to the office.

7.4.2 Corrective actions

Corrective actions concerning measurements (equipment) are checked from the following SOPs:
- SOP Expolis / KTL-F-2 ($PM_{2.5}$ PEM Sampling);
- SOP Expolis / KTL-F-3 ($PM_{2.5}$ MEM Sampling);
- SOP Expolis / VTT-F-4 (VOC sampling);
- SOP Expolis / KTL-F-5 (CO Monitoring) and
- SOP Expolis / ETHZ-L-5 ($PM_{2.5}$ Teflon-Filter Analysis).

If there are still some problems with the questionnaires or the TLAD (or other things), the customer will be called again and asked for the answers. Record any comments that are worthy of mention and might affect the measurement according to the Expolis Data Procedures.

8.0 Data Records

8.1 All records will be completed exhaustively and comprehensively by assigned researchers. Without proper documentation, the data collected by researchers is not usable.

8.2 All data from measurements are recorded according to the following SOPs and the Expolis Data Procedures:

SOP Expolis / KTL-F-2 ($PM_{2.5}$ PEM Sampling);
SOP Expolis / KTL-F-3 ($PM_{2.5}$ MEM Sampling);
SOP Expolis / VTT-F-4 (VOC sampling);
SOP Expolis / KTL-F-5 (CO Monitoring) and
SOP Expolis / ETHZ-L-5 ($PM_{2.5}$ Teflon-Filter Analysis).

8.3 Customer files, meaning all the data from paper material, as well as information of the questionnaires and the TLAD, are recorded in the PC database of each Expolis centre by the researcher according to the Expolis Data Procedures. After the data has been recorded in the PC database the date of this data transfer and researcher's initials should be written down to each sheet and paper.

8.4 Paper database, meaning all the paper material like TLADs, questionnaires and field sheets, are archived in a safe place in each Expolis centre at least 10 years.

8.5 All data files of CO PEM, PQ100 downloading, calibrations, VOC results and information of the questionnaires and the TLAD are saved in the PC database of each Expolis centre according to the Expolis Data Procedures.

8.6 After field measurements data from the centres will be copied to one integrated Expolis database which will be archived in the KTL in Finland. This will be done according to the Expolis Data Procedures.

9.0 Sample Archiving

The archiving of the filters is described in the SOP Expolis / ETHZ-L-5 ($PM_{2.5}$ Teflon-Filter Analysis). The archiving of the VOC samples is described in the SOP Expolis / VTT-F-4 (VOC sampling).

10.0 Implementation and Application

Distribution of this SOP will be done according to the SOP Expolis / KTL-G-1 (Preparation of Standard Operating Procedures).

11.0 Attachments

Figure 1 *PEM Sampling Times Sheet* (example)
Figure 2 'Request of the results' -paper (example)
Figure 4 Exposure Quick Memo List

Figure 1. *PEM Sampling Times Sheet* (example for Monday to Wednesday measurement)

PEM Sampling Times Sheet EXPOLIS-STUDY

Customer ID:
Date and time:
Contact person:

Researcher ____________________________ Telephone

PERSONAL EXPOSURE MEASUREMENT, changing filters of the PEM-case

Filter		Introduction	Real time of change	
			Date	Time
1	Start	1st run of Day Filter started		
2	Day Filter to Night Filter	Please change the Filter on Monday afternoon as soon as possible when arriving at home		
3	Night Filter back to Day Filter	Please change the Filter on Tuesday morning just before leaving home		
4	Day Filter back to Night Filter	Please change the Filter on Tuesday afternoon as soos as possible when arriving at home		
5	End	2nd run of Night Filter ended		

COMMENTS:

____

____

____

____

Figure 2. 'Request of the results' -paper (example)

EXPOLIS
Exposure
Distributions
of Adult Urban
Populations

Many thanks for participating in the EXPOLIS study. If You want to get the results of your measurements, which will be available in the Spring 98, please send this form to the following address:

Kansanterveyslaitos, EXPOLIS-projekti
Mannerheimintie 166
00300 HELSINKI

Please check that you have written down your identification code in the space provided in your request of the results. It is the only way to find the correct results.

