The Effects of Air Quality Measures on Human Exposure to Air Pollutants

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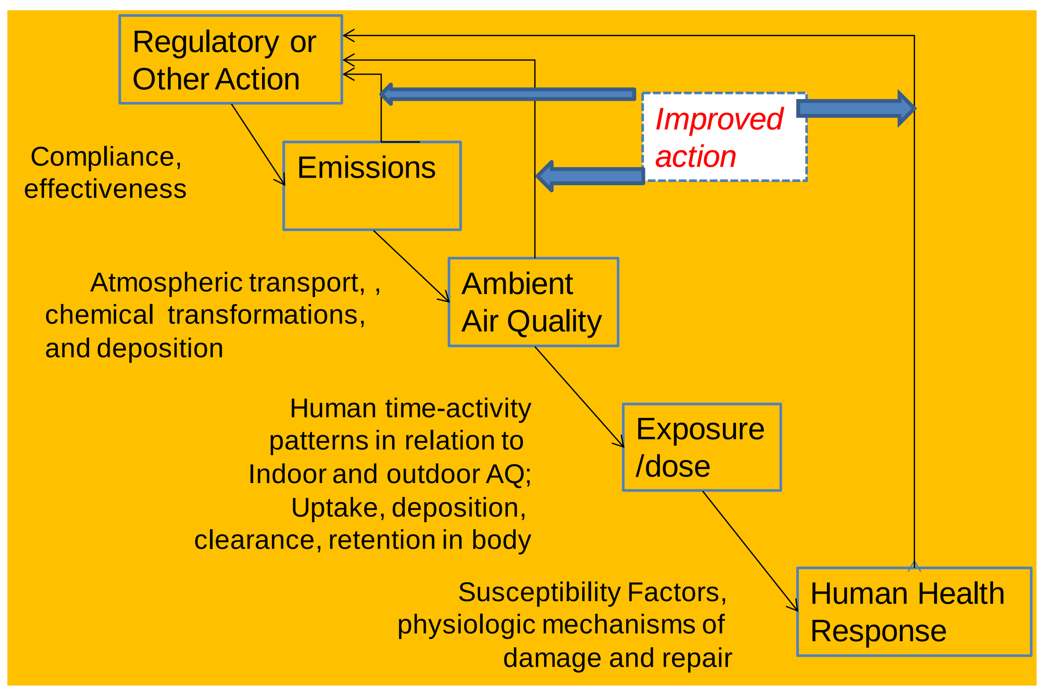
Motivation



Health Effect Institute (HEI) Chain of accountability linking human health response to air pollution. Text bellow the arrows identifies general indices of accountability at that stage. Feedback for improvement of measures is available at several stages. HEI (2003).

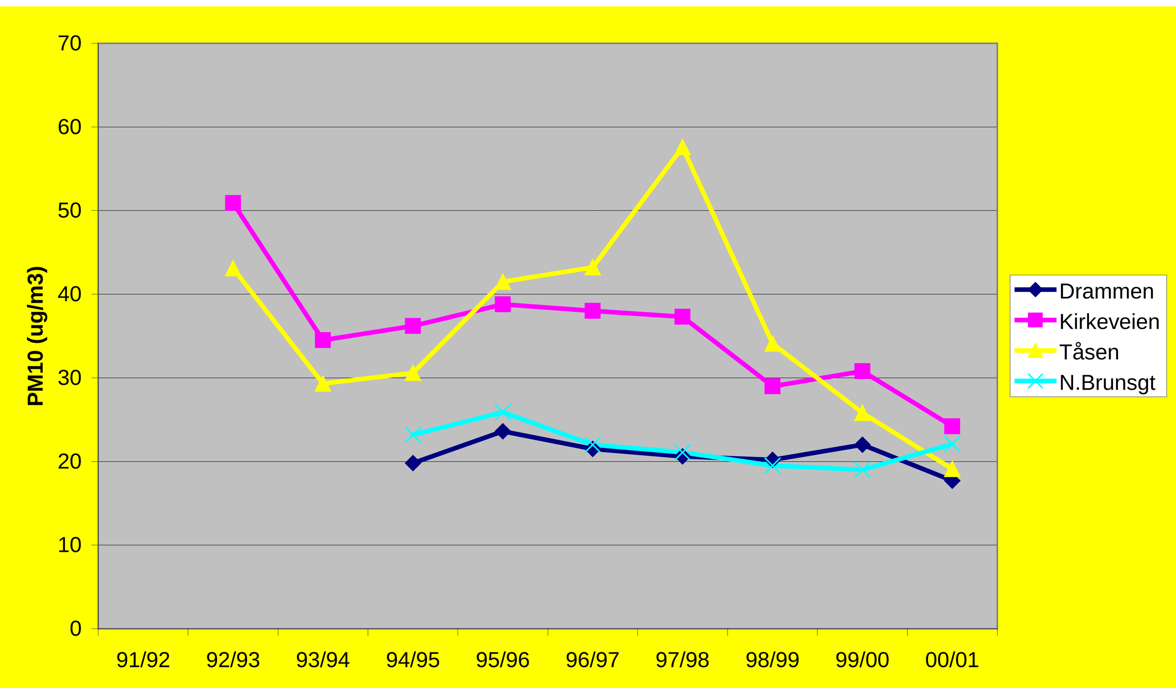
Measures to reduce air pollution effect on human health are taken by different authorities and on different spatial scales. The targets and limits are set based on human and ecosystem health considerations, and are often expressed in terms of environmental concentrations. These limits and targets protect the population on average, but their consequences for individual persons or important population groups may not be equal. Evaluating the effect of measures on exposure would allow the air quality managers to assess the impact of measures in relation to air quality and in general population, and would also allow identification of population groups or geographic areas that benefit most ,or least. Measures to reduce pollution may include measures at pollution sources (e.g. studded tires levy or ban), measures affecting pollutant transport (e.g, introduction of road tunnels), or measures affecting human behavior. To predict effects of measures, studies are often done before implementation (such as in relation to traffic plans or polluting facility permits), but it is rarely investigated if the measures had the desired effect. In this work we will investigate the effectiveness of two traffic-related measures.

