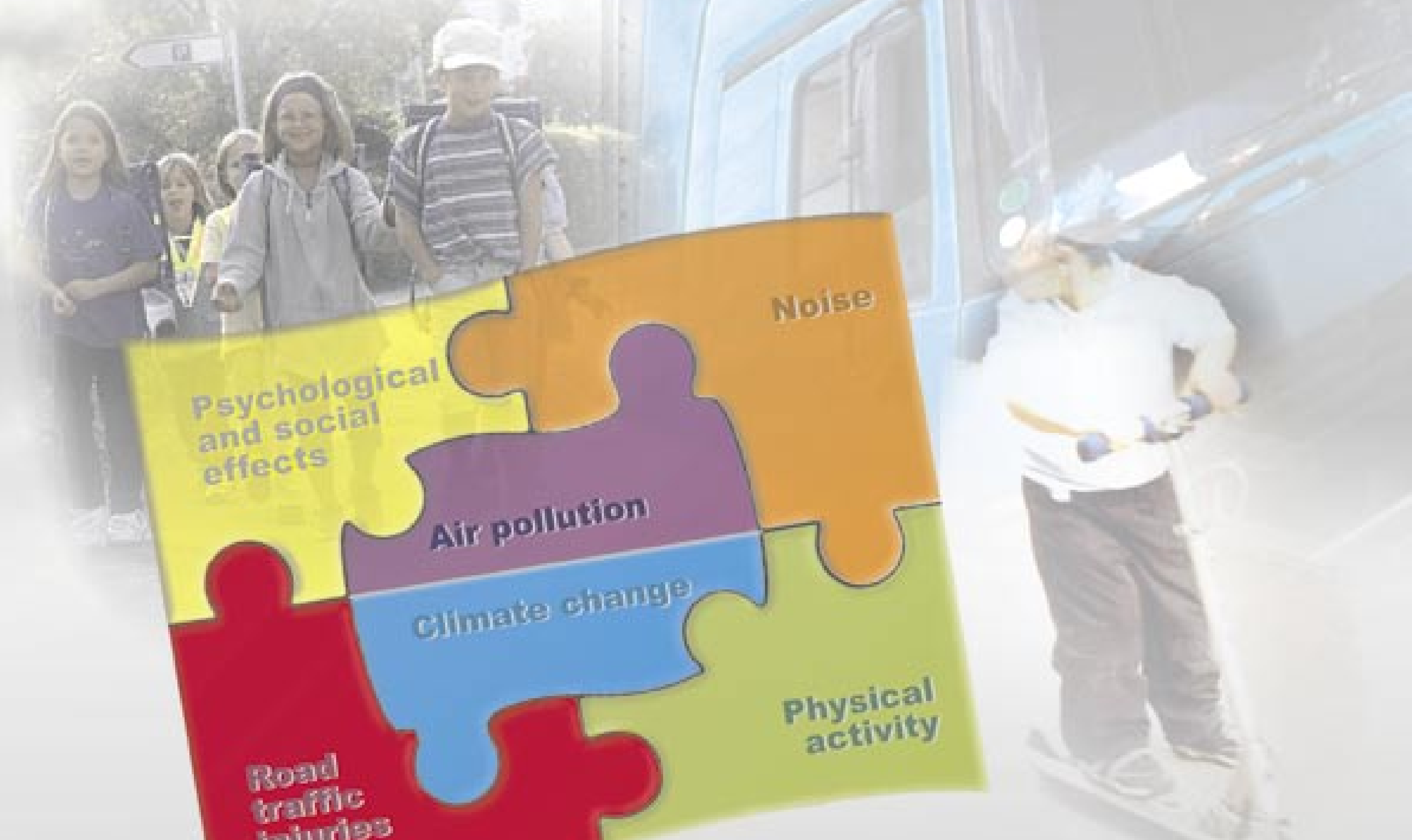
THE PEP Transport, Health and Environment Pan-European Programme

WHO / Europe UNECE

Transport-related Health Effects with a Particular Focus on Children

Towards an Integrated Assessment of their Costs and Benefits. State of the Art Knowledge, Methodological Aspects and Policy Directions



ECONOMIC VALUATION

Transnational Project and Workshop Series of Austria, France, Malta, the Netherlands, Sweden and Switzerland

Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW)

Agency for Environment and Energy Management

Ministry of Health, Elderly & Community Care

National Institute of Public Health and Environment

Swedish Institute for Transport and Communications Analysis

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Transport-related Health Effects with a Particular Focus on Children

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The project "Transport Related Health Effects with a Particular Focus on Children - Towards an Integrated Assessment of their Costs and Benefits. State of the Art Knowledge, Methodological Aspects and Policy Directions" is a contribution to the UNECE - WHO Transport, Health and Environment Pan-European Programme - THE PEP and to the Children´s Environment and Health Action Plan for Europe - CEHAPE.

Specific topics have been elaborated under the responsibility of one leading country:

- **Air Pollution - by France**
- **Noise - by the Netherlands**
- **Physical Activity - by Switzerland**
- **Psychological and Social Effects - by Austria**
- **Economic Valuation - by Sweden**

Within this project the topics Climate Change and Road Safety were covered by contributions from WHO Europe.

This project was developed through a series of reviews and workshops:

Workshop I: "Transport Related Health Impacts - Review of Exposures, Epidemiological Status", Vienna 24-25 April 2003

Workshop II: "Economic Valuation of Health Effects due to Transport", Stockholm 12-13 June 2003

Workshop III: "Health Impacts of Transport on Children", The Hague 16-17 October 2003

Workshop IV: "Synthesis and Policy Recommendations", Malta 19-20 February 2004

This project was commissioned and financed by:

Austria: Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW), Federal Ministry of Transport, Innovation and Technology (BMVIT), Federal Ministry of Health and Women (BMGF)

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Malta: Ministry of Health, Elderly & Community Care

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Sweden: Swedish Institute for Transport and Communications Analysis (SIKA), Swedish National Institute of Public Health (FHI)

Switzerland : Federal Office of Sports, Federal Office of Public Health

This Synthesis Report covers the main outcome and conclusions of the project. Additionally, detailed results and outcomes of the various topics are published in specific topic reports on:

Topic Report 1: Air Pollution, Agency for Environment and Energy Management (ADEME), France

Topic Report 2: Noise, National Institute of Public Health and Environment (RIVM), the Netherlands

Topic Report 3: Physical Activity, Institute of Sport Sciences, Federal Office of Sports, Magglingen, Switzerland

Topic Report 4: Psychological and Social Effects, Institute of Environmental Health, Medical University Vienna, Austria

Topic Report 5: Economic Valuation, Swedish Institute for Transport and Communications Analysis (SIKA)

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Background and Objectives

Motorized road transport has increased rapidly in the European Region in the last decades. Forecasts for 2020 in the EU show a further rise in passenger and freight transport and similar trends are also expected in the eastern part of the European Region. There is an increasing awareness of the environmental and health effects of transport. The health risks posed suggest an increased urgency for action to reduce these effects and related risks. The integration of environmental and health dimensions into transport policies is necessary for achieving sustainability and reducing the disease burden. This is a challenging task but necessary for providing a viable future for our children.

To this end, Austria, France, Malta, the Netherlands, Sweden and Switzerland launched a joint project and series of workshops on "Transport-related Health Effects with a Particular Focus on Children" in 2003. With this joint initiative the participating countries intend to make an active contribution to the UNECE - WHO Transport Health and Environment Pan-European Programme - THE PEP as well as to the development of the CEHAPE - Children's Environment and Health Action Plan for Europe.

The aim of this project which, focused particularly on road transport, was to make progress towards an integrated assessment of major transport related health effects by:

1) Focusing on children
2) Bringing together state of the art of knowledge about these health effects
3) Highlighting their costs and benefits.
4) Focusing on methodological aspects
5) Identifying policy directions to address transport-related health effects on children

One of the outcomes of this joint project is a set of "Key Messages". These 'messages' were developed after reviewing the evidence and a comprehensive list of policies addressing different aspects of transport-related effects on environment and health. This was undertaken by experts and was developed further at the Workshop on "Synthesis and Policy Recommendations" (Malta, 19-20 February 2004) by an panel of decision makers and external experts.

Experts from the six participating countries shared tasks, experiences and resources. Austria focussed on the psychological issues, France on air pollution, Malta on road safety, the Netherlands on noise, Sweden on economic valuation and Switzerland on physical activity. The project was supported by expert input from the WHO on road safety and climate change. A series of reviewing workshops in Vienna, Stockholm, The Hague and Malta complemented these studies involving also external experts and stakeholders. The results and conclusions of this joint project are summarized and published in a synthesis report complemented by five topic reports. It has to be stressed that due to limited time and resources, some effects of transport, such as the contamination of water and soil, as well as more comprehensive economic calculations could not be sufficiently undertaken. Follow-up activities would be advisable.

Air Pollution related Health Effects

Many epidemiological studies have assessed and shown the association between ambient air pollution and health effects on adults using different indicators such as particulate matter (PM expressed as PM10, PM2.5, Total Suspended Particles - TSP, Black Smoke - BS) or gaseous pollutants (nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and ozone (O_3)).

Although fewer studies have focused on the effects of air pollution on European children, their results suggest that there is a relationship between air pollution in Europe and numerous adverse health outcomes in children, in particular, respiratory disease.

Children, in particular those under two years of age and adolescents, are considered to be more susceptible than adults to the effects of air pollution, partly because of their immature metabolism and their physiology.

Even at relatively low levels, ambient air pollution has been shown to affect children with asthma and other conditions. Living along busy streets in urban areas, particularly with heavy motor traffic, has been associated to several respiratory diseases (exacerbation of asthma, chronic respiratory symptoms, allergic symptoms, increased prevalence of a topic sensitization, reduction in lung function).

Results from different study consistently indicate that neonatal or early post-neonatal exposure to air pollution results in mortality; these effects seem to be stronger in the post-neonatal (1-12 months) period and due to respiratory causes. Brazil suggest that there is a positive relationship between exposure to air pollution and respiratory mortality in young children (< 5 years). There are no European studies using this health outcome.

Technical and legal measures implemented since 1990 (e.g. ban of lead in petrol, decrease in sulphur content of fuels, emission standards for vehicles) have led to a reduction of some vehicles exhaust emissions. In contrast, the effects of road transport-related particulate emissions and their continued increase in many countries are at the fore of today's health concerns. Models which forecast traffic growth and factor in both, the implementation of regulations and improved technical measures, suggest that any improvements archived by the latter measures, will be offset by the increased emissions due to traffic growth. As a result, if emission ceilings and air quality objectives are to be met, technical measures will have to be complemented by economic and structural actions, which act to restrict emissions from road transport and other mobile sources.

Several studies have produced estimates of the health benefits that could be attained by decreasing ambient air pollution levels in European cities, using particulate matter with a diameter smaller than 10 μm (PM10) as an indicator. Other important indicators for transport related air pollution are PM2,5, NO_2 and black smoke. To put this in perspective, it has been estimated by the Air Pollution and Health: A European Information System (APHEIS) study that a decrease of 5 μg/m^3 in ambient PM10 levels (other factors unchanged) in nine French cities would prevent 1,561 anticipated deaths. The same scenario if applied to 19 European cities estimates that 5,547 deaths would be prevented. If the PM10 air quality guide value of 20 μg/m^3, which must be implemented in 2010 in Europe, had to be implemented in the 19 European cities, this would prevent 11,855 deaths.

Climate Change and Health

The transport sector is the second largest energy consumer in Europe. Over the period 1990 to 2000, transport greenhouse gas emissions in the EU-15 increased by 19 %, whereas emissions from Central and Eastern Europe had a smaller increase of 4 %. Projected trends forecast that CO_2 emissions will further increase in the future due to the growth in passenger and freight transport.

The health impacts of climate change have a unique set of features, (a) they are global, (b) they affect future generations even more than current ones, (c) they are unevenly distributed, and (d) they can be worsened through coexistent environmental changes. The effects will undoubtedly have a greater impact on societies or individuals with scarce resources, where technologies are lacking, and where infrastructure and institutions are least able to adapt. The Burden of Disease assessment of the WHO estimated, that, in the year 2000 there were an excess of 160,000 deaths due to climate change worldwide. The African and Asian continents face the biggest risk with children being the most vulnerable. In Europe, there is increasing evidence to show that extreme weather and climate events are becoming more frequent and intense and are associated with increases in hospital admissions in children during hot periods. The elderly, disabled, children, women, ethnic minorities and rescue workers may be at greater risk of exposure to the effects of flooding than others.

The analysis of the time series of climate patterns and laboratory confirmed cases of indigenous salmonella infections from ten European countries found that increases in temperature contributed to an estimated 30 % of cases of salmonellosis in most countries investigated. In relation to climate and ecosystem changes preliminary results show that Lyme borreliosis (LB) has spread into both higher latitudes and altitudes, and in some areas is associated with an extended and more intense LB transmission season. Among children, Borrelia burgdorferi is now the most common bacterial cause of encephalitis and facial palsy.

The health impacts of climate change are difficult to quantify and surrounded by a high degree of uncertainty with regard to the long time-scale involved, the extent of the impacts, and the pattern of future world development. However what has become clearer is that international efforts are needed to achieve a world-wide reduction in greenhouse gases emissions, if climate change is to be slowed.

Noise Exposure and Health Effects

In Europe, transport (road, rail and air traffic) is the most important source of community noise. Approximately 30 % of the European Union's population (EU-15) is exposed to levels of road traffic noise of more than 55 dB(A). Exposure to high noise levels has decreased in some countries since 1980 due to technological measures, noise barriers and spatial planning. Due to the expected growth in traffic, extra measures will be needed. At current noise levels many people are annoyed and disturbed in their sleep. A small effect on cardiovascular risk is highly plausible.

The limited number of epidemiological studies in children indicates that noise exposure affects children's learning (cognition), motivation and annoyance. In addition, there is some evidence that noise is associated with impacts on the cardiovascular and endocrine system of children. A few intervention studies show the benefits that could be attained by decreasing noise levels: reduction of railway and aircraft noise improved the long-term memory and reading ability of school children. To avoid such effects, protection of children against noise exposure during the night and during learning activities is recommended. Recent estimations of the noise-related health impacts in the Netherlands suggest that current noise levels may be associated with annoyance in 1.5 - 2 million people (out of a population of 16 million) disturbed sleep in 550,000 - 1 million and about 220,000 cases of hypertension. In total, 1-2 % of the total disease burden could be attributed to traffic noise. Impacts in children cannot be estimated yet. The results of noise and HIA studies in different countries are difficult to compare due to methodological differences. The new EU directive on environmental noise provides a basis for further harmonisation.

The benefits of implementing several source-measures for noise abatement on cars and trains will exceed the costs of these measures, as cost-benefit analyses clearly indicate. For example, it has been estimated in the Netherlands that the implementation of several source-measures on cars and trains will cost about 2 billion Euros. The benefits in terms of reduced annoyance are estimated to be about 4-6 billion Euros . Estimations are that in the EU-15 the overall external (abatement) costs of road and rail traffic noise amount 0.4 % of the total GDP, some 36 billion Euros.

Transport-related Physical Activity and Health

The importance of regular physical activity for health is well established. Positive health effects have been demonstrated for life expectancy, cardiovascular disease, stroke, type II diabetes, obesity, some forms of cancer, osteoporosis, depression and independence at old age.