Matti Jantunen
Research professor

REQUEST OF THE RESULTS

I have been participating in the European Air Pollution Exposure study and I would like to get my results of the measurements to be mailed to the following address:

____ (name)

____ (address)

____

My identification code:

I would also want to get the summary of the study, when it will be available
In English ______ In Finnish ______

____
Date Signature

Post address:
Mannerheimintie 166
FIN-00300 HELSINKI
FINLAND

Visiting address:
Mannerheimintie 170
FIN-00300 HELSINKI
FINLAND

Phone: +358-0-458 3824
Fax: +358-0-474 4468

Figure 4 Exposure Quick Memo List

Phoning

1) Acceptance of the customer to participate the study.
2) Is the proposed measurement time suitable for the customer?
   If not, ask her/him a better suiting time.
3) Tell her/him that the visit at her/his home will take 30...45 minutes.
4) Ask if the customer or somebody else is smoking in her/his home and/or workplace.
5) Find out in what kind of working place does the customer work and what are her/his working hours for planning the work measurement.
6) The address and areal code of the workplace of the customer.
7) Is it possible to connect the MEM sampler to the mains current in the workplace?
8) Is there a balcony (or a stairway balcony of the building) or a yard in home of the customer for outside MEM measurement?
   If yes, ask her/him if it is a safe place, if the O-MEM sampler can be connected to the mains current and if there is a shelter.
9) Make an appointment for visiting home and workplace of the customer.
10) Ask if customer's home address and/or workplace have changed (for example the customer has moved, she/he has gotten unemployed or changed her/his workplace)?
   If yes, take an extra short questionnaire with you, when visiting customer's home.
11) Give the customer your contact information.

Remember also send the information letter to the customer.

Preparation for field:

Check that you have all the following equipment and material with you <u>before leaving office</u>.

Equipment:
* GSMs (1610 and 2110)
* MEM samplers
  - I-MEM sampler + extension cord
  - O-MEM sampler (Andersen PM10 inlet)
  - W-MEM sampler + extension cord
* PEM + Back bag
* Pocket Hygro-Thermometer

Material:
* Card with contact information of the researcher and the customer ID
* *Customer Information Sheet*
* Customer instructions for PEM sampler and GSM phone
* Extra Short Questionnaire
* *MEM Location Description Sheet*
* *MEM Sheet*
* *PEM Sampling Times Sheet*
* *PEM Sheet*
* Pen or pencil
* Questionnaires (additional copies to be used as needed)
* 'Request of the results' -paper
* TLAD (additional copies to be used as needed)

STARTING THE MEASUREMENT
Check list Home

❍ Place the MEM samplers and connect them to mains current

❍ Place the Pocket Hygro-Thermometer stabilize

Give to the customer:
❍ the TLAD
❍ the Questionnaires
❍ the *PEM Sampling Times Sheet*
❍ the instructions of PEM and GSM
❍ the 'Request of the results' -paper
❍ Card with contact information of the researcher and the customer ID
❍ Extra Short Questionnaire, if needed

❍ Go through the instructions with the customer, explain her/him the questionnaires and the TLAD and let her/him to fill in the TLAD

Let the customer try to use:
❍ PEM (change filters)
❍ GSM

❍ Write down the start time of the PEM measurement

❍ Record temperature and relative humidity and take the meter with you

❍ Ask when it is suitable to take the equipment back after the measurement period

❍ Be on call during the 48 hour measurement period

Check list Work

❍ Place the Pocket Hygro-Thermometer to stabilize

❍ Place the W-MEM sampler and connect it to mains current

❍ Ask when it is suitable to take the W-MEM sampler back after the measurement period

❍ Record temperature and relative humidity and take the meter with you

ENDING THE MEASUREMENT

Check that you have the following material with you before leaving office.
- Pocket Hygro-Thermometer
- *MEM Sheet*
- *MEM Location Description Sheet*

Check list Home

❍ Place the Pocket Hygro-Thermometer to stabilize
❍ Ask if there has been any problems during the 48 hours and write them down, if there has been any.
❍ Stop the PEM pump and write down the end time of the PEM measurement
❍ Stop the MEM samplers, if they are still running
❍ Check that you have filled in the *MEM Location Description Sheet* (also PEM night time location)

Check through all the paper material
- ❍ the TLAD
- ❍ the Questionnaires
- ❍ the *PEM Sampling Times Sheet*
- (❍ the Extra Short Questionnaire, if it was needed)

❍ Ask all unanswered questions and other discrepancies that come to mind and make the corrections which are needed.
❍ Record temperature and relative humidity
❍ Thank the customer for participating in the study
❍ Check that you have all the following equipment and material with you before leaving customer's home.