The effect of studded tires ban in Oslo

In Oslo, particulate matter (PM_{10} or PM) concentrations are above the air quality limits, and the Oslo City Authority has to look for ways of achieving compliance. The violations are often occurring during the 6 winter months, when sources of PM are particularly active: these are, in addition to transport of PM from outside Oslo, the local heating and local traffic. The City of Oslo decided in 1995 to impose an additional tax on drivers using studded tires inside the city limits. This measure was in place between 1995 and 2001, when it was estimated that the reduction from 85% to 20% use was sufficient, and that further reduction of percent vehicles using studded tires is not likely to be achieved through additional taxation. In 2002, a study was commissioned to assess if the measures were effective.

Road wear and tear	20-30%, (8-12 μg/m^3)
Car exhaust and local heating	35-40% (14-18 μg /m^3)
Long range transport	30-35% (12-14 μg /m^3)

Estimated source contribution to PM_{10} in Oslo, after Larssen and Hagen 1997.



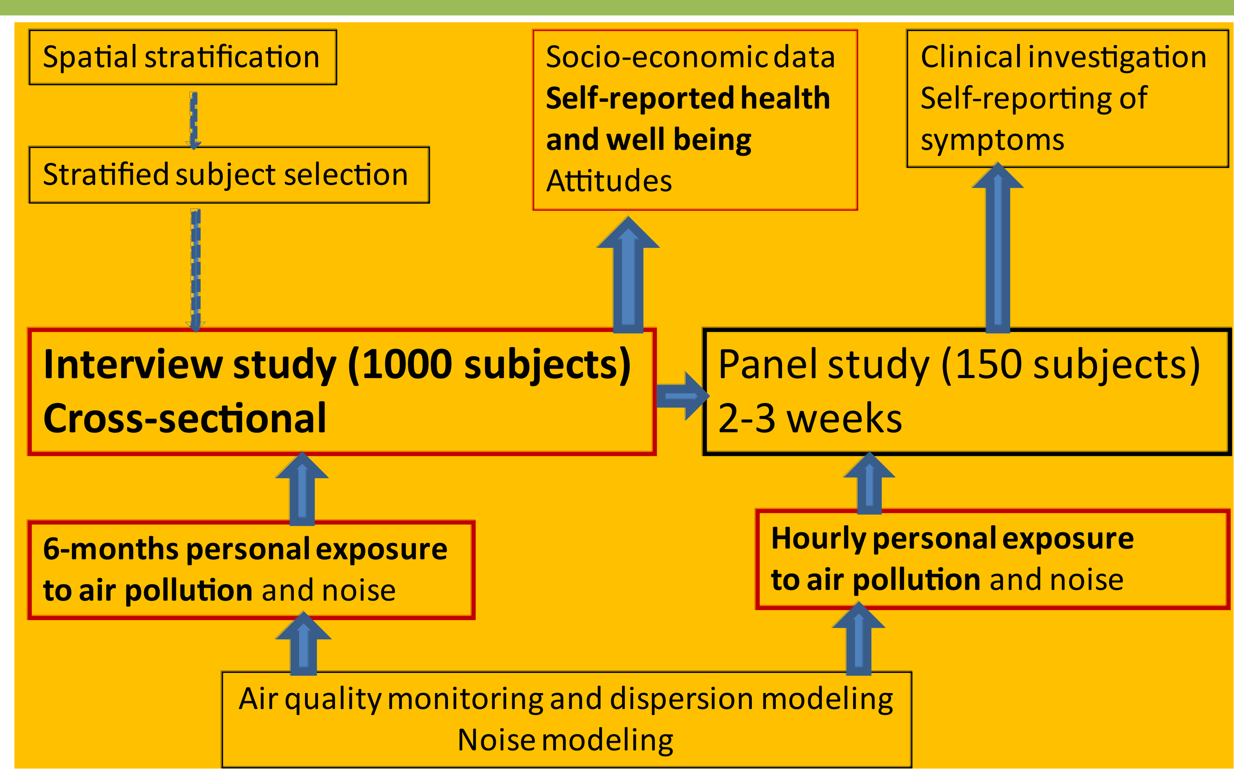
Observed PM_{10} concentrations in Oslo and Drammen, 6 month average (winter). Kirkeveien and Tåsen are traffic sites.

