THE PEP Transport, Health and Environment Pan-European Programme

WHO/Europe UNECE

Economic valuation of transport-related health effects:

Review of methods and development of practical approaches, with a special focus on children

Summary

Transport is an essential component of life. Positive effects of transport result from providing access to education, employment opportunities, services, goods, leisure activities and other amenities and by contributing to economic development and to the logistics of production and distribution. Different modes of transport are associated with specific effects on society, one being health effects. This report focuses on road transport, as it accounts for the largest share of transport activities in Europe, involves nearly the entire population, direct influences urban development and presents the largest effects in terms of emissions of pollutants and of greenhouse gases, as well as consumption of energy. The adverse health effects of road transport result from air and noise pollution, road crashes and deterrent effects on walking and cycling as well as from less obvious effects such as social isolation and reduced quality of life in neighbourhoods affected by heavy road traffic. The topics discussed in this report in more detail included road noise, transport-related air pollution, road safety and insufficient physical activity related to transport that hinders commuter cycling and walking.

Children's exposure may differ from adults' exposure to transport-related pollutants and other health hazards, since their physiology differs, they spend their time in other settings and they behave differently. These factors combine to generate or trigger a wide range of negative health effects. Understanding how the environment affects children's health and development is therefore important for preventing illness and loss of healthy years of life.

As part of the implementation of the joint UNECE/WHO Transport, Health and Environment Pan-European Programme (THE PEP), an earlier project on the economic valuation of transport-related health effects recommended further research and work on transport-related health effects with a specific focus on children. This publication summarizes the main results of the report *"Economic valuation of transport-related health effects: Review*

of methods and development of practical approaches, with a special focus on children" that addresses some of the open questions identified.

The main objective of this project was to develop a practical approach to the economic valuation of transport-related health effects, including a focus on children. The project draws on state-of-the-art understanding of the links between transport and health and on a review of how various economic studies have addressed the issue of valuating transport-related health effects.

The approaches presented in the report target non-health experts and practitioners in transport planning, ranging from experts operating at the national level to those dealing with subnational and local assessments. They are intended to facilitate the integration of health-related effects in the economic valuation of transport options. The geographical scope of application of the proposed approach can be international, national and local, but it could be less suitable for very small-scale interventions due to the specific features of those situations. However, the approaches can also serve as general direction for such situations.

In developing the proposed practical approach based on the best available evidence, attention was given to orient the reader to select the best approach taking into account the specific conditions and possible limitations (such as concerning the availability of some input data) in different countries or subnational study areas. The approach also highlights methodological limitations and uncertainty and acknowledges where gaps exist. The report also discusses how to bring different components together to estimate total health costs due to road transport considering several health effects. This approach is presented as one possible method, as several types of uncertainty exist in this field, which are also discussed in this report. In addition, scientific consensus has not yet been reached on all the issues involved.

General model for the valuation of transport-related health effects

The main steps of the proposed approach can be described as consisting of the following:

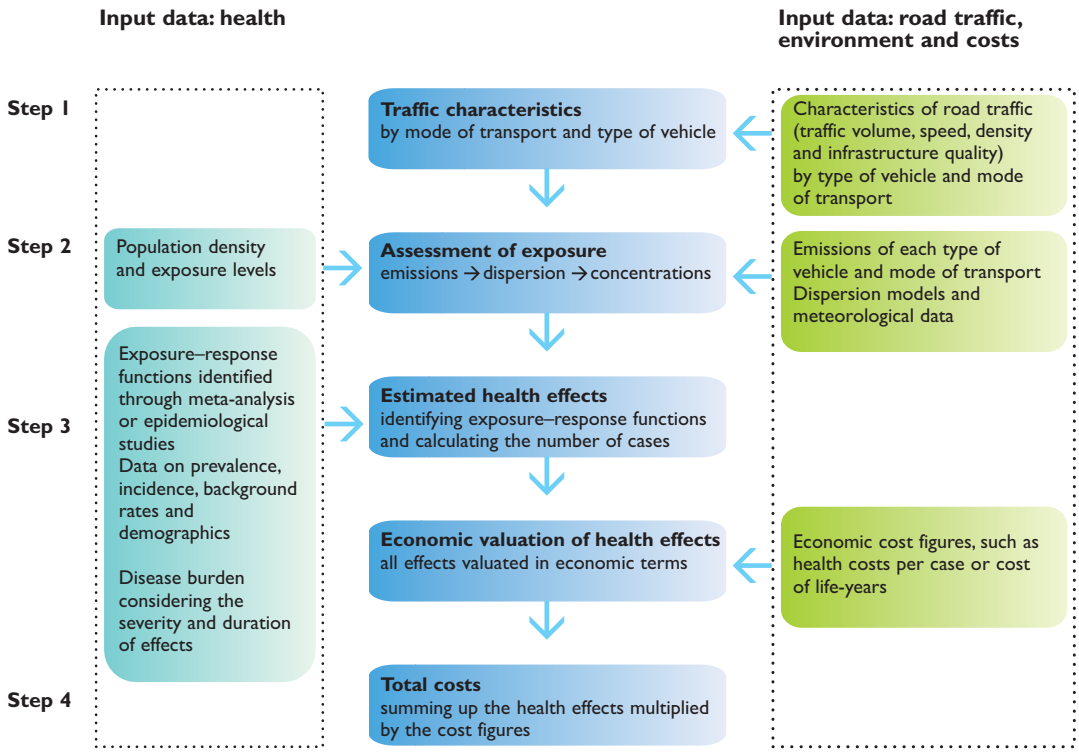
Step 1. Definition of traffic characteristics: Consider the traffic characteristics for each mode of transport, determine all types of vehicles involved and decide which mode of transport should be considered in calculating health costs (such as road and/or rail transport).