International minimum recommendations for health-enhancing physical activity refer to 30 minutes of moderately-intense activities. Moderate intensity is characterised by getting somewhat out of breath but not necessarily sweating, typical examples being walking and cycling. Further activities will convey further health benefits and in many countries the minimum recommendations for children are set at one hour per day.

However, levels of physical inactivity are alarmingly high not only in industrialized countries, and this poses a major public health problem. Studies indicate high levels of inactivity omong young people and a tendency towards declining activity levels from childhood to adolescence, which starts at puberty and continues until the young adulthood. Transport-related physical activity can make an important contribution to overall physical activity in children. A wealth of data exists on overweight and obesity which are strongly influenced by physical activity behaviour. Direct health impacts of physical activity in children have been shown for major diseases. Short-term effects of physical activity are most easily demonstrated and impressive in size for weight control, while the associations with type II diabetes and cardiovascular disease could become very important if current trends of inactivity continue. There is a greater likelihood that physically active young people, compared with those inactive, will be more active in later life as well, so it is perceivable that all health effects of physical activity in adults may be influenced by increasing and maintaining active behaviour in young people.

There is a clear need to develop more interventions to increase physical activity and more specifically transport-related physical activity and to assess their effectiveness. In particular, traffic interventions should be identified, such as awareness programmes relating to taking children to school, that are most likely to increase health-enhancing physical activity and to reach physically inactive population groups.

In Switzerland, a country with 7 million inhabitants, current estimates suggest that between 1.4 and 1.9 million cases of disease, between 2,000 and 2,700 deaths and direct treatment costs of 1.1 to 1.5 billion Euros are caused by physical inactivity.

Psychological and Social Impacts

Psychological and social impacts of transport are often ignored or underestimated despite the fact that they can influence mobility behaviour. For instance fear from traffic dangers has led to an increased number of parents who drive their children to school.

Furthermore health effects of noise and air pollutants also have a psychosocial component and therefore cannot be properly studied nor understood if psychology is neglected. Psychological and social mechanisms triggered by the perceived impact of transport alone can lead to disease. Every disease can also have consequences on the mental and social status of a person or an affected group of people. In addition, mental and social conditions can directly modify the impact of environmental stressors on humans.

In the long run high traffic density in human settlements may also lead to social effects by hindering the development of independence and social interaction in children.

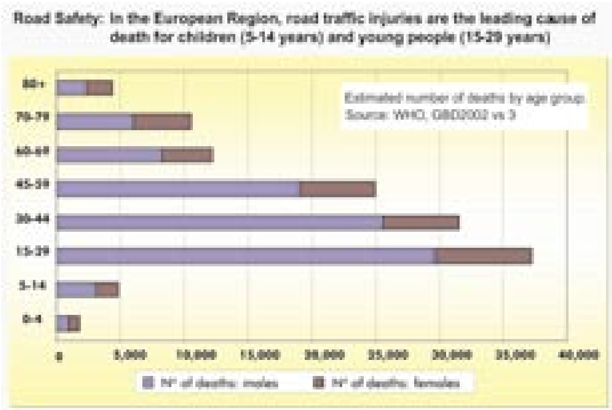
Psychological and social effects of transport should be seen as an integral part of transport-related health impacts. One example is that walking to school instead of being taken by car has a direct positive effect on psychological and physical well-being in children, in terms of lower scores of depression, anxiety, aggression and hostility, fewer psychosomatic symptoms, and improved motor skills. Conversely, fear of road traffic injuries acts as a barrier which prevents children from more walking and cycling.

Addressing our true needs, including those of children, requires us to address physiological, safety, security, social, intellectual and aesthetic dimensions. Moreover, children have very definite ideas as to what they need and what they want. These ideas are surprisingly consistent and coherent and even younger school children are able to express their wishes if they get the proper opportunity. Children's needs and aspirations should be taken as an important reference point in the planning of human settlements and mobility management. This would improve planning processes, children's self esteem and their social competence.

Road Traffic Injuries

Ten percent of the 1.2 million deaths estimated worldwide from road traffic injuries (RTIs) in 2002 occurred in the European Region. Road traffic injuries are the leading cause of death of children and young people (age of 5-29 years). 6,500 deaths/year are reported among children aged 0-14 years. Nearly 67 % of crashes occurred in built-up areas. Cyclists and pedestrians pay a disproportionate price, representing one third of the deaths from road traffic injuries. For the EU, the cost of RTIs are estimated to be 180 billion Euro per year. Children are particularly vulnerable because their ability to cope with traffic is limited until 10 years of age. They are more at risk in conditions with heavy or fast traffic, limited visibility, or when drivers' attention is focused elsewhere rather than on pedestrians or cyclists. A study reported that 33 % of children involved in road traffic crashes had post-traumatic stress disorder.

Real and perceived safety concerns are quoted as the most important barrier preventing many people from choosing walking and cycling as means of transport. Reducing road danger requires control of this threat and reducing casualties. Of particular concern is the issue of speed at the moment of collision, which is a key determinant for the severity of road traffic injuries. In pursuit of reducing road danger, studies using a Willingness to Pay approach suggest that the public may be willing to have more rigorous road safety controls and greater accountability by governments, as in the rail and air sectors. These studies serve as a pragmatic basis for assessing the value and appeal of safety programmes. More generally, road safety, including danger reduction, should become a governing parameter of road transport, and not a tradable variable. This requires strong political commitment and leadership. The adoption of a comprehensive approach to road safety, should address all components of the transport system, namely road users, vehicles and infrastructure, and should take into account the human body's vulnerability to excess kinetic energy and that imperfect road user behaviour is likely.



Lessons Learned: Assessment of Health Impacts and Economic Valuation

Assessments of transport related health impacts should be important tools to guide policy decisions in transport and land use policies. Health Impact Assessment (HIA) studies can also provide relevant information for policy makers on the effects of interventions on public health. Cost-benefit analyses can be derived from these estimates. There are challenges to the estimation of transport related health impacts in children, their costs and their benefits in particular:

- How to select pertinent health effects in children and how to estimate the quantitative relationships between exposure and health effect (exposure response function)
- How to accurately estimate the fraction of exposure coming from transport
- How to measure and express in monetary terms effects of physical, mental and social health and well-being and how to achieve comparability

There are different concepts to evaluate mortality or the risk of mortality and it is important to consider the context in which they are to be used.

For transport related air pollution and the related external costs two main methodologies have been used. These have been designed to answer different questions. The tri-national European project of Austria, France and Switzerland for the London Conference of WHO 1999 and the APHEIS study have led to a more global understanding of the overall impact of air pollution and is more appropriate for general transport policy planning at a national level. The ExternE study, which follows an impact-pathway approach, offers a better methodology to understand and assess the effects of specific interventions, such as minimum standards on fuel quality and engine or exhaust technology.

For noise assessments the mapping of noise exposure of the population and therein of children is crucial. Annoyance and sleep disturbance are recommendable end-points for health impact assessments. For these indicators generalized exposure response functions are available which can be used for impact assessment of transport noise.

Road safety impact assessments should focus in particular on vulnerable road users (e.g. children, bicyclists and pedestrians) and the decisive role of speed. They should be included into impact assessments of transport and land use programs and strategies.

Areas that require further investigation are the quantification and monetary valuation of psychological and social effects and the benefits of physical activity. A number of selected Swiss projects have begun to assess the effectiveness of interventions to promote physical activity. Studies to incorporate the health benefits of cycling into the cost benefit analysis of infrastructure development are also underway in Norway and Sweden. The result of a recent cost-benefit-analysis of cycling infrastructure in three Norwegian cities show that when the positive health aspects of physical activity are considered, the benefits for society of investing in cycle networks, significantly outweigh the cost.

Economic analyses and tools like cost-benefit analysis are often used in decision making regarding transport investments. These economic valuations have not to date taken sufficiently into account the transport related environmental health effects. Another major challenge when undertaking economic valuations is the issue of monetarization. Although not all health effects can be monetized as yet, there is a need to find ways of taking these fully into account when undertaking assessments and evaluations.

The Willingness To Pay (WTP) methodology of monetarization satisfies the condition of economic welfare theory by evaluating people's preferences. So far there have been no economic valuations that have applied this approach to children, but only to their parents as relevant studies of the US Environmental Protection Agency have shown. Economic valuations of transport-related health effects in children should apply at least the same costs as for adults, until child-specific values become available.

Often incomparability is a major obstacle. Different studies may give different results. The reasons for the differences should be made transparent. Harmonization of the methodology is strongly desirable.

Further research and work on traffic-related health effects on children and their economic evaluation is recommended.

KEY MESSAGES AND POLICY DIRECTIONS

Children are vulnerable and their needs should be taken first.

- Children are vulnerable from a physiological, psychological and economic point of view.
- Experience of a "healthy" environment as a child will influence future choices towards a healthy environment as an adult.
- Investments to improve health and environmental conditions for children benefit the entire society and avoid future costs.
- The UN Convention on the Rights of the Child (1989) specifically addresses children's rights to express views freely and be given due weight in accordance with age and maturity (Article 12).

There is an increasing dependence on private car use leading to severe restrictions for children's choice of mobility and physical activity.

- This is the result of the large investments in road infrastructure, the significant growth in road traffic and the rising car ownership and use among families.
- Urban sprawl is inter-related with car-dependent mobility and impediments to short distance trips on foot or bicycle.
- Children are the main losers of car dominated patterns of mobility as they have less opportunities for physical exercise and choice in modes of mobility.
- Consumers'behaviour(bigger/faster/morecars)offsets progress in cleaner technologies.
- Lack of investment and modernization of infrastructure and rolling stock has resulted in a stagnation or even a sharp decline of public transport and rail, particularly in the countries of Eastern Europe, the Caucasus, Central Asia (EECCA).

Present transport patterns and future trends pose a significant threat to children's health and development.

- Children's health is at risk due to traffic related accidents, air pollution, greenhouse gas emissions, noise, and restricted opportunities for safe walking, cycling and other outdoor activities.
- Present transport patterns are major contributors to ill health in children, for example through road traffic injuries and respiratory illness, and have contributed to the epidemic of childhood obesity and adult illnesses such as heart disease and osteoporosis.

Healthy mobility makes a difference.

- A minimum of 30 minutes a day of moderately intense physical activity significantly reduces the risks of important diseases such as cardiovascular disease, hypertension, Type II diabetes and some forms of cancer and enhances psychological wellbeing.
- Moderate physical activity will bring the biggest benefits to the sedentary.
- Safety concerns need to be addressed, by providing appropriate infrastructures in order to make walking and cycling realistic options (rather than being an excuse for a lack of action).
- Substituting car trips by journeys undertaken on foot, by bicycle and other forms of human powered mobility as well as public transport will also contribute to reducing congestion, exhaust emissions and noise.

Prioritising health and environment considerations as part of transport decision making, (particularly those addressing children's needs), would increase the efficiency and sustainability of transport systems. Policy makers should focus on implementing measures, which are highly beneficial to children, as they would also bring benefit to everyone.

Integrated policies for making transport children friendlier:

- Integrate a „children friendly mobility" vision into transport and transport related policies as well as infrastructure and human settlement planning. This could be facilitated by developing environment and health targets specific to children i.e. reductions in road traffic injuries, increase in physical activity.

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- Implement sustainable mobility management plans in schools including kindergarten and pre-schools. These plans should be developed and implemented in cooperation with pupils, teachers, parents organisations, local authorities and transport operators, with a view to promoting walking, cycling and public transport and less car use on the way to and from school.
- Give priority to speed reduction and control, for example by establishing 30 km/h as maximum speed limit in urban residential areas, implementing traffic calming, reducing car traffic and restricting access for motorised vehicles particularly around schools, playgrounds and kindergarten.
- Develop policies facilitating the reduction of car dependence and promote car-free settlements, housing and shopping, leisure activities and tourism.

Tools to support the integration of health concerns and children's needs into transport policies and decision-making

- Make use of tools for decision making such as Environmental Impact Assessments (EIA), Health Impact Assessment (HIA) and Strategic Environmental Assessments (SEA) in bringing health and environmental considerations at the core of decisions related to transport and land use planning.
- Children Impact Assessment (CIA) should be one of the tools used to measure effects of planned interventions at national/regional/local levels in order to identify areas of high concern for children. This approach can be used to assess health impacts, costs and benefits, and support the identification of recommended policy actions and implementation tools.
- Undertake and use economic studies and valuation methods for valuing and prioritising road safety and health benefits of walking and cycling in the development of transport policies.

Awareness raising, education and communication strategies:

- Launch national awareness-raising programmes on child friendly mobility, highlighting in particular the benefits of human powered mobility.
- Use communication strategies, which are action-oriented and tailored for different target groups.
- Promote more ecological and safer driving behaviour, such as "eco-driving", by implementing eco-driving measures including training of the drivers in safe and children-friendly driving styles.

Infrastructural measures and planning

- Extend and improve safe and attractive infra-structure for bicycles and pedestrians.
- Improve and extend public transport infrastructure and services, increase service quality and the use of fleets with child friendly low floor vehicles, and prioritize public transport in road traffic schemes.
- Reform design-standards and planning guidelines for infrastructure, transport codes, and zoning regulations according to children's needs.
- Implement noise abatement plans and measures, tighter noise requirements for sensitive areas such as schools and residential areas to minimize harmful educational and psychological effects.

Technical measures and standards

- Substantially reduce particle emissions by advocating the installation of particle filters or other appropriate technologies in cars and further tighten the particle emission standards for motorized vehicles in particular passenger cars.
- Implement safety measures, which are known to save children's lives such as child car safety seats, seat belt use, improving visibility, helmet use.

Research programmes should focus more on children specific concerns.

- Give more priority and support to assessments and monitoring of the transport related environment and health threats posed on children including epidemiological research on air pollution and noise, research on cumulative effects and inter-linkages with psychological and social issues as well as the positive impacts of mobility patterns relying on physical exercise.

Children's health can also be promoted by general policy using economic instruments and normative interventions.

- Implement mobility management in communities including parking fee schemes, car traffic restrictions and prioritization of walking, cycling and public transport.
- Enforce speed limits and speed control.
- Enforce maximum permissible alcohol blood level for drivers of less than 0.05 g/dl.
- Reduce traffic emissions by restricting traffic and improving vehicle technologies to meet the requirements set by the EU National Emission Ceilings of air pollutants.
- Further tighten emission standards (air pollutants as well as noise) for all motorized vehicles and improve safety for both their occupants and other road users (e.g. pedestrians, cyclists).
- Enforce periodic maintenance checks and improve emission remote control systems.
- Use CO_2 / energy taxes and incentives for introducing energy-saving technologies.
- Establish fiscal incentives for public transport and cycling.
- Consider pricing of road infrastructure - road pricing, parking fees, charging of car purchase and ownership.
- Provide incentives for zero or ultra-low emission vehicles (noise, pollution).

KEY MESSAGES AND POLICY DIRECTIONS

Individual costs of mobility do not reflect the full costs to society. In particular children's specific costs and needs for mobility are not yet accounted for: it is necessary to improve economic assessments and internalisation of costs and benefits, correct pricing-signals and include children specific costs in economic valuations.

- Promote and improve economic valuation of the transport related health impacts on children, including negative health effects of transport such as exhaust emissions and noise, as well as the positive health effects of walking and cycling.
- Integrate transport related health impacts on children and their costs and benefits into policy instruments e.g. when conducting cost-benefit-analysis of infrastructure and when considering internalisation of the external costs of transport.