Equipment:
- GSM (1610)
- MEM samplers
  - I-MEM sampler + extension cord
  - O-MEM sampler (Andersen PM10 inlet)
- PEM + Back bag
- Pocket Hygro-Thermometer

Material:
- Questionnaires
- Sheets:
  - *MEM Location Description Sheet- MEM Sheet*
  - *PEM Sheet*
  - *PEM Sampling Times Sheet*
- TLAD
- (- Extra Short Questionnaire, if it was needed)
- (- 'Request of the results' -paper)

Check list Work

❍ Place the Pocket Hygro-Thermometer to stabilize
❍ Stop the MEM sampler, if it is still running
❍ Ask if there has been any problems during the 48 hours and write them down, if there has been.
❍ Record temperature and relative humidity
❍ Check that you have the following equipment and material with you before leaving customer's workplace.

- *MEM Sheet*
- Pocket Hygro-Thermometer
- W-MEM sampler + extension cord

KTL/EXPOLIS/EU IV Environment and Climate contract No°ENV4-CT96-0202(DG12-DTEE)

Customer Procedure - TLAD Only Group

Identification code: SOP Expolis / KTL-I-2.0	APPROVALS
❑ Full SOP ❑ Working SOP # pages____	Coordinator:__/__/__ ________________
Issue Date: ___/___. __________	QAU: __/__/__ ______________________
Revision No: Revision date: ___/___. __________ Revision description:	Coordinator: QAU:
Revision No: Revision date: ___/___. __________ Revision description:	Coordinator: QAU:
Revision No: Revision date: ___/___. __________ Revision description:	Coordinator: QAU:

Distributed to: Name of recipient:	Original date	Rev. 1. date	Rev. 2. date	Rev. 3. date
KTL Helsinki				
University of Athens				
University of Basel				
RIVM Bilthoven				
University of Grenoble				
VTT Helsinki				
University of Milan				
PIAS Prague				

CUSTOMER PROCEDURE - TLAD ONLY GROUP

1.0 Purpose and Applicability

This SOP outlines the researcher's responsibilities in public contact and behavior with TLADo customers. The purpose of this SOP is also to describe basic pre- and post-field visit activities and standards which are expected of every researcher. The procedure applies to all Staff who interact with the customers of the Air Pollution Exposure Distributions within Adult Urban Populations in Europe (Expolis) European multicenter project consortia.

2.0 Definitions

Customer:	A person participating in the Expolis study as a study subject
TLADo customer:	Customer participating in TLAD only group
Customer file:	All customer data sheets including all data collected from the customer during the measurement
Customer ID:	Each Customer is uniquely identified by Expolis identification code.
Measurement period:	48 hours customer measurement
Paper database:	Collection of all customer files
PC database:	The computerized Expolis database into which data is entered according to the Expolis Data Procedures
Questionnaires:	The Home, Commuting & Work Environment Questionnaire and the 48 Hour Exposure Questionnaire
Short Questionnaires:	The mailed questionnaire (three different versions)
SOP:	Standard Operating Procedure, which must be prepared revised, distributed and applied with full SOP formalities.
TLAD:	Time Location Activity Diary
TLAD only group:	Customers who participate the Expolis study by filling in the TLAD and questionnaires, but not participating in personal or microenvironmental monitoring.

