ECONOMIC VALUATION OF TRANSPORT-RELATED HEALTH EFFECTS

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

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With acknowledgments to:
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Outline

• Aims of the project
• The general framework
• Results and guidance for:
  – Air pollution
  – Noise
  – Road traffic crashes
  – Transport-related lack of cycling and walking
• Conclusions
• A glimpse on the benefit side…
Collaborative project

Main partners:
- WHO Regional Office for Europe
- Ecoplan (Switzerland) – economic aspects
- RIVM (Netherlands) and contributors – epidemiological aspects

Contributors
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- Advisory group (18 experts, 10 countries and WHO), 3 reviewers
- Synergy with key related initiatives:
  - OECD/EC VERHI project
  - THE PEP/HEPA Europe project on quantification of health benefits of cycling and walking
  - ENHIS/WHO guidelines for HIA air pollution, noise
  - INTARESE
- Supported by:
  - USEPA, ADEME (France), MoE (Austria), PRONET (EU project)
Aims of the project

To follow-up areas for further work identified by the THE PEP project *Transport-related health effects with a particular focus on children (2004)*:

- Selection of health effects in adults and children
- Estimated relationships between exposure and health effect (dose-response relationships)
- Estimated fraction of exposure coming from transport
- Practical guidance for measurement and monetary valuation of health effects with views of achieving a more harmonized approach
- Particular focus on children (but not only)
The general framework

Transport system
- Trip characteristics (e.g., distance, purpose, luggage)
- Indiv. characteristics (gender, income, age, fitness etc.)
- Mode characteristics (e.g., comfort, price/km etc.)

Effects and exposures
- Active mobility (cycling & walking)
- Traffic injuries
- Air pollution
- Noise
- Physical activity
- Congestion
- Use of space
- Etc.

Health effects
- Risk of some diseases
- Obesity
- Other effects
- Morbidity, mortality

Mode choice

Items included in report
Key features of the guidance

- **Scope of the guidance:**
  - for non-experts, practitioners

- **Pragmatic approach**
  - Point out which factors are contributing the majority of the costs and which can be neglected in situations of limited resources

- **Based on existing approaches, combining health and economic evidence**

- **Focus on the health part of cost evaluation**

- **Guidance can be used in a modular or combined approach**
In detail, guidance on:

- Relative risks to use for suggested health endpoints
- Input data to use (“state of the art” and second-best approach)
- How to calculate costs
- How to deal with uncertainties:
  - General
  - Exposure-specific
- Practical example application of the framework for
  - air pollution, noise, road crashes
  - General considerations on lack of cycling and walking due to unsupportive transport environment
Guidance – basic structure

**Input data: health**

- **Step 1:** Traffic characteristics by mode of transport and type of vehicle
- **Step 2:** Population density and exposure levels
  - Assessment of exposure emissions → dispersion → concentrations
- **Step 3:** Exposure–response functions identified through meta-analysis or epidemiological studies
  - Data on prevalence, incidence, background rates and demographics
  - Estimated health effects identifying exposure–response functions and calculating the number of cases
- **Step 4:** Economic valuation of health effects all effects evaluated in economic terms
  - Total costs summing up the health effects multiplied by the cost figures

**Input data: road traffic, environment and costs**

- Characteristics of road traffic (traffic volume, speed, density and infrastructure quality) by type of vehicle and mode of transport
- Emissions of each type of vehicle and mode of transport
  - Dispersion models and meteorological data
- Economic cost figures, such as health costs per case or cost of life-years
Costing approach: COI & WTP

**Total health costs**

- **Direct and indirect costs**
  - Administration costs
  - Costs of medical care
  - Economic production losses
    - (lost consumption)

- **Intangible costs (for victims)**

**Market prices / COI** vs. **No market prices**

- **Costs borne by the society**
- **Costs borne by the victim / WTP**

Part of total health costs which is double counted (by COI and WTP)

COI method with only net economic production losses (lost (future) consumption will be subtracted)

-> double counting of small part of the costs of medical care and of the administration costs
Guidance: road traffic crashes

INPUT DATA: HEALTH

STEP 1

Traffic characteristics
by transport mode and type of vehicle

STEP 2

Assessment of exposure
Number of traffic crashes
(either from official statistics or based on traffic quantity)

STEP 3

Estimated health effects
(calculation of number of cases)

Population density

STEP 4

Economic valuation of health effects
all effects valued in economic terms

Number of total traffic crashes
(possibly, number of traffic crashes per vehicle/km by category of vehicle)

Total costs
summing up health effects multiplied by cost figures

INPUT DATA: TRAFFIC, ENVIRONMENT, COSTS

Number of total traffic crashes
(e.g. traffic volumes, speed, density, quality of infrastructure) by vehicle type and traffic mode

Number of deaths
Number of non-fatal injuries
(possibly by severity of outcomes)

economic cost figures: e.g. health costs per case, cost of life years
Guidance: air pollution