There is a need to redesign human settlements and infrastructure to provide more space for physical, mental and social development of children. Integration of children's needs in planning and decision-making would help overcoming segregation effects and social deficits.

- Consider needs of children in the decision making process of transport, human settlements, land use and infrastructure planning, etc.
- Make children's needs and aspirations an important reference point in the creative planning process of human settlements and mobility management and follow a participative approach by involving children.
- Bring all relevant partners together for implementation; build new partnerships with children's interest groups.

Incorporating children's needs requires a shared responsibility of families, the educational, health, environment, transport and urban planning sectors as well as of the private sector, industry and civil society.

- Enforce better integration of children's needs and the related specific requirements into relevant policies at all political levels (international, national, local).
- Intensify pan-European co-operations and use the implementation of international agreements such as the WHO-CEHAPE, WHO/UNECE THE PEP, the EU-Environment & Health Strategy as driving forces for child friendly adaptation of existing policies and the formulation of new policies and actions.
- Strengthen the role of the health as well as of the education sector e.g. extending the concept of "healthy schools" by encompassing the journey to school.
- Promote the notion of liability for children´s health and the environment in industry (vehicle manufacturers, public transport companies) and amongst transport providers and infrastructure planners.

There is a world to win: Start to act now!!

- Collect and disseminate examples of best practices and assessments, establish new partnerships and co-operation among sectors.
- Develop and implement children friendly mobility plans and monitor their achievements.
- Design a "package" of integrative measures with a timeframe for implementation. These could start with pilot projects.
- Assess the transferability of different strategies across different cultural, political, economic and social settings.
- Start assessments of transport related health effects which include their costs and benefits with a particular focus on children.


Federal Office of Sports; CH

Front Cover: HERRY Consult; Puzzle: based on WHO publication „Preventing road traffic injury: a public health perspective for Europe"

<u>Links for further information</u>

Children' Environment and Health Action Plan for Europe
www.euro.who.int/budapest2004
THE PEP - Transport Health and Environment Trans-European Programme
http://unece.unog.ch/the-pep/en/welcome.htm
"Transport-related Health Effects with a Particular Focus on Children" (Transnational study and workshop series by Austria, France, Malta, the Netherlands, Sweden and Switzerland, 2004)
www.herry.at/the-pep
"Health Costs due to Road Traffic-related Air Pollution" (Tri-lateral study by Austria, France and Switzerland, 1999)
www.euro.who.int/transport/HIA/20021107_3
World Health Organization
www.euro.who.int/transport
ADEME – Agency for Environment and Energy Management, France
www.ademe.fr
bmgf - Austrian Federal Ministry of Health and Women
www.bmgf.gv.at
BMLFUW - Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management
www.lebensministerium.at
bm:vit - Austrian Federal Ministry of Traffic, Innovation and Technology
www.bmvit.gv.at
Federal Office of Public Health, Switzerland
www.bag.admin.ch
FOSPO - Federal Office of Sports, Switzerland
www.baspo.admin.ch
Medical University Vienna, Environmental Health Institute, Austria
www.univie.ac.at/umwelthygiene/
Ministry of Health, Elderly & Community Care, Malta
www.health.gov.mt
Ministry of Housing, Spatial Planning and the Environment of the Netherlands (VROM)
www.vrom.nl
Ministry of Transport, Public Works and Water Management of the Netherlands (VenW)
www.minvenw.nl
RIVM - National Institute of Public Health and Environment, the Netherlands
www.rivm.nl
Swedish Institute for Transport and Communications Analysis (SIKA)
www.sika-institute.se

Transnational Project and Workshop Series of
Austria, France, Malta, the Netherlands, Sweden and Switzerland

Transport-related Health Effects with a Particular Focus on Children

Towards an Integrated Assessment of their Costs and Benefits. State of the Art Knowledge, Methodological Aspects and Policy Directions

Topic Report

ECONOMIC VALUATION

SIKA

Martina Estreen, Swedish Institute for Transport and Communications Analysis (SIKA)
Göran Friberg, Swedish Institute for Transport and Communications Analysis (SIKA)

Commissioned by

SIKA

FHI
National Institute of Public Health

Final Report, 09 June 2004

Preface

This report presents the results from the Stockholm Workshop that was held on 12 – 13 June 2003. The workshop is part of the workshop series on *Transport Related Health Impacts, Costs and Benefits with a Particular Focus on Children*. This workshop series is a cooperation between Austria, Switzerland, France, Sweden, The Netherlands and Malta. The series of workshops is a contribution to the implementation of the UNECE – WHO Transport Health and Environment Pan-European Programme (PEP). The outcome of the workshops is also intended to provide input to the Ministerial Conference on Environment and Health *The Future of our Children* in Budapest 2004, CEHAPE and WHO guidelines for economic valuation of transport related health effects and their internalization.

The main purposes of the Stockholm workshop were to present an overview of different methods used for economic valuation of health effects due to transport, to compare and discuss their advantages and shortcomings, and to discuss the possibilities of implementation in different countries, with particular reference to the economic valuation issue and harmonization aspects.

The Stockholm Workshop was jointly hosted by the Swedish National Institute of Public Health (FHI) and the Swedish Institute for Transport and Communications Analysis (SIKA).

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1 Introduction

In the framework of the preparation of the WHO Charter on Transport, Environment and Health and the WHO Ministerial Meeting 1999 in London Austria, Switzerland and France jointly collaborated on a health cost study on effects of air pollution of road traffic, known as the tri-national study. These three countries than decided together with Sweden, Malta and The Netherlands on further cooperation in the field of assessment of transport related health impacts and their costs and benefits as a joint effort and contribution to the implementation of the WHO Charter on Transport, Environment and Health. Within this cooperation a workshop series on *Transport Related Health Impacts, Costs and Benefits with a Particular Focus on Children* was launched.

The series of workshops is a contribution to the implementation of the UNECE – WHO Transport Health and Environment Pan-European Programme (THE PEP) in particular to the following PEP-priorities:

- Promotion, implementation and review of policies designed to internalize the health and environmental externalities generated by transport activities.
- Special care for groups at high risk, in particular children.

The outcome of the workshops is also intended to provide input to:

- Fourth Ministerial conference on Environment and Health *The future for our children* in Budapest 2004
- CEHAPE – Children's environment and health action plan for Europe
- WHO-guidelines for economic valuation of transport related health effects and their internalization.

The first workshop focused on transport related health impacts (the Vienna workshop). The second workshop focused on economic valuation of health effects due to transport (the Stockholm workshop). The third workshop focused on issues specific to children (the The Hague workshop) and the fourth and final workshop discussed the synthesis report (the Malta workshop).

This is the report from the Stockholm Workshop that was held on 12 – 13 June 2003. The main purposes of the Stockholm Workshop were:

- to present an overview of different methods used for economic valuation of health effects due to transport,
- to compare and discuss their advantages and shortcomings, and
- to discuss the possibilities of implementation in different countries, with particular reference to the economic valuation issue and harmonization aspects.

The following topics were covered at the workshop: air pollution, noise, physical activity, psychological and social effects, road safety and climate change.

2 Existing data and results on economic valuation (national/international experiences)

2.1 Overall methodology issues

The DPSEEA framework applied to transport policy

Tord Kjellström presented the WHO DPSEEA (driving forces, pressures, state, exposures, health effects and actions) framework applied to transport policy, as shown in figure 1, in a paper at the Stockholm workshop (Kjellstrom et al, 2003). The framework presents linkages between health, environment and development. It is an adaptation of the pressure-state-response (P-S-R) framework that was developed by OECD. The DPSEEA is a descriptive representation of the way in which various driving forces generate pressures that affect the state of the environment and ultimately human health through the various exposure pathways by which people come into contact with the environment. Both the Impact Pathway Approach and the Damage Function Approach that will be described later on adopt this approach even though the approaches are not directly developed from the DPSEEA framework.

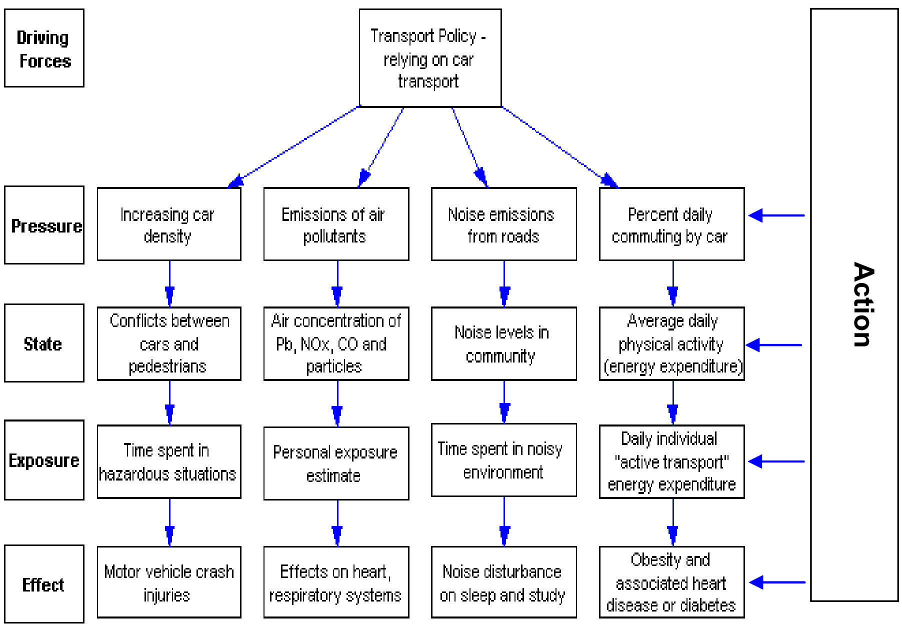

Figure 1. The DPSEEA framework applied to Transport policy

Concepts of monetary valuation

There are different approaches to evaluate and monetize health effects, both mortality and morbidity. In this section we will only give you a short presentation of the concepts that were discussed on the Stockholm workshop.

Willingness to pay (WTP) and willingness to accept (WTA)

The WTP approach measures the willingness to pay of the population for a reduction of risk which for example arises from the exposure of air pollution. The WTA approach measures the willingness to accept compensation for increased risk. WTP and WTA satisfy the condition of economic welfare theory by evaluating people's preferences.

The approach considers:
- Treatment costs that are individually borne
- Loss of production that is individually borne
- Averting expenditures individually borne
- Intangible costs (pain)

Disadvantages of the approach are:
- It is restricted to the individual borne costs.
- Reliability of the answers
- Interdependence between WTP and income.

WTP may be estimated by studying stated preferences (SP) or revealed preferences (RP). Stated preference studies are survey based, and rely on what individuals say they would do under specified, hypothetical circumstances. For SP there are a number of different methods: contingent valuation (CV), choice experiments (CE), conjoint analysis (CA) etc. CV studies for example directly ask individuals to report their willingness to pay to avoid illness or reduce their risk of dying. Revealed preference studies infer the value of avoiding illness and reducing the risk of dying by observing individual's behaviour and expenditures on related activities and goods. For RP, mainly Hedonic Pricing (HP) is used. (See also section 2.3 Noise about methods of estimating WTP.)

Cost of illness (COI)

The COI-approach takes material costs of mortality and morbidity into account. It is based on the determination of the damage for the entire society, without regarding the individual difference in valuing lower or higher risks of mortality or morbidity. The COI-approach considers:

- Gross loss of production. The gross loss production considers the entire salary for a person. The individual consumption of this person is included because it represents a (foregone) benefit.
- Costs of medical treatment
- Administrative costs of personal insurance.

Disadvantages of this approach are:

- Prevention or immaterial costs are not considered.
- Individual preferences are not considered.

Concepts of evaluation of mortality and morbidity

There are different concepts to evaluate mortality or the risk of mortality. The conventional approach is based on WTP for a change in the risk of death. This is converted into the Value of a Statistical Life (VOSL)[1] by dividing the WTP by the change in risk. The validity of this approach depends on a number of assumptions holding true, not least that there is "linearity" between risk and payment. Whilst this is likely to be a reasonable assumption over a small range of the risk of death it will be indefensible for large ranges of risk levels (Bickel, 2003).

When discussing VOSL it is also important to consider the context in which it is going to be used. There is evidence suggesting that WTP for reducing environmental mortality risks is higher than for traffic accidents risks (context sensitivity). Jones-Lee et al (1998) propose a factor of 2 to transfer the VOSL for road accidents to the air pollution context. In the EC funded project UNITE they used this context factor to transform the VOSL from road accidents into the environmental context, and in the tri-national study no context factor was used.

When discussing the value of a VOSL the question of age also arises. Should every year of life have the same value or should the years over say 90 count less? This is mainly an ethical question, and different studies have dealt with this issue differently.

Instead of looking at the probability of death one can look at the years of life lost to evaluate the mortality risk due to acute effects. A value of a life year lost (VLYL) can be derived from VOSL. The VLYL can be derived by assuming that the observed VOSL is the discounted present value of the future years, allowing for the survival probabilities.

For chronic effects the calculation is more complicated because after exposure impacts can occur with a latency that is variable. One way of estimating the chronic effects is to estimate the number of years of life lost (YOLL) (Bickel, 2003). After calculating YOLL for each future year and the total YOLL for the total number of years the $VLYL_{chronic}$ can be estimated. The concepts of YOLL and VLYL are based on changes in age-specific mortality risks and do not give fatalities.

The use of VLYL needs more work both regarding empiric and methodology (Bickel, 2003). The methodological advantages of using VLYL is that it allows greater flexibility in valuation, and secondly that it is one that clinicians are more comfortable in estimating in that it brings the WTP approach closer to the Quality Adjusted Life Year (QALY) approach. In addition, it is more amenable to valuing

[1] In the tri-national study VOSL is referred to as the value of prevented fatality (VPF).

chronic mortality as it is easier to express chronic impacts in terms of life years lost (Bickel, 2003).

Quality-adjusted life years (QALY) converts all health impacts (both mortality and morbidity) into changes in quality adjusted life years. Once conversion to QALY has been accomplished QALY can be aggregated across health outcomes and combined with cost to provide cost-utility ratios. Alternatively, a monetary value can be assigned (Hubbell, 2002).

Disability-adjusted life years (DALY) measures the loss compared to a hypothetical life profile, whilst QALY measures the actual health quality integrated over time. DALY's are the sum of YOLL and the years lived with disability (YLD) (Murray et al, 1996). The DALY concept cannot be converted into monetary terms. Neither QALY nor DALY is consistent with economic theory.

Valuation of children

We cannot measure the WTP of children, but rather of their parents. Since economic valuation for children is not available we have to rely on second person's perspective for the time being. At the The Hague workshop in October 2003 it was concluded that the effects on children should be valued at least at the same WTP as adults until there are children specific values available. The focus should be on mortality.

Transferability, harmonization and transparency

During the workshop the questions of transferability and harmonization of VOSL were discussed. When using different VOSL between countries in the same study there may be problems with consistency. Another problem when using different VOSL is that it can distort the competition between countries when for example internalizing the external costs in road tolls. There may exist reasons for having different VOSL, but it is important to explain why another value is used. Transparency is of great importance.