3.0 References

The development of this SOP is based on

3.1 SOP # UA-T-1.0 (February 1995) developed in University of Arizona for the U.S. EPA NHEXAS project

3.2 SOP # UA-T-3.0 (February 1995) developed in University of Arizona for the U.S. EPA NHEXAS project

3.3 SOP Expolis / KTL-G-1 (* (Preparation of Standard Operating Procedures)
3.4 SOP Expolis / KTL-I-1 (Customer Procedure - Exposure Customers)
3.5 SOP Expolis / UoA-I-3 (Home, Commuting & Work Environment Questionnaire
Forty Eight Hour Exposure Questionnaire)
3.6 SOP Expolis / UoB-I-4 (Time-Location-Activity-Diary: Instruction for Field Workers)

3.7 Expolis Data Procedures

*) This statement refers to the latest SOP revision available. Make sure that you know and have it.

4.0 Discussion

This SOP outlines generalities in the training of researchers. Pre- and post-field visit activities and on-site data collection standards concerning TLAD only group. The goal of field visit activities within the Expolis study is to collect accurate and comparable information regarding personal exposure to air pollutants from the customers in the study. Data retrieval and handling are the primary job responsibilities of all researchers. Researchers are expected to execute their responsibilities in an exhaustive and comprehensive fashion in accordance with stated protocol. The researcher's methods of contact with the public is very important area of consideration in the gathering of good data.

Respect for Customers: The information sought is respectfully requested of the environment of the customer as a gift of time and information. Most respondents will recognize the occasion as an opportunity to contribute to the efforts being made to improve the community and environment. This gift should be given and received in dignity; it must not be demanded nor obtained by coercion. Remember, a refusal to provide information is the prerogative of the Customer; it is not a personal affront, but the expression of a fundamental human right.

5.0 Responsibilities

5.1 The Coordinator is responsible for the final review and approval of this SOP.

5.2 Local Principal Investigator is responsible that any new version of this SOP will be made available to all members of the project team, according to the SOP Expolis / KTL-G-1 (Preparation of Standard Operating Procedures).

5.3 All members of the project team are responsible for working according to this SOP and reporting any local and/or temporal deviations and/or changes of it, according to the SOP Expolis / KTL-G-1 (Preparation of Standard Operating Procedures).

5.4 Tuulia Rotko from the Expolis Centre in Helsinki is responsible for the contents of this SOP.

6.0 Equipment and Materials

6.1 Equipment

None

6.2 Materials

- Card with contact information of the researcher and the customer ID for needs of further contact
- *Customer Information Sheet* (Name, phone number and address (home or workplace) of the Customer) (SOP Expolis / KTL-I-1; Appendix 3)
- Envelope with the return address and a stamp
- Extra Short Questionnaire, if needed (See 7.1.1, page 5)
- Pen or pencil
- Questionnaires (SOP Expolis / UoA-I-3; Appendix 1)
- 'Request of the results' -paper (SOP Expolis / KTL-I-1; Appendix 2)
- TLAD (SOP Expolis / UoB-I-4; Appendix 1)

7.0 Procedure

A) Pre-field standards expected of all researchers include punctuality, professionalism, safety and reliability. The nature of this research project requires flexibility and researchers must be prepared to respond to a variety of sampling environments.

B) In-field QC checks of data and method are the responsibility of all field researchers. Every form, questionnaire, sample and data item collected must be labeled with the customer ID, type of sample, date of collection, time of collection and researcher's initials at a minimum.

C) At least as many Customers of TLAD only group as are involved in exposure measurements (250 customers in Helsinki area and 50 customers in other centers involved) will be contacted personally for training to fill in the TLAD and the questionnaires.The personal contact with TLAD only group can be done by inviting 5 to 10 customers at a time to come to an information meeting or by visiting each customer at their home or workplace. Customers of TLAD only group will be contacted through the entire Expolis field stage (from October 96 to the end of 97) so that some of TLAD only customers will participate to the study at least every second month.

If more than the minimum number of customers of TLAD only group are chosen to participate in the study, they can be contacted by a mailed TLAD and questionnaires and pre- and post-telephone calls for giving the instructions and checking afterwards. However in this case these mail only TLAD customers are given a specific identification code (according to the Expolis Data Procedures) to be separated from the TLAD only customers who are visited by the researchers.