Step 2. Assessment of emissions and population exposures: For air pollution and noise, total emissions can be calculated using information on the emissions of each mode of transport and type of vehicle. For road crashes, the number of people exposed (victims) is derived directly from the statistical data sources. For noise, an alternative way of estimating exposure is based on the number of homes exposed to noise levels exceeding guideline values.

Step 3. Estimation of transport-related health effects: The health effects due to these exposures are estimated by using exposure–response functions for the exposed part of the population. With these functions, the population-attributable fraction (PAF) can be calculated: the proportion of a health effect attributable to a certain exposure.

Step 4. Economic valuation of health effects: This step consists of valuating these effects by applying economic cost figures, comprising direct and indirect costs (i.e. costs related to material damage, costs of health care, administrative costs and economic production losses), and intangible costs of the victim (i.e. suffering and grief). In this proposed approach, the total costs are quantified by using the cost-of-illness method (which includes items for which market costs are available, such as administrative costs, cost of health care and of lost production due to illness) in combination with the willingness-to-pay method (which allows estimating the costs borne by victims, and include the part of administrative and health care costs borne by victims, the intangible costs and the costs due to lost consumption), but including only net economic production losses (that is, without the value of lost consumption, because otherwise production losses would be counted twice).

Current evidence did not yet allow proposing a complete model for transport-related insufficient physical activity, but two main issues – the apportionment and the calculation of morbidity costs – and ideas for calculating the costs of all-cause mortality are discussed.



Health end points to be considered in economic assessments of transport-related interventions

The development of the proposed approach was based on a review of the relevant recent epidemiological literature to identify the health end-points related to road transport for which sufficient evidence and data (such as exposure–response functions) exists for including them in economic valuation. Literature was analysed for both adults and children.

For some health end-points, the available evidence is not sufficient enough to firmly recommend inclusion, but they can be included if the aim is a more comprehensive rather than a conservative estimate of transport-related health costs and the larger uncertainty related to the other morbidity end-points is accepted and clearly acknowledged.

Summary of selected health end points to be considered for economic valuations of transport-related interventions and policies in adults

Transport-related exposure	Selected health end-point
Road traffic noise	Severe annoyance Severe sleep disturbance Myocardial infarction*
Traffic-related air pollution	Mortality: all-cause, cardiovascular/pulmonary and respiratory+ Morbidity: hospital admissions (cardiac and respiratory), lower respiratory symptoms*, chronic bronchitis*, restricted activity days*, working-loss days*
Road crashes	Fatalities Non-fatal injuries
Transport-related physical activity	Mortality: all-cause CHD, stroke, type II diabetes, colon/breast cancer* Morbidity: CHD, stroke, type II diabetes, colon/breast cancer*

+ for short-term exposure only
** for indicative estimates only*

Summary of selected health end points to be considered for economic valuations of transport-related interventions and policies in children

Transport-related exposure	Selected health end-point
Road traffic noise	NA
Traffic-related air pollution	Mortality: all-cause Lower respiratory symptoms* Medication use*
Road crashes	Fatal injuries Non-fatal injuries
Transport-related physical activity	NA

** for indicative estimates only*
NA: not available

Applying the proposed approach: estimating transport-related health costs in Switzerland

As an illustration of the application of the proposed methodological approach, examples of health costs due to road crashes and road transport-related noise and air pollution in Switzerland in 2005 were calculated. The costs amounted to US$ 7345 million. Road crashes are clearly the dominant source of health costs due to motorized road transport (77%). The remaining costs are more or less evenly split between air pollution and noise, with air pollution being somewhat more important. Compared with road crashes, the total costs as well as the costs per vehicle-km were on average about one seventh for noise. The difference was particularly large for mopeds (a factor of more than 400). For cars, the most important vehicle category, the factor was 10. Only for lorries exceeding 3.5 tonnes were noise costs marginally higher than crash costs.