Another question that was also discussed during the workshop was morbidity value transfer. Different countries values morbidity differently. CSERGE et al (1999) conducted a morbidity valuation study with 5 countries. Within the study six morbidity episodes were valued by contingent valuation. The five countries were Netherlands, Norway, Portugal, Spain and UK. The study suggests that Spain and Norway have the highest WTP for all episodes, while Netherlands and UK have the lowest. The results for Portugal showed more variation. Differences in income do not explain the total differences. The fact that different countries have different WTP does not mean that they value people less. It can be explained by different hospital costs in different countries and that people in different countries have different preferences.

According to Nelltorp et al (2001) it is appropriate to use a European Standard value for VOSL for a European Union project, but for UNITE the following were recommended in the final draft *Valuation Conventions for UNITE*:[2]

- If a national value exists, if it is based on the WTP/WTA principle and if the basic study is well-designed it should be used in UNITE.
- In the absence of national values a European standard risk value should be used, adjusted in accordance with real per capita income at purchasing power parity exchange rates for each country.

2.2 Air pollution

Different approaches

Tri-national study

In 1998/1999 Austria, France and Switzerland conducted a tri-national study on health costs due to road traffic-related air pollution. With a common methodological approach, it was aimed to obtain comparable results for the health costs due to road traffic-related air pollution in the three countries in 1996. The study analyses the impact of a permanent abolishment of the road traffic-related air pollution on health costs in order to evaluate their long-term annual savings. The results of these investigations have been published in one synthesis report and three partial reports.[3] The country-specific results represented an input for the WHO Ministerial conference in June 1999 in London.

---

[2] UNITE – Unification of accounts and marginal costs of transport efficiency. UNITE is an EU funded project that was ended in 2002. The aim for UNITE was to value the environmental costs of transport.

[3] Fillinger P., Puybonnieux-Texier V. and Schneider J. (1999). *Health Costs due to Road Traffic-related Air Pollution, PM10 Population Exposure - An impact assessment project of Austria, France and Switzerland*. Prepared for the WHO Ministerial Conference on Environment and Health, London, 16 – 18 June 1999. PM10 Population Exposure – Technical Report on Air Pollution. Berne, Paris, Vienna.

Künzli N., Kaiser R., Medina S., Studnicka M., Oberfeld G. and Horak F. (1999). *Health Costs due to Road Traffic-related Air Pollution, Attributable cases - An impact assessment project of Austria, France and Switzerland*. Prepared for the WHO Ministerial Conference on Environment and Health, London, 16 – 18 June 1999. Air Pollution Attributable cases – Technical Report on Epidemiology. Berne, Paris, Vienna.

Seethaler R. (1999) *Health Costs due to Road Traffic-related Air Pollution, Attributable cases - An impact assessment project of Austria, France and Switzerland*. Prepared for the WHO Ministerial Conference on Environment and Health, London, 16 – 18 June 1999. Synthesis. Berne, Paris, Vienna.

Sommer H., Seethaler R., Chanel O., Herry M., Masson S. and Vergnaud J. Ch. (1999). *Health Costs due to Road Traffic-related Air Pollution - An impact assessment project of Austria, France and Switzerland*. Prepared for the WHO Ministerial Conference on Environment and Health, London, 16 – 18 June 1999. Economic Evaluation – Technical Report on Economy.

The monetary evaluation of the health costs is based on an interdisciplinary co-operation in the fields of air pollution, epidemiology and economy. Figure 2 presents an overview of the different tasks of the three domains (Sommer, 2003).

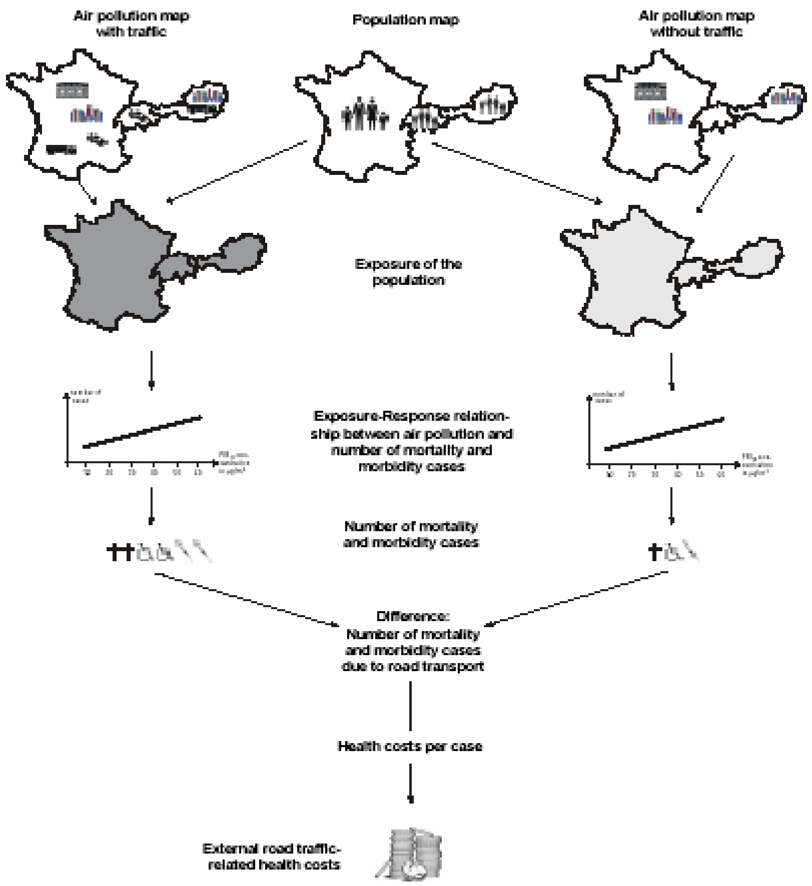

Figure 2. Methodological approach for the evaluation of mortality and morbidity due to road traffic-related air pollution. Source: Sommer (2003)

Air pollution

PM10 was chosen as leading indicator of air pollution although air pollution is a mixture of many substances. Several of the pollutants are often highly correlated (e.g. NO_2, CO, PM10, TSP etc.). The reason for choosing just one indicator was the risk of double-counting and overestimation.

To calculate the spatial distribution of PM10 empirical dispersion models or statistical methods were used. The general methodological framework for the air pollution assessment consisted of four main steps:

- Acquisition and analysis of the available data on ambient concentrations of particulate matter for model comparison or correlation analysis between different particle measurements methods.
- PM10 mapping by spatial interpolation with statistical methods or empirical dispersion modelling
- Estimation of the road traffic-related part of PM (based on emission inventories for primary particles and for the precursors of secondary particles)
- Estimation of the population exposure from a superposition of the PM10 map on the population distribution map.

To determine the regional background of PM10 the study used measured and modelled data from EMEP. According to the study over 50 % of PM10 may originate from large-scale transport. The contribution of traffic to PM10 background concentration is substantial and it may vary in space.

Health impacts

Health outcomes that met the following three criteria were considered:

1. there is epidemiological evidence that the selected health outcomes are linked to air pollution,
2. the selected health outcomes are sufficiently different from each other,
3. the selected health outcomes can be expressed in financial terms.

According to these criteria, seven health outcomes were considered, see table 1.

Table 1. Air pollution related health outcomes considered

Health outcome	**Age**
Total mortality	Adults, ≥30 years of age
Respiratory hospital admissions	All ages
Cardiovascular hospital admissions	All ages
Acute bronchitis	*Children, <15 years of age*
Restricted activity days	Adults, ≥30 years of age
Asthmatics: asthma attacks	*Children, <15 years of age;* Adults, ≥15 years of age

Exposure-response functions were derived by meta-analytical assessment of various (international) studies selected from the peer-reviewed epidemiological literature. The evaluation was based on epidemiologic results of extensive cohort studies as well as time series studies.

The impact of air pollution on mortality is based on the long-term effect. Accordingly, for the purpose of impact assessment, the study did not use response functions from daily mortality time-series studies to estimate the excess annual mortality but *the change in the long-term mortality rates associated with ambient air pollution.*

The expose response-functions were assumed to be the same for all countries, but the health outcome frequency was assumed to differ across countries. Therefore national or European data were used whenever possible to establish the countries' specific health outcome frequency.

Health costs

After having discussed the advantages and disadvantages of COI and WTP the tri-national study decided to mainly use the WTP to evaluate the social costs. According to the country specific needs, in addition to the WTP approach an alternative partial assessment approach was conducted based on COI. The considerations for choosing the WTP approach were:

- The main advantage of the WTP-approach lies in evaluating the individual preferences for risk reductions of morbidity and premature fatalities. It therefore meets the requirements of welfare economics, since it reflects the individual point of view.
- This approach enables to consider in a more or less liable way the intangible costs, which are especially in the case of death very high. The negligence of these costs – as in the COI-approach – would lead to a considerable underestimation of the effective health costs.

To evaluate the *costs due to mortality* the tri-national study chose the value of prevented life. The reason for that was the available budget and time restrictions. Therefore, empirical results of road accidents related WTP were used as a starting point. Based on a study by Jones-Lee et al from 1998 the starting point was set at EUR 1.4 million. No context factor was used to adjust for that the risk is different for air pollution than for traffic accidents. In the study the value of prevented life was age-adjusted with 40 per cent, so the WTP-value was set at EUR 0.9 million.

To evaluate the costs due to morbidity the study used studies that referred to the US context. The used WTP-values for the avoidance of air pollution related health outcomes in the tri-national study are presented in table 2. None of these values are specifically for children.

Table 2. WTP-values for the avoidance of air pollution related health outcomes.

Health indicator	WTP-values (€1996)
Respiratory hospital admission	7 870 per admission
Cardiovascular hospital admission	7 870 per admission
Chronic bronchitis	209 000 per case
Bronchitis	131 per case
Restricted activity day	94 per day
Asthmatics: asthma attacks (per day)	31 per attack

To calculate the costs due to air pollution from traffic the calculations were made for the current exposure to particulate matter as well as for a hypothetical situation without road traffic-related air pollution. The difference between the two results corresponds to the number of morbidity and mortality cases attributable to road traffic-related air pollution.

ExternE

ExternE is a series of projects supported by the European Commission. Initially ExternE aimed to calculate the external costs of air pollution from energy plants in Europe. In 1998 the method was developed to also be able to calculate the external costs from the transport sector's air pollution. The report of the 1998 – 2000 phase was published in Friedrich and Bickel (2001) and the latest phase – continuing until 2004 – has started.

Within the ExternE the *impact pathway-approach* was developed. The impact pathway-approach is a bottom-up approach. The term impact pathway relates to the sequence of events linking burden to an impact and subsequent valuation, as shown in figure 3. The chain of causal relationships starts from the emission of burden through transport and chemical conversion in the environment to the impact on various receptors, such as human beings, crops, building material or ecosystems. Based on exposure-response functions physical impacts are calculated. Finally the resulting welfare losses are transformed into monetary values.

Emissions
↓
Transport & Chemical conversion
↓
Concentration & Deposition
↓
Response of receptors
↓
Physical Impact
↓
Change in utility
↓
Welfare losses
↓
Costs

Figure 3. The Impact Pathway Approach

The approach can be used to value costs of small (marginal) and large changes in emissions. The cost estimates are case specific and depends on a number of case specific factors such as meteorological conditions, population density, traffic situations, vehicle technologies etc. Consequently, it is not possible to make simple generalisations of the results (Nerhagen & Johansson, 2003).

Within two other EU-funded projects RECORDIT and UNITE the approach has also been extended to noise impacts (See section 2.3 about noise). The methodology is also being developed for traffic accidents.

Air pollution

In ExternE both local and regional effects of air pollution are valuated. Local is up to 20 km and regional is Europe. Local health effects for PM2.5, SO_2, CO and carcinogenic substances are calculated. Regional health effects due to PM2.5, NO_x (through nitrates and ozone), VOC (through ozone) and SO_2 (directly and through sulphates) are calculated. For some of the substances effects on materials and on the ecosystems are also calculated. In this report we will, however, focus on the health effects (See Friedrich and Bickel, (2001) for further details).

Health impacts

The health impacts considered in ExternE are presented in table 3.

The estimate for the long-term mortality impacts of PM is based on an epidemiological study in the US (Pope et al, 1995). When it comes to the valuation of morbidity effects many of the recent ExternE values are based on European studies, for others US studies are still used.

Table 3. Health impacts in ExternE.

	Pollutant/Burden	**Effects**
Mortality	PM2.5	Reductions in life expectancy due to short and long time exposure
	SO_2, O_3	Reduction in life expectancy due to short time exposure
	Benzene, BaP, 1.3-butad., diesel part.	Reduction in life expectancy due to long time exposure (cancer)
Morbidity	PM2.5, O_3, SO_2	Respiratory hospital admissions
	PM2.5, O_3	Restricted activity days
	PM2.5, CO	Congestive heart failure
	Benzene, BaP, 1,3-butad., diesel part.	Cancer risk (non-fatal)
	PM2.5	Cerebrovascular hospital admissions, cases of chronic bronchitis, cases of cough in children, cough in asthmatics, lower respiratory symptoms
	O_3	Asthma attacks, symptom days

Health costs

The valuation is based on individual preferences, which are expressed as WTP or WTA. The total value of environmental impacts is taken as the sum of WTP and WTA of individuals.

ExternE uses discount rate values of 0% and 3% (see Hunt and Markandya, 2001).

Table 4. Monetary valuation of health effects due to air pollution.

Physical endpoint	Value €2000	
Lost life expectancy acute effects	165 700	per YOLL (3% DR)
Lost life expectancy acute effects	96 500	per YOLL (3% DR)
Value of prevented fatality	3 400 000	per case
Leukaemia, fatal	2 416 000	per case
Lung cancer, fatal	1 636 000	per case
Non fatal cancer	480 000	per case
Chronic bronchitis	169 000	per new case
Cerebrovascular hospital admission	16 730	per hospital admission
Respiratory hospital admission	4 320	per hospital admission
Congestive heart failure	3 260	per hospital admission
Chronic cough in children	240	per episode
Restricted activity day	110	per day
Asthma attack	75	per day
Minor restricted activity day	45	per day
Symptom day	45	per day
Cough	45	per day
Bronchodilator usage	40	per day
Lower respiratory symptoms	8	per day

To calculate the number of years life lost (YOLL) life tables with population-at-risk and age-specific death rates in four European countries were used. The pollution effect is calculated by the differences in a baseline scenario and a changed scenario. In the changed scenario the hazard rates change for one year.

Modelling assumptions:
- Concentrations revert to their initial values after one year.
- Variation of latency between 0 and 20 years; selection of values for latency of 10 years
- Application to all age cohorts (not only 30+)
- Short-term effects are included.

Both WTP and COI are used for the monetary valuation.

The Swedish case – comparison between ExternE and ASEK

Lena Nerhagen at VTI, Sweden, presented results from an "ExternE project" where the costs of air pollution from the transport sector in Sweden for the year 2000 were calculated with the Impact Pathway Approach. This has been a joint project between VTI, TFK and IER at the University of Stuttgart. IER performed the calculations. The paper by Nerhagen focuses on the cost due to health effects in urban areas that are due to locally dispersed pollutants. Costs have been estimated for all urban areas in Sweden. Two specific cases were estimated, namely Stockholm and Skellefteå. For locally dispersed pollutants only health effects are accounted for.

Within the project the results from the study were compared with the estimates currently in use in Sweden, the ASEK-values. The reason for making comparisons was to explore how the differences in assumptions and models that have been used influenced the results.

"The ExternE study"

The "ExternE study" used the same assumptions as in the EU-funded UNITE project. Costs have been estimated for the following categories; HDV, bus, diesel car, petrol car and two-wheelers.