7.1 Preparation

7.1.1 Phoning

The customer will be contacted by telephone at least one week before the assumed personal contact. The measurement period should be two consecutive weekdays. Before calling the customer check through the information about the customer from mailed questionnaire (PC database). Print this information about the customer as a *Customer Information Sheet*. If there are some questions without an answer, ask them on the phone. If the customer is not employed, skip question 4. When reaching the eligible customer and after proper introduction, ask her/him the following questions and mark the answers into the blank space of the *Customer Information Sheet* and also into the PC database according to the Expolis Data Procedures:

1) Acceptance of the customer to participate the study in TLAD only group

2) If the customer is willing to come to the proposed information meeting

   if yes 3) Give her/him the date and time of the meeting and the address and instructions to find the place

   if not 3) Make an appointment for visiting home or workplace of the customer

4) The address and areal code of the workplace of the customer

5) Ask if customer's home address and/or workplace have changed from the earlier given information in mailed questionnaire (for example the customer has moved, she/he has gotten unemployed or changed her/his workplace)?

   If yes, give her/him an extra short questionnaire, when meeting the customer, to be filled in with the present information.

6) Give the customer your contact information

7.1.2 Information Letter

Right after the telephone contact the customer should be approached with a letter reminding about this study, the fact that she/he has been selected for filling in the time location activity diary and the questionnaires, a brief description about what will be required from her/him and how this will interfere with her/his life. The letter should also remind the customer of the date for actual contact, give the contact information of a specified researcher, and a suggestion to call the contact person as soon as possible for any questions or problems with the suggested date.

7.1.3 Preparation for Information Meeting and for Field

Collect the needed paper material and **fill in the customer ID** to the TLAD, the Questionnaires and the 'Request of the results' -paper. Prepare the questionnaires according to the SOP Expolis / UoA-I-3 (Questionnaires) and the TLAD according to the SOP Expolis / UoB-I-4 (TLAD).The TLAD only group should be distributed equally between those who have started filling in the TLAD in the morning (from 8:00 to 8:00) and those who have started in the evening (from 20:00 to 20:00). If you are going to visit the customer's home or workplace, study the location and environment of the customer's home or workplace with the help of a map and any other helpful material. Check that you have all the needed material with you according to the following list:

Material:

- Card with contact information of the researcher and the customer ID
- Envelope with the return address and a stamp
- Extra Short Questionnaire, if needed
- *Customer Information Sheet*
- Pen or pencil
- Questionnaires (additional copies to be used as needed)
- 'Request of the results' -paper
- TLAD (additional copies to be used as needed)

7.2 Field Procedures

7.2.1 Information Meeting

Establish an initial friendly relationship with the Customer to enhance cooperation and to facilitate the collection of the needed information. Attempt to get the Customer positively involved by giving her/him a feeling that the Customer can contribute something worthwhile in this research effort. Start the information meeting by describing briefly the Expolis study and its' targets to the customers.

Give each customer the TLAD, the Questionnaires and the extra Short Questionnaire, if needed. Go through the questionnaires according to the SOP Expolis / UoA-I-3 (Questionnaires) and the TLAD according to the SOP Expolis / UoA-I-4 (TLAD). Let then the customers try to fill in the exercise page of the TLAD. Ask the customers to fill in the TLAD for two following consecutive weekdays. Ask if there is still anything unclear and answer the questions. Give each customer the ‘Request of the results’ -paper, the return envelope and the card with contact information of the researcher and the customer ID for needs of further contact.

Thank the customer for participating in the study and ask her/him to mail the filled in TLAD and questionnaires (also the extra short questionnaire, if it was needed) back as soon as possible by using the given envelope. Be on call during the 48 hour measurement period.

7.2.2 Visiting the Customer

Get to the home or workplace of the customer at accurate time. Establish an initial friendly relationship with the Customer to enhance cooperation and facilitate the collection of the needed information. Attempt to get the Customer positively involved by giving her/him a feeling that the Customer can contribute something worthwhile in this research effort.

Hand the customer the TLAD, the questionnaires and the extra short questionnaire, if needed. Go through the questionnaires according to the SOP Expolis / UoA-I-3 (Questionnaires) and the TLAD according to the SOP Expolis / UoA-I-4 (TLAD) with the customer. Let then the customer try to fill in the exercise page of the TLAD. Ask the customers to fill in the TLAD for two following consecutive weekdays. Ask if there is still anything unclear and answer the questions. Give each customer the ‘Request of the results’ -paper, the return envelope and the card with contact information of the researcher and the customer ID for needs of further contact.