For air pollution and noise, the total health costs (or the costs per vehicle-km) were comparable. For freight transport, air pollution–related costs were about 60% higher than noise-related costs (for all vehicle categories), and the air pollution–related costs of passenger transport were 6% lower than noise-related costs. This was mainly due to motorbikes, which caused about 10 times higher noise-related costs than air pollution–related costs. For cars, air pollution–related costs were 26% higher.

Summary of health costs from road crashes, air pollution and noise in Switzerland (reference year: 2005)

	Passenger transport								Freight transport				Total
	Car	Public bus	Trolley	Tram	Private coach	Motor-bike	Moped or scooter	Total	Delivery van vehicle	Heavy goods	Articulated lorry	Total	
Costs in millions of US dollars													
Road crashes	3675		53[a]		119	923	438	**5208**	251	113	54	**419**	**562**
Air pollution	461	33	3	NA	8	19[b]		**523**	126	176	91	**393**	**916**
Noise	365	18	0	1	9	165	1	**559**	72	114	57	**243**	**802**
Total	**4470**		**108[a]**		**135**	**1547[b]**		**6290**	**449**	**404**	**202**	**1054**	**7345**
Costs in US dollars per vehicle-km								Average					Average
Road crashes	0.071		0.177[a]		1.12	0.449	2.99	**0.095**	0.076	0.079	0.077	7.7	**0.094**
Air pollution	0.009	0.143	0.096	NA	0.073	0.009[b]		**0.010**	0.038	0.124	0.129	7.2	**0.015**
Noise	0.007	0.08	0.007	0.022	0.08	0.080	0.007	**0.010**	0.022	0.080	0.080	4.5	**0.013**
Total	**0.087**		**0.361**		**1.273**	**0.701[b]**		**0.115**	**0.14**	**0.283**	**0.286**	**18.9**	**0.122**

Cycles, pedestrians, tractors and work machines, which have been taken into account for crashes, are disregarded here as no data for air pollution and noise are available for these vehicle categories.
NA: not available.
[a] *average of public and trolley buses and tram*
[b] *average of motorbike and moped or scooter*

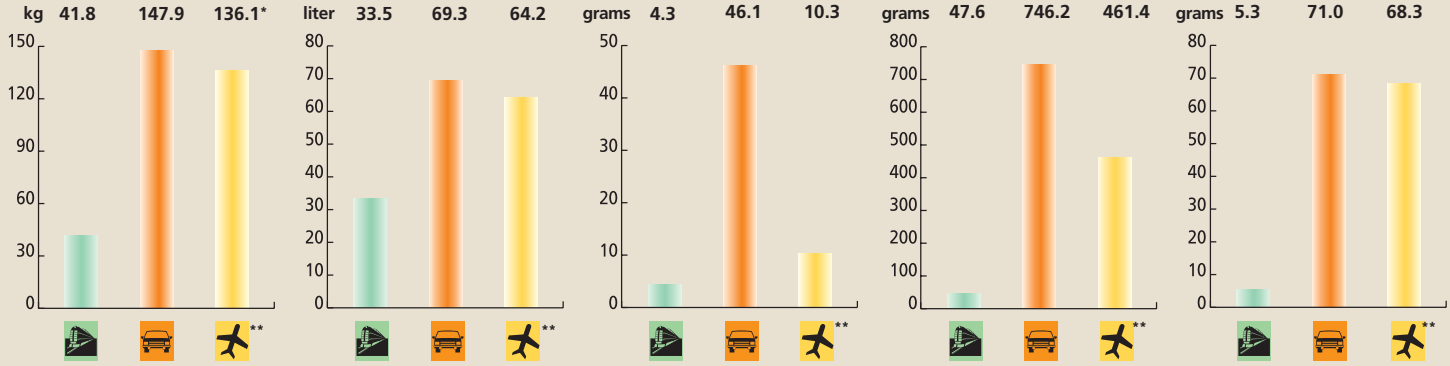
Additional health effects

Transport-related health effects include also effects that, based on the current status of knowledge, cannot be expressed in monetary terms, such as community severance (the barrier effect) and other mental effects. These aspects are important, as they often implicitly determine preferences and choices and their influence should be acknowledged and captured in assessing transport interventions even if economic tools cannot be used, for example by applying qualitative approaches.