The pollutants considered on the local scale in the "ExternE study" were particles, CO, SO_2, Benzene, BaP and 1.3 Butadiene. All calculations are based on average yearly emissions.

In the presentation to the Stockholm Workshop only the health cost due to locally dispersed pollutants and their health impacts were considered. In the "ExternE study" also regional impacts were accounted for. The regional costs are not only based on the Impact Pathway Approach but also on abatement costs for acidification and eutrophication.

The starting point for the calculation of vehicle mileage in urban areas for road transport in the "ExternE study" was an estimate of the total vehicle mileage in urban areas in Sweden given by SIKA. This was then distributed proportionally to the population in urban areas. Emissions were calculated by using emission factors from COPERT III.

For directly emitted particles only chronic mortality is included in the calculation in the "ExternE study". Chronic mortality is death that occurs with latency.

The costs of emissions on urban roads in the "ExternE study" have been calculated for different vehicle categories in every urban area in Sweden, i.e. for accounting for geographical distribution of the emissions. The cost for each area and each vehicle category are than added to obtain the total cost for all urban areas.[4] The total cost is then used to calculate the average cost per km in urban areas in Sweden.

The cost per km differs between different vehicle categories since the amount of pollutants emitted differs. The costs are highest for bus and HDV since they have large specific emissions. Diesel cars in general have higher costs due to the large amount of particles emitted. The relatively high costs for two-wheelers are due to the emissions of NMVOC (the carcinogenic substances considered). Emissions also vary within a certain category. For example there are new diesel vehicles with lower particle emissions than for an average petrol vehicle.

The study shows that the cost is dominated by the health effects of particles. For all vehicle categories the mortality cost is the largest component. It is found that

[4] All the calculations were based on factor prices as in UNITE. To obtain market prices, the value added tax has to be added. We assume market prices = 1.20*factor prices. To make comparison with Swedish estimates the estimates were converted from EUR to SEK (EUR 1 = SEK 9).

particles impose the highest cost and this is due to chronic mortality and morbidity. Since the calculations are based on average yearly emissions, the cost calculation is based on the total years of life lost for each city. The value of years of life lost due to chronic mortality is EUR 76 400.

ASEK

The ASEK-values are used in transport investment analysis.[5] These values are the result of a study undertaken by Leksell (1999), which was commissioned by SIKA. As in the “ExternE study” there are cost estimates for pollutants with local impacts. The ASEK estimates on the local scale are partly based on the estimates in the ExternE-approach from 1995 and 1998. The cost per kg is dependent upon the number of individuals that are exposed. Leksell used abatement costs to estimate the costs of regional impacts.

In ASEK particles, NMVOC, NO_2 and SO_2 are accounted for on the local scale. For regional impacts ASEK have cost estimates for NMVOC, NO_2 and SO_2. On the local scale one important difference is the treatment of NO_x.

Comparison between ASEK and the “ExternE study”

Of the ASEK values only those for particles are truly based on the Impact Pathway Approach. The assumptions behind these cost estimates are, however, somewhat different from those in the “ExternE study”. One difference is that the used exposure-response coefficient is higher in ASEK. This is in accordance with the assumptions in the earlier ExternE projects. Another difference is that the estimates in ASEK are based on a lower VOSL. A third difference is that the estimates in ASEK are based on market values and the “ExternE study” used factor prices. To make comparison between the different studies all prices were converted to market prices and the original coefficient for chronic mortality (up scaled) were used.

One reason for the big difference between ASEK and the “ExternE study” is differences in the used values and how these values are derived. The most influential difference is however the calculation of the impact (specific exposure) in urban areas that gives the much higher cost per kg in ASEK. The “ExternE study” did not have the resources to further investigate the reasons for these differences.

[5] ASEK is an abbreviation (in Swedish) for Working Group for Cost Benefit Calculations.

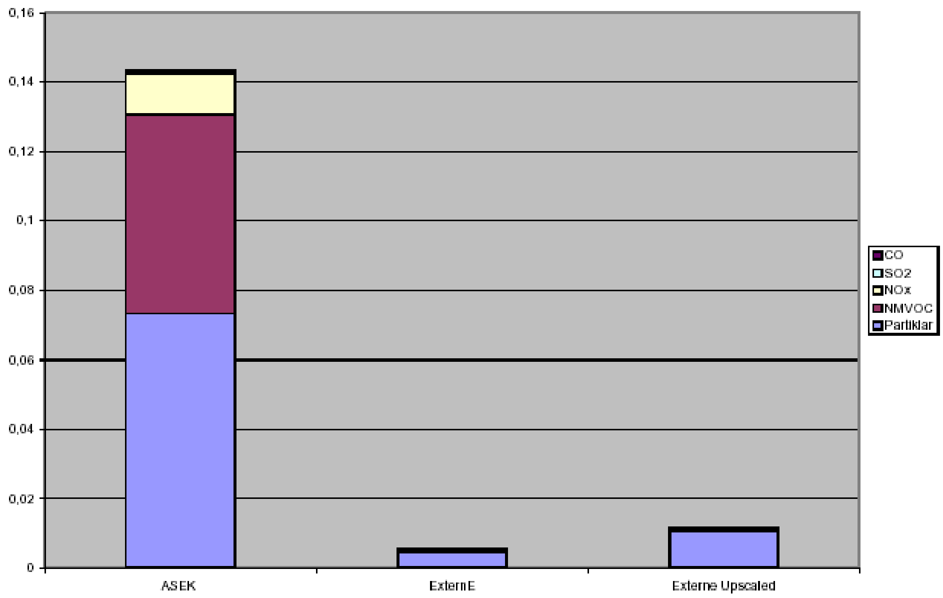

Figure 4. Cost/km for petrol cars in urban areas (SEK). Source: Nerhagen (2003).

Lena Nerhagen pointed out some of the shortcomings with the study and the Impact Pathway Approach:

- Only impacts are included where a quantified exposure-response relationship exists.
- Differences of the costs/km in different urban areas are mainly due to population density and meteorological conditions.
- The present Impact Pathway Approach only calculates the average cost over a year. Other variations, due to short-term weather conditions for example, are not accounted for.
- At present, only chemical reactions that influence regionally dispersed pollutants are included.
- It is not straightforward to compare average cost estimates with cost estimates for specific studies. The average will be influenced by the geographical location of the emissions where meteorological conditions and population density will be different from those in a case study.

Differences between approaches

The previous sections have shown that different studies give different results due to a number of circumstances. This has a negative impact on the credibility of the use of economic valuation of health effects. This gives rise to a number of questions, e.g.:

- Why are the results so different?
- Are the differences justified and can we accept them?
- Is there a need for harmonization?

There are many possible reasons for differences in outcome of calculations. In this section we will point out some of them. However, to map all the differences takes time and it will therefore require a special investigation. In this paper we will only give a brief indication on some of the differences between the studies. The workshop concluded that it was of great importance to initiate an investigation of this kind and that it is important that different expertise is included in the investigation. This comparison project needs to identify the differences in the calculations at each stage: emissions, air concentrations, exposures, effects and finally economic valuation, in order to identify where the greatest source of difference lie.

Air pollution

The results depend on:

- Type of the considered air pollution (only PM10 or other substances too)
- Estimated emission of air pollution
- Modelling of the exposure to air pollution (e.g. handling of cross national emission, handling of natural background exposure).

According to Sommer significant differences (up to a factor 2) can arise.

Emission inventories can cover emission sources to a different extent. In ExternE transboundary air pollution is included. This is not the case for the tri-national study.

Another difference is that in the tri-national study only one indicator is used (PM10) and in ExternE several indicators are used. If more than one parameter is used, there is a risk for double counting. In ExternE this is discussed when choosing the ER-functions.

Health impacts

The results depend crucially on the way of considering the effects of mortality:

- Short and long term mortality
- Value used from the exposure response-function (e.g. 4.3% per 10μg/m^3 PM10 in the tri-national study, around 0.6% per μg/m^3 in previous ExternE project or 0.214% per μg/m^3 which is the current value in ExternE).

At this level, the differences can be up to a factor 6.

Exposure calculation can be carried out in different ways. Exposure at all levels or only at levels above a threshold value may be considered.

Different exposure-response function may be used. Even though different methods refer to the same/similar studies on exposure-response relationships, the concrete application of the study results may differ with potentially high effects on the results. This holds in particular for the quantification of mortality impacts in the tri-national study and ExternE.

Different health effects may be included. Short or long term mortality may be considered. In the tri-national study only long term effects of mortality were considered, while both short and long-term mortality were considered in ExternE.

Health costs

The evaluation of mortality and lost life years respectively is particularly important. At this level there can also arise significant differences. The evaluation of a reduction to the risk of mortality differs from 0.9 to 3 million Euros per prevented fatality, depending on the study referred to.

When valuing mortality, different approaches may be used, e.g. number of deaths or years of life lost (YOLL). The tri-national study uses number of deaths, while ExternE uses YOLL.

Different types of costs may be taken into account. Welfare costs may be included or not, e.g. Willingness to pay (WTP) or Cost of Illness (COI).

WTP may be different in different countries, cultures, ages, socioeconomic groups etc. WTP may be estimated by transferring results from studies of other effects or of other population groups, sometimes using a "context factor".

Depending on the aim of the study, the total costs, the average costs (AC) or the marginal costs (MC) may be calculated. Methods for calculating health effects and associated costs are designed for specific purposes and are therefore suitable for certain applications. The method applied in the tri-national study is designed for calculating the total cost of air pollution in general and from the road transport sector in particular. The ExternE methodology allows the assessment of different emission scenarios, which is appropriate for assessing different policy measures as well as marginal costs.

We have to accept that results differ but we should be aware of the reasons for the differences. The differences may well be justified as different methods are to be used to answer different questions. The results can be used in a number of different ways, and it is necessary that the methods are transparent in order to judge whether the results can answer the actual questions. For example, different uses of results may be:

- Special interest in different specified effects and impacts
- Different temporal or special scales
- National or international policy setting
- Special interest in effects for specified groups (e.g. children)
- Total costs, pricing or changes due to policy changes.

There is a need for harmonization of which methods should be used different purposes. There should be recommendations on where harmonization could be achieved and where it cannot.

Economic valuation on effects on children

A few health end-points have been identified, for which ERFs could be derived from ongoing international review meta-analysis.

There is a need for guidance by economists on which of the identified outcomes that could be valued in economic terms.

The consideration of the specific exposure and health impacts for children is desirable. Facing the actual need for clarification on a general level, this work can probably not be done before the next WHO Ministerial Conference in Budapest 2004 without additional effort between the different workshops.

2.3 Noise

The transport sector is to a great extent responsible to the noise annoyance in society. EC has proposed a directive on the assessment and management of Environmental Noise (END). In accordance with the proposal the Member States are required to produce "strategic noise maps" by using noise indicators (L_{den}[6] and L_{night}[7])[8] assessing the number of people affected by noise, to inform the public about noise exposure and its effects. Another requirement is to draw up "action plans" to reduce noise where necessary and to maintain environmental noise quality where it is good. In order to perform cost-benefit analyses of action plans under the new directive the EC and each individual member state need to establish interim economic values from different transportation modes and industrial noise.

Different approaches

Damage Function Approach (DFA)

Ståle Navrud presented the Damage Function Approach (DFA). A description of DFA applied to noise is given in figure 5. The DFA is divided into seven steps, where steps written in capital letters denote models/methods, while steps in small letters denote input and output to these models/methods. In figure 5 only the annoyance impact of noise is considered, but the same framework can be used to consider other impacts in terms of endpoints of ERFs.

[6] L_{den} (day-evening-night indicator): noise indicator for overall annoyance, defined in Annex I of the END.
[7] L_{night} (evening-noise indicator): noise indicator for sleep disturbance, defined in Annex I of the END.
[8] These noise indicators relate noise levels outside the dwelling.

1. Measure → Reduced noise emission
2. NOISE DISPERSION MODEL
3. Changes exposures (L_{den}, L_{night} – noise maps)
4. EXPOSURE-RESPONSE FUNCTIONS (ERFs)
   Endpoints:
   - Ischaemic heart disease/myocardial infarction
   - Hypertension
   - Subjective sleep quality (Sleep disturbance)
   - Speech interference in offices (Communications disturbance)
   - *Annoyance (level of annoyance)*
     (e.g. percentage of exposed persons highly annoyed (HA) as a function of noise exposure (L_{den}))
5. Noise Impact (e.g. "reduced no. of persons HA per year")
6. ECONOMIC VALUATION TECHNIQUES
   (e.g. "euro per person HA per year")
   - Benefit transfer
   - Conduct new, original valuation study
7. Economic benefits
   (e.g. "euro per person HA/year" x "reduced no. of person HA/year") Aggregate over all endpoints of ERFs (avoid double counting)

Figure 5. Damage Function Approach

The DFA is able to consider

- Non-linear relationships in ERFs and value functions
- Different initial noise levels
- The importance of context (e.g. characteristics of different noise sources).

To calculate welfare loss from noise following costs should be calculated for each ERF (Hunt 2001):

1. Resource Costs (Medical Costs)
2. Opportunity Costs (Lost productivity at work and opportunity cost of leisure and non-paid work)
3. Disutility (activity restrictions, discomfort, inconveniences, anxiety about the future, concern and inconvenience to family members and others)

The components 1 and 2 can be valued by market prices (COI). This measure needs to be added to a measure of affected individual's loss of utility, reflected in a valuation of WTP/WTA to avoid/compensate for the loss of welfare associated with the illness (component 3). Component 3 should be valued by valuation techniques. For annoyance the welfare component (3) is thought to dominate, but opportunity costs (component 2) should also be added when applicable. By using both COI and WTP/WTA there is however a risk for double-counting. To avoid double-counting Navrud suggests that one should assume welfare loss from annoyance as a lower estimate of welfare loss from all impacts from noise. This also avoids using uncertain ER-functions for health impacts.

There are three alternatives when choosing unit for economic valuation:

1. NSDI (Noise Sensitivity Depreciation Index)
   - HP studies
   - Delphi studies of real estate agents and assessors
2. "Euro per person (household) per dB per year"
   - HP studies (assuming discount rates and time horizon)
   - SP studies – CV/CE/CA
3. "Euro per annoyed person (household) per year"
   - SP studies – CV/CE/CA
   - Unit for valuation correspond with endpoint of ER-function
   (annoyance levels: HA only vs. values for each level)

The first two alternatives are exposed-based valuation approaches, and skips steps 4 and 5 in DFA. The third alternative is an annoyance-based valuation approach and follows all seven steps in DFA. According to Navrud an economic value for a specific level of annoyance is most probably more transferable, as the level of annoyance is a measure of individual preference.

Which of the units that should be chosen for benefit transfer (BT) depends on

- theoretical recommendation
- stock of relevant studies to support unit value
- uncertainty/validity of BT technique (assumptions, possible correction factors)
- values for short term vs. long term

Impact Pathway Approach (IPA)

The IPA for noise is similar to the IPA for air pollution. The IPA was used to calculate marginal external costs of noise from road and rail transport in the EC project RECORDIT (Schmid et al 2001) and for total and marginal external costs of road, rail and air transport in the EC project UNITE (Bickel et al 2001). The IPA is equivalent to DFA.

In the IPA exposure-response functions for stress-related health effects and sleep disturbance were established. The ER-functions are based on recommendations on adverse health effects for ischaemic heart disease, hypertension and subjective sleep quality (sleep disturbance), see table 5.