Thank the customer for participating in the study and ask her/him to mail the filled in TLAD and questionnaires (also the extra short questionnaire, if it was needed) back as soon as possible by using the given envelope. Be on call during the 48 hour measurement period.

7.3 After Fieldwork

When getting back the filled in TLAD and questionnaires from the TLAD only customers, check through the material. If there is something unclear or missing, call back to the customer and make the needed corrections. Ask also, if there has been any problems during the 48 hours and write them down on the customer file, if there has been any. If the TLADo customer has not sent the filled in TLAD and questionnaires back after two weeks, she/he is called and asked for it.

The results of the customer measurements will be prepared and mailed to the customers, who have asked for their own results.

7.4 Quality Control

7.4.1 Checking

The questionnaires and the TLAD will be 100 % QC checked for completeness and comprehensiveness by the researcher when getting them back by mail.

7.4.2 Corrective Actions

If there are still some problems with the questionnaires or the TLAD (or other things), the customer will be called again and asked for the answers. Record any comments that are worthy of mention and might affect the measurement according to the Expolis Data Procedures.

8.0 Data Records

8.1 All records will be completed exhaustively and comprehensively by assigned researchers. Without proper documentation, the data collected by researchers is not usable.

8.2 Customer files, meaning all the data from paper material, like information of the questionnaires and the TLAD, are recorded in the PC database of each Expolis centre by the researcher according to the Expolis Data Procedures. After the data has been recorded in the PC database the date of this data transfer and researcher's initials should be written down to each sheet and paper.

8.3 Paper database, meaning all the paper material like TLADs and questionnaires, are archived in a safe place in each Expolis centre at least 10 years.

8.4 All data files, like information of the questionnaires and the TLAD are saved in the PC database of each Expolis centre. After field measurements data from the centres will be copied to one integrated Expolis database which will be archived in the KTL in Finland. This will be done according to the Expolis Data Procedures.

9.0 Data Archiving

None

10.0 Implementation and Application

Distribution of this SOP will be done according to the SOP Expolis / KTL-G-1 (Preparation of Standard Operating Procedures).

11.0 Attachments

Appendix 1: TLADo Quick Memo List

TLADo Quick Memo List

Phoning

1) Acceptance of the customer to participate the study in TLAD only group
2) If the customer is willing to come to the proposed information meeting
 if yes 3) Give her/him the date and time of the meeting and the address and instructions to find the place
 if not 3) Make an appointment for visiting home or workplace of the customer
4) The address and areal code of the workplace of the customer
5) Ask if customer's home address and/or workplace have changed from the earlier (in mailed questionnaire) given information (for example the customer has moved, she/he have got unemployed or changed her/his workplace)?
 If yes, give her/him an extra short questionnaire, when meeting the customer, to be filled in with the present information.
6) Give the customer your contact information

Preparation

Check that you have the following material with you <u>before</u> having an <u>information meeting</u> for TLADo customers or <u>visiting a TLADo customer</u> at her/his home or workplace.

* Card with contact information of the researcher and the customer ID
* Envelope with the return address and a stamp
* Extra Short Questionnaire, if needed
* *Customer Information Sheet*
* Pen or pencil
* Questionnaires (additional copies to be used as needed)
* 'Request of the results' -paper
* TLAD (additional copies to be used as needed)

Check list for Information Meeting or Visiting a TLADo Customer

❍ Start the information meeting by describing briefly the Expolis study and its' targets to the customers.

Give each customer:

❍ the TLAD
❍ the Questionnaires
❍ the extra Short Questionnaire, if needed.
❍ the 'Request of the results' -paper,
❍ the return envelope
❍ card with contact information of the researcher and the customer ID

❍ Go through the questionnaires and the TLAD and let then the customers try to fill in the exercise page of the TLAD
❍ Ask her/him to mail the filled in TLAD and questionnaires (also extra short questionnaire, if it was needed) back as soon as possible by using the given envelope
❍ Thank the customer for participating in the study
❍ Be on call during the 48 hour measurement period