Design: The data analysis was based on data from Oslo (studded tires tax) and Drammen (no tax), 1991-2001. We included all urban monitoring sites, meteorological data, and data measured by the road authorities on the roads, in all over 250 different data files from several sources. The analytical stra-tegy (multiple regression analysis) was based on the differences between Oslo and Drammen with the same development in car technology (catalysts) but different development in studded tires use.

Results: There is a clear decrease in nitrogen oxides, both in Oslo and Drammen, explained by an increased use of catalyst-equipped cars in the period. PM shows this trend also in Oslo, and in episodes with unfavorable dispersion conditions, but not in Drammen, and not in favorable dispersion conditions. The estimated relationship between changes in percent studded tires and PM concentration is consistent with other information, and amounts to 1 μg/m^3 decrease with each 10% decrease in studded tires use (6 month PM_{10} average).

The effect of major traffic changes: the Oslo Traffic Study

In the middle of 1980ies, Oslo was very much congested with vehicular road traffic. The authorities invested in a series of tunnels, leading the traffic from the historical centre, and started a large urban rehabilitation project in the area. At the same time, they funded a "before and after" study on environmental consequences of the measures for human health and well being. The study run from 1987 to 1996, with similar design and the same interdisciplinary study team with members from several research institutions, and has allowed confirming that the environmental improvements were beneficial for the population. The overall aim of the investigation was to assess the developments in exposure to air pollution in the investigation area, and to assess health consequences of these exposures, and their changes. The program was designed as a series of a cross-sectional (interview) and a short-term cohort (panel) investigations, repeated three times during 10 years. The **results** showed that there was a significant improvement in air quality, attributable to the changes in traffic. We estimated that pollution levels decreased overall, and also that estimated exposure decreased for most study participants, but for a group affected directly by the tunnel portals, it increased. We were able to show that there is an improvement in health status related to exposure improvements.



Design of the study. Bold letters and red boxes indicate which elements of the study have been analyzed Dotted arrows show that the initial subject selection was done by an external contractor specialized in interview studies.

Air concentrations and other exposure metrics: implications

In the first study, measured concentration values are used as exposure metric directly. This is the most common approach, implicitly using the fact that most air quality guidelines are based on studies that relate monitoring data (air concentrations) to effects. In the second study, we recognize that exposure (often defined as contact between the medium and the subject) is influenced by a variety of factors not correlated with air pollution levels. We have estimated exposure using time activity and other information, applying the concept of microenvironments. This trend is continued In ongoing research projects, allowing us to arrive at exposure estimates with better health relevance.

Acknowledgements and references

The research was conducted supported by grants the Norwegian Road Authorities (Grant nr, 30880, grants 1987-2000), and the Research Council of Norway (grants 1987-2000). Clench-Aas, J., Bartonova, A., Klæboe, R. and Kolben-stvedt, M. (2000) Oslo Traffic Study – Part 2. Quantifying effects of traffic measures using individual exposure modeling. *Atmos. Environ.* 34 (27), 4737-4744. Health Effects Institute (2003). Assessing health impact of air quality regula-tions: concepts and methods for accountability research. Boston, MA: HEI Accountability Working Group, (HEI .communication 11). Larssen, S. og Hagen, L.O. (1997) Particle pollution from studded tires (in Norwegian). Kjeller (NILU OR 16/97).

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