Table 5. Health effects from noise exposure and their expectancy value. Source: Bickel (2004)

Health effects from noise exposure	Expectancy value (per 1,000 adults exposed)[a)]
Myocard infarction (MI), fatal, years of life lost (YOLL)	0.084 Lden-5.25
Myocard infarction, non-fatal, days in hospital	0.504 Lden-31.5
Myocard infarction, non-fatal, days absent from work	0.896 Lden-56
Myocard infarction, expected cases of morbidity	0.028 Lden - 1.75
Angina Pectoris, days in hospital	0.168 Lden- 10.5
Angina Pectoris, days absent from work	0.684 Lden - 42.8
Angina Pectoris, expected no of morbidity days	0.240 Lden - 15
Hypertension, days in hospital	0.063 Lden - 4.5
Sleep disturbance road traffic	0.62 Lnight - 43.2 [b)]
Sleep disturbance rail traffic	0.32 Lnight - 40.0[c)]
Sleep disturbance aircraft traffic	0.48 Lnight – 32.6[d)]

a) Threshold is 70 dB(A) Lden; b) Threshold is 43.2 dB(A). Other assumptions: Myocardial Infarction, 7 years of life lost per fatal heart attack in average; base risk is 0.005 and survival probability: 0.7; Angina Pectoris, base risk: 0.0015. The Lnight as assessed outside at the most exposed facade

To calculate the welfare loss from noise the IPA also uses the methodology that Hunt (2001) provided. The valuation techniques used in IPA is HP-studies.

Table 6. Economic values for impacts from transport noise. Source: Bickel (2004)

Health effects from noise exposure	Costs (EUR) per unit
Myocard infarction (MI), fatal, years of life lost (YOLL)	EUR 96,500 /YOLL
Myocard infarction, non-fatal, days in hospital	EUR 680/cardio-related inpatient days
Myocard infarction, non-fatal, days absent from work	EUR 100 /day
Myocard infarction, expected cases of morbidity	EUR 14,400 /case to avoid morbidity
Angina Pectoris, days in hospital	EUR 680 /cardio-related inpatient day
Angina Pectoris, days absent from work	EUR 100 /day
Angina Pectoris, expected no of morbidity days	EUR 230 /day to avoid morbidity
Hypertension, days in hospital	EUR 350 /inpatient day
Sleep disturbance	EUR 220 /person/year (COI)

On an ExternE workshop that was held in Prague in February 2004 Bickel (2004) concluded the work that has been done so far within the ExternE projects on the valuation of impacts from noise:

- Marginal costs are highly non-linear (background noise is very important)
- Noise exposure estimation is difficult due to very local effects (e.g. topography, noise, barriers)
- Additional work on ERFs and valuation is required
- "Bundling effect" if pricing based on marginal noise costs decrease with increasing traffic flow.

Methods for estimating WTP

Environmental valuation methods, both stated preferences (SP) and revealed preferences (RP) methods have been applied to estimate the economic value of changes in noise levels. Most studies have applied the RP approach of Hedonic Price (HP) to the housing market to analyse how differences in property prices reflect individuals' willingness-to-pay (WTP) for lower noise levels. Navrud presents in his input paper to the Stockholm Workshop the different methods to estimate WTP. In this paper we will only give a brief presentation of some of these discussions.

Most of the studies on noise are HP studies. The strength of HP-studies is that they rely on actual behaviour in the housing market where individual WTP for noise and other characteristics of the house can be observed. General weaknesses are that the result of HP studies, in terms of the implicit price of the environmental factor (NSDI) is very sensitive to modelling decisions and the conditions in the local housing markets. According to a review of hedonic pricing studies by Bateman et al (2001) the depreciation in house prices per 1 dBA increase in noise from road traffic is 0.55 percent (range 0.08 – 2.22).

However, there has been an increased interest more recently in applying SP methods to value noise. Contingent Valuation (CV), Conjoint Analysis (CA) and Choice Experiments (CE) have all been applied to value transportation noise. One reason for the relatively few CV studies could, according to Navrud, be the difficulties in constructing a good CV. Many of the SP studies are linking noise level and WTP and not annoyance level and WTP, as Navrud recommends.

Navrud has also conducted a review of noise valuation studies. The review shows that the methodological approach and unit used to measure the economic value of noise annoyance in four European countries (UK, Denmark, Sweden and Norway) differ between countries, and even between different sectors/agencies in the same country. However, there seems to be two main approaches:

- An economic value per decibel per year, measured by NDSI, defined as the average percentage change in property prices per decibel
- An economic value per year per person (or household) annoyed by noise. Two measures are used, value per year per person "highly annoyed" (HA) and value per person "annoyed" independent of the level of annoyance.

EU DG Environment recommends using EUR 25 /dB/household/year (2001 price level) as an interim value in their CBAs concerning road traffic noise. This estimation is based on a number of SP studies. Interim values for noise from air-crafts and railways are not possible to establish due to the number of studies being very small.

Guillaume Faburel (2003 and 2004) addresses the issue of noise annoyance from aircraft. He uses the CV approach to value the social costs of annoyance near Orly Airport. The result from the study on noise annoyance near Orly Airport gives an estimate on about EUR 7 (1999)/household/month as a mean WTP (range 1.47 to 16.39). CV studies are, according to Faburel, the only economic valuation of social cost which is able to address not just noise emissions. The WTP of neigh-bouring residents for a mitigation of this annoyance is more correlated to annoy-ance than noise intensity or to other physical characteristics of noise.

According to Faburel the econometric results indicate that other individual factors than income play a role in the willingness to pay. Some of the correlated factors are household size, the educational level, dwelling, time spent in the house, use of garden and political opinions. Behind the WTP for a mitigation of annoyance, there is an influence of territorial parameters, all else equal, the others more linked to the local context. Faburel therefore suggests that when dealing with economic valuation on noise externalities from transportation on should deal with annoyance.

Transferability

Navrud drew at the following conclusion concerning the transferability:

- In order to refine and improve the transferability of the interim value for road traffic noise and establish similar values for aircraft and railway noise:
    - The DFA should be applied to value welfare loss from noise annoyance.
    - This implies a great need for new SP studies.
    - These studies should be constructed to provide values for endpoints of exposure-response functions for different annoyance levels, defined according to the current international standard.
- It also needs to establish values for:
    - Annoyance from low noise levels (which could also better determine a potential cut-off rats for noise values, below which we can assume zero economic damage),
    - Multiple noise sources, health impacts from noise and
    - The effect of being exposed to multiple environmental impacts including noise.

Harmonization

There is evidence for different NSDI and values for dBA per person in different countries (and within countries) and also depending on income level.

Exposure-response functions could vary between countries, and so could economic value for each annoyance level.

There are some empirical evidence for lower values in association countries, but not conclusive. From an ethical point of view there should be the same value in all countries.

Economic valuation on effects on children

Little is known about health effects of noise on children, and no economic valuations exist to date:

- Cognitive effects are being assessed for airports and road through RANCH;
- No information on annoyance and sleep disturbance (existing ERFs are valid only for adults).

Gaps and research needs

- More SP studies producing values for endpoints from ER-functions (based on a standardized noise annoyance scale)
- Annoyance and valuation of noise during day, evening and night
- More SP studies on aircraft and railway noise
- Annoyance and valuation of noise outside the home
- Annoyance and valuation of noise from multiple sources. Noise in a broader context of all environmental factors affecting peoples well-being
- ER-functions, annoyance level and valuation of noise at lower noise levels
- Impacts and economic values of noise annoyance for children (How can ER-functions and economic values for adults be transferred to children? Results from morbidity valuation shows that parents put higher value on avoiding ill health episodes in children, e.g. Navrud 2001 – is the same true for noise annoyance?)

2.4 Psychological and social effects of transport

At the Vienna workshop a framework for consideration of psychological and social aspects on health effects of transport was outlined, as shown in table 7. At the Stockholm workshop we did not make further progress in completing the framework. It was, however, stated that there was a need for further research to enable to set cost estimates on psychological and social aspects. Different fields must work together if such work is to be successful.

There are a number of effects (e.g. physiological) that can be detected even if people do not perceive them and are not annoyed.

While it is possible to value perceived annoyance, effects that are not perceived cannot be assessed in Stated Preference studies. Some of the effects could be valued (e.g. effort for performance, if it is related to longer time to perform the task, this time could be valued; other effects, such as on creativity could be more difficult to assess; IQ can be another measure).

In addition to effects related to noise, there are other important effects, such as "fear" of traffic dangers, which is a powerful modifier of travel behaviour (e.g. parents driving children to school). Also these effects and their costs should be captured by economic valuations.

For those effects which cannot be valued (e.g. effects on creativity), there should still be a statement of their possible occurrence.

Table 7. Considerations on a framework on health effects of transport: Psychological and social aspects. (Output from the Vienna workshop, slightly modified.)

Framing theory: "***Human Needs***"	Topics relevant to transport (+/-)	Operationalization	Solutions
Aesthetic Needs *Interests, hobbies, goals, wishes,*	Special needs for e.g. artists (music), special needs for creative activities, personal target values, ...	Self rated "annoyance, disturbance, ...", creativity tests, interviews ...	
Intellectual Needs *Cognitive performance, learning, creativity, …*	Undisturbed reading, working activities, learning (school), learning to read, to speak,	Performance, cognitive tests, attention tests, memory tests, creativity, ...	
Social Needs *Significant primary relationship, autonomy, social roles and opportunities to participate, …*	(Focus on young/old/handicapped persons, sex aspects, social competence) means to communicate, meet other people (friends, relatives), educational needs, reach recreational areas, social behaviour, accessibility of shops, cultural events, medical care, workplace, participation,	Questionnaires, interviews, focus groups, observed behaviour, (aggressiveness), measured distances, time spent (physical measure) and lost (perceived), ...	
Safety, Security Needs *Housing, economic security, non-hazardous environment, appropriate health care, security in childhood, basic education, …*	Playground for children, safe space in the living area, low risk for pedestrians, cyclists, passengers, and car drivers,	Questionnaires, observed behaviour, (aggressiveness), measure distances, time spent (physical measure) and lost (perceived), census data, ...	
Physiological Needs *Nutritional food, clean water, recreation, no sleep disturbance, …*	No sleep disturbances, recreation areas (in vicinity), unpolluted air, water, food,	Questionnaires, physiological tests, performance, ...	
Cross-cutting "third dimension":	Values, Attitudes, Emotions, Equality ("Win-win-strategies"), Effort, Annoyance,	Ratings	Exposure reduction /control, mediation, information
Other psychological aspects to be considered	Posttraumatic stress disorder, anxiety disorder, ...	Classification systems	
Other social aspects to be considered	"Secondary effects" of injured/killed persons (on family, employer, etc.)		
Others …	Consideration of LOW INTENSITY expositions and (over additive?) combined environmental effects.		

2.5 Physical activity

Cost- benefit analyses (CBAs) of walking- and cycling track networks in three Norwegian cities were presented by Kjartan Saelensminde. A request from the Norwegian Parliament in 2001 to: "prepare a National Cycling Strategy where the main goal is to make it safer and more attractive to choose the bicycle as means of transport" motivated the study. The CBAs take into account the benefit of reduced insecurity and the health benefits of the improved fitness the use of non-motorized transport provides. In addition to such reduction in health costs, it is included that a change from travel by car to cycling and walking means reduced external cost (e.g. air-pollution and noise) from road traffic and reduced parking costs. The benefit of cycle network investments is nevertheless estimated to at least 4-5 times the costs. Such investments are thus more profitable to society than other transport investments. The result from such "complete" CBAs gives the possibility to calculate the benefit to society that is not realized because road traffic obstruct people in choosing bicycle and walking as much as they otherwise would have preferred. These barrier costs attributable to motorized traffic are estimated to at least the same magnitude as air pollution costs and over double the noise costs. Barrier costs should therefore be taken into account, in the same way as other external costs, when the issue is to determine the "right" level of car taxes or to evaluate different kind of restrictions on car use.

Methodology

The "complete" cost- benefit analysis includes estimates of the following components:

- Traffic accidents: A walk- and cycle track network with safe crossing facilities will probably reduce the number of traffic accidents involving pedestrians and cyclists. Within this survey it has been assumed that the number of traffic accidents resulting in personal injury will not be changed because of the new walking- and cycling tracks, in order to avoid overestimation of the benefit
- Travel time: In this CBA it has been assumed that travel time for pedestrians and cyclist are not changed because of the walking- and cycle tracks.
- Insecurity: Insecurity felt by pedestrians and cyclists moving along a road are included in the analyses with a cost of NOK 2 per km. assuming an average speed of 10-20 km/h the cost of insecurity is about NOK 20-40 /h for cyclists. Compared to the values of travel time included in CBAs for crossing facilities at NOK 66 /h the estimated cost of insecurity seems to be of reasonable relative magnitude.
- School bus transport: School children are offered transport to and from school if the road is classified as too dangerous to walk or cycle along. It has been assumed that 50 percent of these children will not need transport if the walking- and cycle track networks (with safe crossing facilities) are constructed. Based on an estimated cost of NOK 3.90 per child-km (price adjusted from Engebretsen and Hagen) the cost per child with school transport is calculated at NOK 4 680 per year.

- Less severe diseases and short time absence: As a benefit of physical activity (walking and cycling) it has been assumed that short time absence from work is reduced by 1 percentage point (from 5% to 4%). An economic saving of about 1 percent of the annual income per employee could be achieved in case that this person would become more physically active. Twenty five percent of all journeys are assumed to be work-trips. In order to not overestimate this benefit it has been assumed that 50 percent of new pedestrians and cyclist will gain better health due to the additional walking and cycling.
- Severe diseases and long time absence/disability: Physical activity (walking and cycling) reduces the occurrence of severe diseases. In order to not overestimate this benefit only four types of severe diseases have been included in the cost-benefit analyses.
- The four types of diseases included, are the diseases for which NCNPA has estimated the costs to the society in the form of medical costs, treatment costs and possible production loss. The four types of diseases are cancer (five different types), high blood pressure, diabetes type 2 and muscle-/skeleton diseases. In addition it has been estimated costs due to welfare loss for people who have these diseases. The welfare loss is estimated at 60 percent of the total costs. This is the same magnitude as for welfare loss for people injured in traffic accidents. In order not to overestimate the benefit of reduction in severe diseases it has been assumed that 50 percent of new pedestrians and cyclists will gain better health due to the additional walking and cycling. In the cost-benefit analysis an economic saving of NOK 7 300 per year per person who becomes “moderately more physical active” is included.
- External costs of road transport: In order not to overestimate the accident costs have been excluded from external costs of road transport. The reason is that we have assumed that the number of injury accidents is not affected by a substitution from car and public transport to walking and cycling. Included in the external costs are CO_2-emissions, local emissions to air, noise, congestion and infrastructure costs. These are from Eriksen et al. and are price adjusted to 1.36 per km for cars and NOK 9.03 per km for buses, in major cities (Trondheim). For minor cities (Hokksund and Hamar) the external costs are 0.40 per km for cars and NOK 4.57 per km for buses.
- Parking costs: Parking costs are estimated on the basis of rental prices companies pay for parking places in the different cities. These parking costs are therefore judged as a realistic estimate of the marginal parking costs for companies. The analysis does not include any reduction in the need of parking places for customers. Work-trips by car substituted by walking or cycling were assumed to reduce parking costs for business companies in Trondheim (NOK 1 165), Hamar (NOK 560) and Hokksund by NOK 325 per month.