Box: Supporting informed travel choices: examples of tools developed by the railway sector

Rail transport has the lowest specific CO_2 emissions compared to road and air: it is estimated that three times less energy is needed to transport 1,000 tons of goods by rail than by trucks and ten times less than by plane. The external costs of rail transport have been estimated in 2000 at 2% of the total external costs of transport, while road accounted for around 84% of these external costs. Even if noise annoyance is lower compared to other transport modes, the main environmental and health issue posed by rail transport is noise, perceived in particular by people living near by railroad lines. This is prompting the development of improved methods to evaluate sleep disturbance caused by noise, and of new technical solutions, such as the replacement of cast iron brake blocks for freight trains, to achieve a noise reduction equivalent to halving the noise perceived.
In order to support more informed travel choices with respect to carbon dioxide (CO_2) emissions, two internet-based tools, Eco Passenger and Eco Transit, have been developed to help calculating and comparing the energy consumption and emissions performance between different modes of transport for passenger and freight transport, respectively, in Europe. These tools can be used also by decision makers to develop more sustainable transport policies. Two examples of the results obtained using Eco passenger and Eco Transit are provided, showing that choosing trains for both passengers and freight may result in important reductions of emissions of CO_2, air pollutants, as well as in reduced energy consumption.

Example 1: Eco Passenger (www.ecopassenger.org): Passenger travel from Copenhagen to Paris by train, plane and car



Carbon dioxide
greenhouse-gas, global warming

including emissions associated with the production and distribution of electricity/fuel

Energy resource consumption
resource consumption/primary energy

including energy consumed in the production and distribution of electricity/fuel

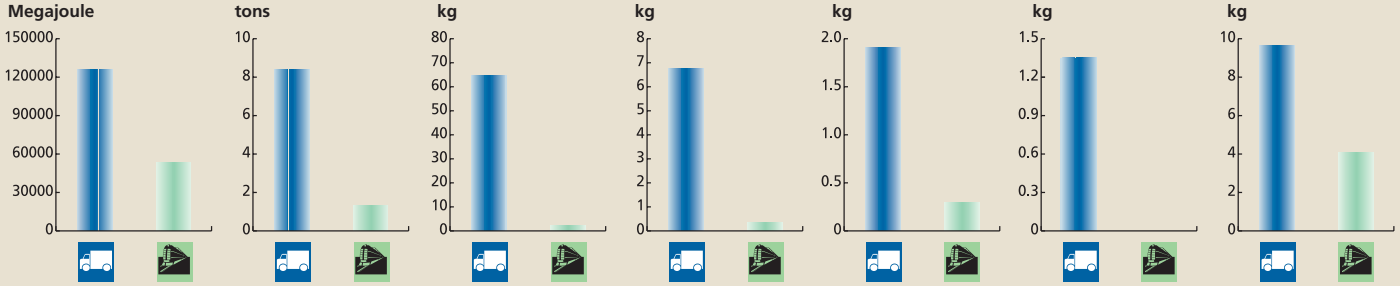
Particulate matter
human toxicity

Nitrogen oxides
acidification, nutrification, summer smog/ozone

Nonmethane hydrocarbons
summer smog/ozone

* *This does not cover the whole global warming impact of the flight. To consider it totally, select "CO_2-emissions with climate factor" in the settings. The RFI Factor takes into account the additional climate effects of other GHG emissions, especially for emissions in high altitudes (nitrogen oxides, ozone, water, soot, sulphur).*
** *Incl. feeder by railway services resp. car*

Example 2: Eco Transit (www.ecotransit.org): Freight travel from Rotterdam to Genova by train and truck (cargo weight 1000t with average goods)



Primary Energy
resource consumpton

Carbon dioxide
greenhouse-gas, global warming

Nitrogen oxide
acidification, nutrification, summer smog/ozone

Nonmethane hydrocarbons
summer smog/human toxicity

Dust (incl. Particles)
human toxicity, greenhouse effects

Particles
human toxicity, greenhouse effects

Sulfur dioxide
acidification, eco and human toxicity

Acknowledgements

This brochure is a summary of the report *"Economic valuation of transport-related health effects: Review of methods and development of practical approaches, with a special focus on children"*.

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