Findings

The main results of the Norwegian survey as regards the calculations are compiled within the following tables:

Table 8. Benefits and costs (based on best estimates of future walking and cycle traffic) of investments in walking- and cycling track networks in Hokksund, Hamar and Trondheim. Unit: mill. NOK (NOK 1 = 0.1242 Euro)

Benefit- and cost components	Hokksund	Hamar	Trondheim
Benefits of walking- and cycle tracks (present value)			
Accidents (assumed no change)	0	0	0
Travel time (assumed no change)	0	0	0
Reduced insecurity for current pedestrians	4.2	2.7	107.6
Reduced insecurity for current cyclists	9.5	6.1	398.2
Reduced insecurity for new future pedestrians	0.5	0.4	13.7
Reduced insecurity for new future cyclists	3.5	2.3	100.7
Reduced costs for school children transport	2.6	1.1	3.6
Reduced costs related to less severe diseases and short time absence	16.7	35.4	269.2
Reduced costs related to severe diseases	97.7	206.6	1572.4
Reduced external costs of motorized road transport	9.4	20.0	124.4
Reduced parking costs for employers	9.5	34.6	433.4
TOTAL BENEFIT	153.7	309.1	3023.3
Costs of walking- and cycle tracks (present value)			
Capital costs	23.6	15.8	600.0
Maintenance costs	1.6	1.0	39.5
Tax-cost factor, 20% of budget costs	5.0	3.4	127.9
TOTAL COSTS	30.2	20.1	767.4
Net benefit- cost ratio	4.09	14.34	2.94

Table 9. Results from sensitivity analyses. Benefits and costs (based on minimum and maximum estimates of future walking and cycle traffic) of investments in walking- and cycling track networks in Hokksund, Hamar and Trondheim. Unit: mill. NOK (NOK 1 = 0.1242 Euro)

	Hokksund		Hamar		Trondheim	
Benefit- and cost components	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Benefits of walking- and cycle tracks (present value)						
Accidents (assumed no change)	0	0	0	0	0	0
Travel time (assumed no change)	0	0	0	0	0	0
Reduced insecurity for current pedestrians	4.2	4.2	2.7	2.7	107.6	107.6
Reduced insecurity for current cyclists	9.5	9.5	6.1	6.1	398.2	398.2
Reduced insecurity for new future pedestrians	0.1	1.1	0.1	0.7	2.7	28.3
Reduced insecurity for new future cyclists	0.2	7.9	0.2	5.1	10.0	221.7
Reduced costs for school children transport	2.6	2.6	1.1	1.1	3.6	3.6
Reduced costs related to less severe diseases and short time absence	1.4	37.2	3.0	78.6	29.8	588.5
Reduced costs related to severe diseases	8.2	217.1	17.3	458.9	173.9	3437.1
Reduced external costs of motorized road transport	0	22.0	0	46.6	0	290.4
Reduced parking costs for employers	0	22.1	0	80.6	0	1011.1
TOTAL BENEFIT	26.2	323.7	30.5	680.5	725.8	6086.6
Costs of walking- and cycle tracks (present value)						
Capital costs	23.6	23.6	15.8	15.8	600.0	600.0
Maintenance costs	1.6	1.6	1.0	1.0	39.5	39.5
Tax-cost factor, 20% of budget costs	5.0	5.0	3.4	3.4	127.9	127.9
TOTAL COSTS	30.2	30.2	20.1	20.1	767.4	767.4
Net benefit- cost ratio	-0.13	9.71	0.51	32.78	-0.05	6.93

Reduced costs related to severe diseases constitute approximately 50% to two-thirds of the total benefit. The following figure shows that other benefit components with considerable contributions come from reduced parking costs, reduced costs due to less short time absence and reduced external costs of transport.

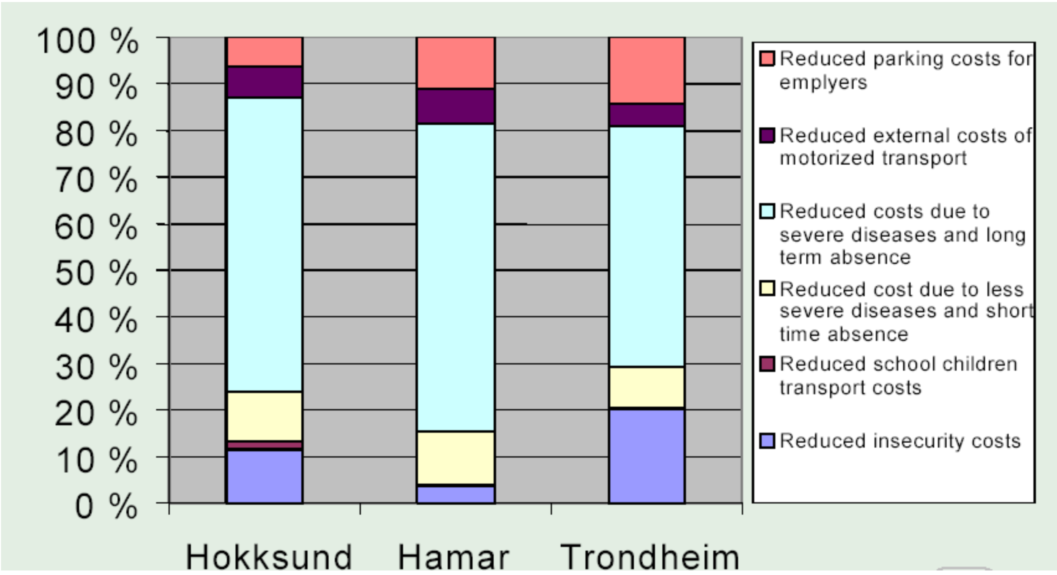

Figure 6. Benefit components as shares of total benefit of investments in walking- and cycling track networks in Hokksund, Hamar and Trondheim

The following conclusions are drawn as regards the applicability of the analyses, profitability to society and perspectives with respect to prioritization of transport investments:

- Best estimate of future walking and cycling traffic leave no doubt that building walking- and cycling track networks in Hokksund, Hamar and Trondheim is profitable to society. Net benefit-cost ratios in these cities are approximately 4, 14 and 3, respectively.
- By implementing high, but realistic, cost estimates in the strategic analyses planners of walking- and cycling track networks have a large opportunity set when in the next stage a choice must be made of the designs that give the best overall solution for different sections of the network.
- Compared to the relatively low net benefit- cost ratios for other transport investments (e.g. “The National Transport Plan 2002-2011”), investment in walking- and cycle tracks in Norwegian cities is a chance for the transport sector to make investments with considerably higher profitability to society than seen for a long time.
- Barrier cost is a large external cost related to motorized traffic. It is therefore important to take the barrier cost into account, in the same way as other external cost, when for example the issue is to determine the “right” level of car taxes or to evaluate different kind of restrictions on car use.

Table 10. Calculated average barrier costs related to motorized road traffic in Hokksund, Hamar and Trondheim. Calculations based on "best estimate" of future walking and cycle traffic (NOK 1 = 0.1242 Euro)

Barrier costs calculated as benefit loss (different units)	Hokksund	Hamar	Trondheim
Benefit loss due to non-realized benefit of a "natural" amount of walking and cycle traffic (NOK, present value)	123 773 667	276 192 952	2 195 788 978
Benefit loss, NOK per year (annuity)	8 782 046	19 596 569	155 796 624
Benefit loss, NOK per day	24 060	53 689	426 840
Benefit loss, NOK per journey non-realized walking- and cycle traffic	7.98	8.42	9.60
Benefit loss, NOK per km non-realized walking- and cycle traffic	3.74	3.95	4.33
Benefit loss, NOK per motorized journey (all passenger transport journeys added 20 % freight transport journeys)	0.73	0.77	1.33
Benefit loss, NOK per motorized "person"-km (assumed an average of 5 km per motorized journey)	0.15	0.15	0.27
Benefit loss, cars (NOK per vehicle-km when assumed an occupation of 1.77 persons per car)	0.26	0.27	0.47
Benefit loss, buses (NOK per vehicle-km when assumed an occupation of 10-12 passengers per bus)	1.46	1.54	3.20

(Within this calculations of the barrier costs the benefits of reduced insecurity for pedestrians and cyclists are excluded)

Gaps and Research Needs

The CBAs of walking and cycling track networks are based on limited knowledge about many of the benefits included and preliminary cost estimates. In order to reduce such uncertainties the following points are suggested as necessary further research:

- on accidents, travel time and insecurity, and to put a focus on the relation between statistical risk reflected in road safety statistics vs. subjective felt insecurity.
- Limited knowledge on the relationship between physical activity and the occurrence and costs of different diseases will probably be available in the near future.
- Limited knowledge whether substitution from car and public transport to walking and cycling will result in more or less people injured in traffic accidents.
- Limited knowledge about both current and future numbers of pedestrians and cyclists (e.g. and how different designs of cycle routes influence the amount of cycling).

- Uncertainties in the estimates of future walking and cycle traffic influence the magnitude of the net benefit-cost ratio, but it is probably in any case higher than zero. Limited knowledge on risk and insecurity related to for example cycling on separate tracks vs. cycling on cycle-lines in the roads
- Differentiation between induced walking and cycling journeys vs. substituted from car or public transport

Transferability

- The analyses are based on average amounts of pedestrian and cycle traffic on the cycle track networks in the three cities.
- The CBAs presented are based on high, but realistic cost estimates, and "low" benefit estimates in order to prevent overestimates. The analyses are therefore judged to produce "down-to-earth" and conservative estimates of the profitability to society of building walking- and cycling track networks in Norwegian cities.

Key Messages

The key messages **drawn in the paper** are:
- Better safety is more highly valued than reduced travel time for cyclists (Hopkinson and Wardman).
- Walking- and cycling track networks are not sufficient. – Other measures like safe crossing facilities and parking facilities should also be implemented.
- Physical activity (walking and cycling) reduces the occurrence of severe diseases.
- Need for "complete" cost-benefit analysis.
- Isolated uncertainties in the future number of accidents; cost estimates and the discount rate do not influence the conclusion about profitability to society.
- Investment in walking- and cycle track networks improve welfare. The benefit of cycle network investments is estimated at at least 4-5 times the costs.
- Barrier costs caused by road traffic have to be taken into account as benefit losses, too (i.e. people can not choose transport mode according to their preferences). Importance of taking barrier costs into account (e.g. road traffic also obstructs people from choosing bicycle and walking) which have to recognized as non-realized benefits to the society.

The key messages **from the Stockholm workshop** are:
These studies should pay attention to the key assumptions that may influence the results, namely:
- Assumptions on induced walking and cycling and modal shift from cars or public transport;
- Relationships between physical activity and health end-points considered
- "Threshold" in increased walking and cycling that is necessary for investments to be profitable (depends on quality and completeness of the network)

For comparisons with CBAs made for car infrastructure, these CBAs *must* include health benefits/dis-benefits in the calculation.

For investments to be profitable and result in modal shifts it is important that a system approach is taken (networks vs. isolated stretches; inter-modality opportunities e.g. with public transport)

2.6 Climate change

An increased number of heat waves, cold spells and flood events have led to increased mortality and morbidity. According to the World Health Report (WHO 2002) the attributable burden of disease of climate change worldwide has been estimated to have been around 5.5 Million DALY's and 150.000 deaths in 2000. The estimates referred to diarrhoeal diseases, malaria cases, and unintentional injuries from floods, and non-availability of recommended daily calorie intake.

Anna Alberini and Bettina Menne presented a WHO project cCASHh[9] that addresses climate change and adaptation on strategies for human health. [10] The project started in June 2001. The project is a combination of impact and adaptation assessment for four climate-related health outcomes:

- health effects of heat and cold (mortality and morbidity);
- health effects of extreme weather events (mortality and morbidity);
- infectious diseases transmitted by insects and ticks, e.g. tick-borne encephalitis, malaria (vector borne diseases);
- Infectious diseases transmitted in the water supply or through food (waterborne and food borne diseases).

The project will answer two questions:

- What will the total health impact caused by climate change be for the years 2000, 2001, 2005, 2010, 2020 and 2030?
- How much of this impact could be avoided by reducing the risk factor (i.e. stabilizing greenhouse gas emissions)?

One purpose of the input paper to the Stockholm Workshop by Alberini and Menne was to present techniques for estimating the benefits of adaptation to human health effects of climate changes, and to discuss the challenges and difficulties with these techniques. They argue that when carefully designed and properly implemented contingent valuation studies should be able to capture all components of WTP, including the value of the discomfort and suffering due to the illness. It is important to distinguish between two types of effects, namely morbidity and mortality effects.

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[9] cCHASHh – climate Change and Adaptation Strategies for Human health in Europe.
[10] Alberini A. and Menne B (2003), *Valuing the Health Effects of Climate Change*. Draft 9 October 2003 Unedited.

The project is so far going to be conducted in Italy, Germany and the Czech Republic, but the project is searching for additional countries to participate in the study. Currently a CV survey questionnaire is developed by using focus groups.

For instance the participants were shown the expected number of victims in Italy with and without climate change, based on the highest risk estimates made prepared by our research partners. People were struck by the differences in the scenarios with and without climate change, and the increase in the expected annual number of victims over the next 30 – 50 years. There was, however, considerable disagreement among the participants on whether extreme event deaths are a serious cause of deaths. The project subsequently developed a risk ladder which showed clearly that the risk of dying in flood events is relative to other causes of deaths. One-to-one pre-tests showed that this risk communication device helped people to grasp the relative magnitude of the risks.

People did very well in the risk-risk questions, which were meant to acquaint them with trade-offs between resources and risk reductions. They indicated that they understood that risk reduction has a cost, and were willing and capable of making choices requiring such tradeoffs. The risk-risk questions that were asked were to choose which city they deemed more desirable between city A and city B, where A has a higher death rate and lower cost of living, and B has a lower risk but higher cost of living. The risks were expressed in terms of dying in car accidents and floods.

There are two main approaches to estimate the cost of climate change, one is the damage cost approach and the other is the abatement cost approach. The cCASHh project is an example of the damage cost approach. Within the ExternE projects it has been tried to use the damage cost approach, but it has proven difficult to get a "good" estimate. There are several problems involved trying to estimate the costs due to climate change. The greatest challenge is to know what impacts are going to occur in the future. This has led to that the abatement cost approach is now being used in ExternE projects. In ExternE the estimated price for tradable permits are used as a cost estimate for climate change. In Sweden there is a discussion of the use of the tax level for carbon dioxide emissions or the shadow price for implementing the Swedish environmental goal for greenhouse gas emissions as cost estimates for climate change.

2.7 Traffic safety

In Sweden, the Swedish National Road Administration (SNRA) is responsible for road maintenance and road construction and for the execution of cost-effective road construction projects. Since the second half of the 1960's, the SNRA has included more or less conventional social cost-benefit analysis in their framework for investment appraisal.

Within this investment framework, prospective safety improvements are given explicit monetary values. These values are then considered together with other costs and benefits, such as the value of changed travelling time and changes in vehicle operating costs. In developing a method for investment appraisal that would withstand economic cross- examination, SNRA has consulted economists on several occasions which has led to several major revisions of SNRA's way of valuing safety.

For purposes of costing road accidents, i.e. for estimating benefits of preventive measures, there are two types of costs. First, reducing the number of accidents can save *material costs* e.g., of health-care costs, lost production, cost of property damage and administration and it can offer value from increased safety per se. Second, the *value of risk reduction* per se has a value for individuals and the society, based on individuals' preferences for safety and concern for health and longevity.

The *material costs* are usually estimated using the cost-of-illness approach (COI). The *value of risk reduction per se* is usually estimated using the individual willingness-to-pay (WTP) approach. SNRA uses the concept of the *value of a statistical life*, given by the mean marginal rate of substitution of wealth for risk, calculated over the affected population of individuals.

The traditional measure of medical outcome has been survival. This is not surprising as it is easy to measure and as most people desire to live longer. However, people are also interested in the quality of extra life years. Some might sacrifice a little life expectancy in order to improve their quality of life, while others would be willing to sacrifice quality of life to increase their lifetime. Both life expectancy and quality of life need to be measured. Under the concept of *health indices*, there have been several attempts among economists and other disciplines to find such a composite benefit measure of health.

All three approaches, i.e. the COI-, the WTP- and the health-index approach, have been used in Sweden to estimate values of safety in the transport sector. The values have been revised a number of times where a number of approaches have been tested.

At present, no single approach can answer the question of what is the benefit to society of reducing the risk of death and traffic injuries.

Monetary values of safety per se for use in cost-benefit analysis of investments in new roads or new safety programmes in the road traffic sector should be defined in a way to reflect the preferences for safety of members of the affected population. The CV approach is one method to analyze the sums that they would individually be willing to pay or to accept as compensation for pre-specified variation in safety. Standard gamble, risk-risk and conjoint analysis are other methods, which can and has been used in combination with the CV method to estimate safety values in the transport sector. Real market transactions can also be used to estimate the trade-off value. Implicit values of statistical life have been estimated by analyzing prices of new automobiles and their corresponding accident risks.

The human capital approach has been used in Sweden and in other countries to estimate the value of resources not produced due to short-term illness, early retirement, and death before retirement age. Market prices have been used in

Sweden and other countries to estimate other resources lost, property damage, administrative costs, health care costs, etc. A combination of approaches discussed is necessary. However, under each approach there are several different ways to proceed. None of the approaches is in itself superior to others. They are not even competing, rather complementary. However, to answer a certain question, one can argue that one method or a combination of methods is more relevant than others.

3 Conclusions

Different studies produce different results. Lack of transparency in making explicit their underlying assumptions, boundaries of validity, objectives and methodological approaches may have a negative impact on the credibility of the use of economic valuation of health effects and give rise to a number of questions, e.g.:

- Why are the results so different?
- Are the differences justified and can we accept them?
- Is there a need for (and the possibility of) harmonization?

While *it is acceptable that results differ*, the reasons for the differences should be made explicit. Such differences may well be justified as different methods, approaches and variables are to be used to answer very different questions (see Box 1). What is necessary is that *the methods and assumptions are made transparent in order to judge whether the studies can answer the questions they are meant to address.*

An aspect deserving attention comes from the possibility that, regardless of the original purpose of the study, its results may be used (or misused) also for different purposes than those originally envisaged. Therefore, it becomes necessary that *clear statements are made about the range of applicability, boundaries of validity and limitations of the study results*.

In particular, the applicability of methods and use of their results should be specified as a function of:

- special interest in different specified effects and impacts
- different temporal or special scales
- local, national or international policy setting
- special interest in effects for specified groups (e.g. children)
- total costs or cost changes due to policy changes
- limitations regarding the availability of the necessary input data (e.g. availability of the appropriate measures, indicators and statistics)
- type of analysis being performed (e.g. Cost-Benefit vs. Cost-Effectiveness Analysis)

Box 1: Main variables that intervene in explaining the possible reasons for differences in outcome of economic valuations:

Emission inventories
Emission inventories can cover emission sources to a different extent. For example, transboundary air pollution may be included or not.

Measurement or calculation?
Air pollution concentrations or noise levels may be measured or calculated/modelled. In both cases there are uncertainties but in different ways.

Indicators
Different studies may use different pollutants as indicators.

Exposure
Exposure calculations may be done in different ways.

Exposure-response
Different exposure-response functions may be used.

Double counting
If more than one parameter is used, there is a risk for double counting. For example, indicators as annoyance and PM10 might include effects due to other parameters used.

Effects
Different health effects may be included. Short or long term mortality may be considered.

Population(s) at risk
Different groups of population (children, elderly) may be differently vulnerable to certain health risks

Threshold levels
Exposure at all levels or only at levels above a threshold value may be considered.

Measures of outcome
When valuing mortality, different measures may be used, e.g. number of deaths or years of life lost (YLL). For morbidity disability-adjusted life years (DALY) or quality-adjusted life years (QALY) maybe used.

Type of costs
Different types of costs may be taken into account. Welfare costs may be included or not, e.g. Willingness To Pay (WTP) or Cost Of Illness (COI).

Variation in WTP
WTP may be different in different countries, cultures, ages, socioeconomic groups etc.

Total, average or marginal costs?
Depending on the aim of the study, the total costs (TC), the average costs (AC) or the marginal costs (MC) may be calculated.

Methods for estimating WTP
WTP may be estimated by studying revealed preferences (RP) or stated preferences (SP).
For SP there are a number of different methods: CV, CE, CA etc. For RP, mainly Hedonic Pricing (HP) is used.

Transferability
WTP may be estimated by transferring results from studies of other effects or of other population groups, sometimes by using a “context factor”.

Quantification and monetary valuation of psychological and social effects, as well as benefits of physical movements require substantial work to be done to reach the same level of acceptability as air pollution and noise external cost estimates. The same holds with respect to cost estimates for the specific situation of children.

Focusing on only one environmental target at the time can underestimate the benefits of a measure, as it does not take into consideration other “collateral benefits”. For example if a calculation of the benefits of a CO_2 reduction policy only focuses on the benefits due to reduced CO_2 emissions it can underestimate the benefits, as it does not consider reduction in air pollution, noise, congestion and improvements in safety, cycling and walking.

4 Statements concerning specificities of children regarding transport related environmental & health impacts

We cannot measure the WTP of children, but rather of their parents. Since economic valuation for children are not available we have to rely on second person's perspective for the time being. At the Hague workshop in October 2003 it was concluded that the effects on children should be valued at least at the same WTP as adults until there are children specific values available. The focus should be on mortality.

Air pollution

- A few health end-points have been identified, for which ERFs could be derived from on-going international review meta-analysis
- Need for guidance by economists on which of the identified outcomes could be valued in economic terms

Noise

- Little known about health effects of noise in children, and no economic valuations exist to date:
    - Cognitive effects are being assessed for airports and roads through RANCH;
    - No information is available on annoyance and sleep disturbance (existing ERFs are valid only for adults)

The consideration of the specific exposure and health impacts for children is desirable. In view of the current need for clarification at a general level, this work can probably not be done before the next WHO Ministerial Conference in Budapest 2004 without additional effort between the different workshops.

5 First proposal for policy derived from key facts of impact assessment

A project should be initiated to solve the differences between different methods. An impact pathway matrix could provide a framework to critically analyse different studies and methods and identify the main point of difference/convergence. This could be used as a basis to provide guidance on how different methods can be used in different contexts and on their suitability to address certain policy questions. This comparison project needs to identify the differences in the calculations at each stage: emissions, air concentrations, exposures, effects and finally economic valuation, in order to identify where the greatest sources of differences lie.

Impact pathway matrix.

Impact pathway	**ExternE (50 countries)**	**3-country study**	**UNITE**	**INFRAS/IWW**
Emissions	Inventories (from IASA)	No		
Transport & Chemical Conversion	From dispersion models PM2.5 BaP Benzene ……	From monitoring stations PM10 only		
Response of receptors				
Physical impact				
Change in Utility				
Welfare losses				
Costs				

- There is a need for achieving consensus and providing guidance about *harmonization* of which methods and input data should be used for different purposes (e.g. across different health effects, and for different groups of the population). There should be recommendations on where harmonization could be achieved and where it cannot.
- It is important that all health impacts are taken into account, as well as those effects for which it is not possible to get any cost estimates.

Abbreviations

AC	Average costs
ASEK	An abbreviation (in Swedish) for Working Group for Cost Benefit Calculations
BaP	Benzo-(a)-Pyrene
BT	Benefit Transfer
CA	Conjoint Analysis
CBA	Cost Benefit Analysis
CE	Choice Experiments
CEHAPE	Children's environment and health action plan for Europe, WHO Regional Office for Europe
CO	Carbon monoxide
CO_2	Carbon dioxide
COI	Cost of illness
COPERT III	Computer Programme to Calculate Emissions from Road Transport
CSERGE	Centre for Social and Economic Research on Global Environment, University College London and East Anglia
CV	Contingent Valuation
DALY	Disability-adjusted life years
DFA	Damage Function Approach.
DPSEEA	Driving forces, Pressures, State, Exposures, health Effects and Actions
ERF	Exposure-Response Function
FHI	Swedish National Institute of Public Health

HA	Highly annoyed
HDV	Heavy Duty Vehicle
HP	Hedonic Pricing
IER	Institute of Energy Economics and the Rational Use of Energy, University of Stuttgart, Germany
IPA	Impact Pathway Approach.
MC	Marginal costs
NCNPA	The National Council on Nutrition and Physical Activity, Oslo, Norway
NMVOC	Non methane volatile organic compounds
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NSDI	Noise Sensitivity Depreciation Index
OECD	Organization for Economic Co-operation and Development
O_3	Ozone
PM2.5	Fine particles with a diameter of 2.5 µm or less
PM10	Fine particles with a diameter of 10 µm or less
QALY	Quality-adjusted life years
RANCH	Road traffic Aircraft Noise exposure and Children’s Cognition and Health.
RECORDIT	Real cost reduction of door-to-door intermodal transport.
RP	Revealed Preferences
SIKA	Swedish Institute for Transport and Communications Analysis
SNRA	Swedish National Road Administration
SO_2	Sulphur dioxide

SP	Stated Preferences
TC	Total cost
TSP	Total Suspended Particulate
UNECE	United Nations Economic Commission for Europe
UNITE	Unification of accounts and marginal costs of transport efficiency
VLYL	Value of Life Year Lost
VOCs	Volatile Organic Compounds
VOSL	Value of Statistical Life
VPF	Value of prevented fatality
VTI	Swedish National Road and Transport Research Institute
WHO	World Health Organization
WTA	Willingness to accept
WTP	Willingness to pay
YLD	Years lived with disability
YOLL	Years of Life Lost

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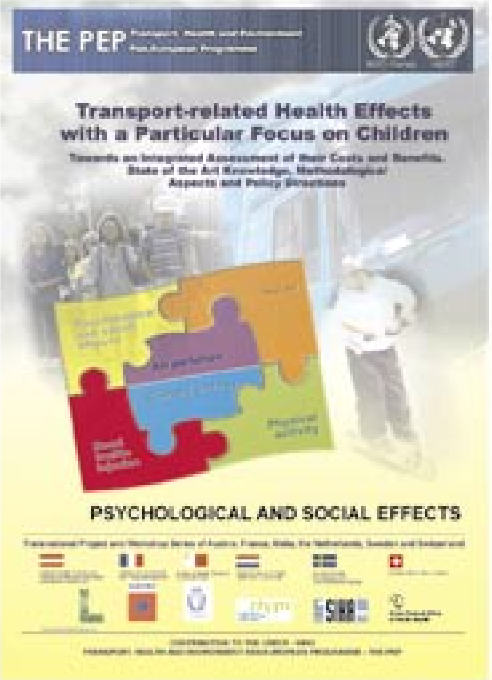
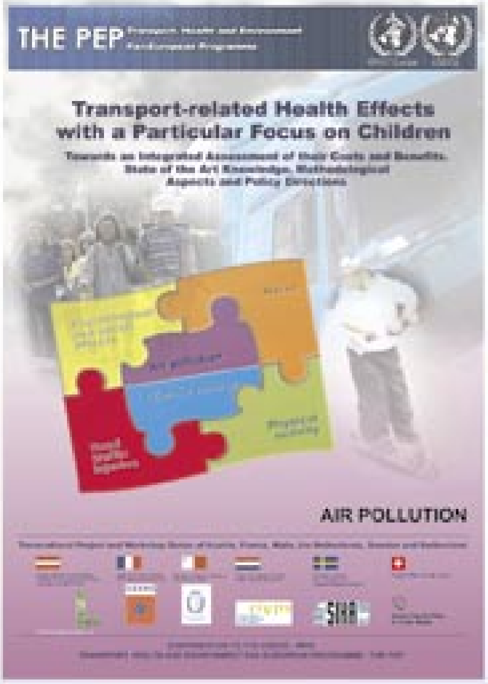
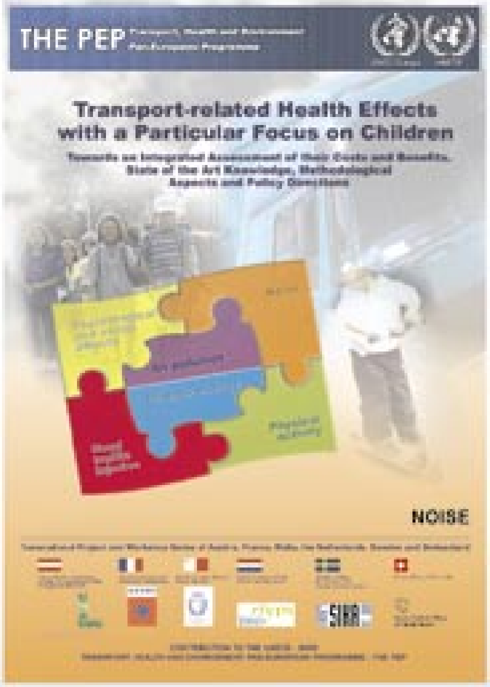


THE PEP
Transport-related Health Effects with a Particular Focus on Children
Towards an Integrated Assessment of their Costs and Benefits. State of the Art Knowledge, Methodological Aspects and Policy Directions
PSYCHOLOGICAL AND SOCIAL EFFECTS



THE PEP
Transport-related Health Effects with a Particular Focus on Children
Towards an Integrated Assessment of their Costs and Benefits. State of the Art Knowledge, Methodological Aspects and Policy Directions
AIR POLLUTION



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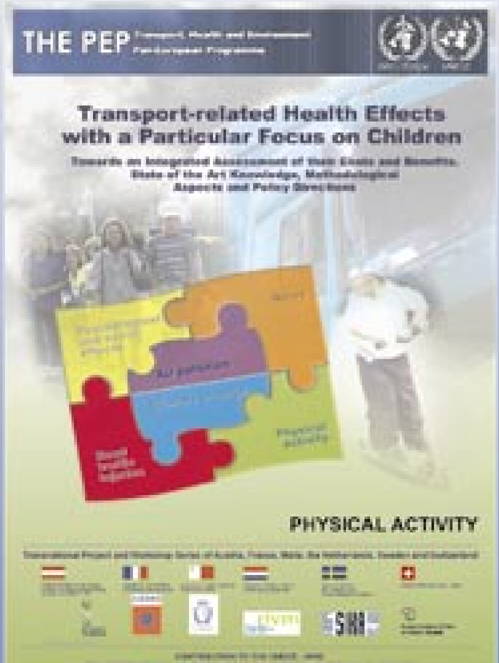
NOISE



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PHYSICAL ACTIVITY

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ECONOMIC VALUATION