INPUT DATA: HEALTH

STEP1

Population density, modeled or measured exposure levels

STEP2

Exposure-response functions identified through meta-analysis or epidemiological studies
Data on prevalence, incidence, background rates and demographics
Disease burden taking severity and duration of effects into consideration

STEP3

Traffic characteristics by transport mode and type of vehicle

Assessment of exposure
emissions -> dispersions -> concentrations

Estimated health effects
(identification of exposure response functions and calculation of number of cases related to air pollution)

STEP4

Economic valuation of health effects
all effects valued in economic terms

Total costs
summing up health effects multiplied by cost figures

INPUT DATA: TRAFFIC, ENVIRONMENT, COSTS

traffic characteristics (e.g. traffic volumes, speed, density, quality of infrastructure) by each vehicle type of each traffic mode

emissions of each vehicle type of each traffic mode
dispersion models and meteorological data
air pollution indicators

economic cost figures: e.g. health costs per case, cost of life years
Guidance: noise

**Step 1**
Population density and modelled or measured exposure levels (homes and people)

**Step 2**
Characteristics of road traffic (traffic volume, speed, density and infrastructure quality) by type of vehicle and mode of transport

**Step 3**
- Emissions of noise for each type of vehicle and mode of transport
- Noise dispersion models

**Step 4**
- Emissions of noise for each type of vehicle and mode of transport
- Noise dispersion models

**Traffic characteristics**
by mode of transport and type of vehicle

**Assessment of exposure**
Homes
- People
emissions ⇒ dispersion ⇒ concentrations

**Effects on homes**
- annoyance and sleep disturbance

**Effects on people**
- Alternative for annoyance and sleep disturbance
- Myocardial infarction (indicative estimates)

**Economic valuation of health effects**
- all effects valued in economic terms

**Total costs**
- summing up the health effects multiplied by the cost figures

**Step 1**
- Ratio between reduction in cost of rent and noise level
- Data on prevalence, incidence, background rates and demographics
- Disease burden, considering severity and duration of effects

**Input data:**
- road traffic, environment and costs
- health

**Input data:**
- characteristics of road traffic (traffic volume, speed, density and infrastructure quality) by type of vehicle and mode of transport
- emissions of noise for each type of vehicle and mode of transport
- noise dispersion models
- economic cost figures, such as health costs per case or cost of life-years
Guidance: t-r lack of physical activity

Methodological challenges:

• Which fraction of physical inactivity is attributable to “traffic”?

• Which approaches can be proposed to calculate this attributable fraction?

• Which assumptions can be made regarding morbidity costs related to cycling and walking?
Example Switzerland (1): exposure to air pollution

- PM10 as exposure indicator as high quality data only for PM10 available
- Gaussian dispersion model to calculate population exposure to PM10 (on a 200m x 200m grid)
- Average PM10 exposure due to road transport: 4.34 µg/m3
Example Switzerland (2): health effects

- Health end points: all-cause mortality, respiratory and cardiac hospital admissions
- Hospital admissions due to air pollution from traffic based on:
  - dose response functions
  - number of hospital admissions per 100’000 people
  - population in Switzerland (7.4 Million people) and
  - Average population exposure (4.34 µg/m3)
- Years of life lost based on detailed calculations

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory hospital admissions</td>
<td>256.8</td>
</tr>
<tr>
<td>Cardiac hospital admissions</td>
<td>257.4</td>
</tr>
<tr>
<td>Years of life lost</td>
<td>12’070</td>
</tr>
</tbody>
</table>
Example Switzerland (3): economic valuation

- Costs in US$ per health end-point and health cost category

<table>
<thead>
<tr>
<th></th>
<th>Willingness to pay</th>
<th>Health care costs</th>
<th>Net loss of production</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of life lost</td>
<td>74'217</td>
<td>-</td>
<td>4'283 $1</td>
<td>78'500</td>
</tr>
<tr>
<td>Respiratory hospital admission</td>
<td>7'303</td>
<td>7'441</td>
<td>233</td>
<td>14'977</td>
</tr>
<tr>
<td>Cardiac hospital admission</td>
<td>8'107</td>
<td>10'580</td>
<td>259</td>
<td>18'945</td>
</tr>
</tbody>
</table>

- WTP for years of life lost based on a VOSL (value of statistical life year) of € 1.5 millions (~US$ 1.8 millions).
Example Switzerland (4): results

- Health costs of US$ 920 millions
- 99% of the costs due to life years lost

<table>
<thead>
<tr>
<th></th>
<th>Willingness to pay</th>
<th>Health care costs</th>
<th>Net loss of production</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of life lost</td>
<td>858.2</td>
<td>-</td>
<td>49.5</td>
<td>907.8</td>
</tr>
<tr>
<td>of which adults above 30 years of age</td>
<td>836.1</td>
<td>-</td>
<td>48.3</td>
<td>884.3</td>
</tr>
<tr>
<td>of which infants (0-1 years of age)</td>
<td>22.1</td>
<td>-</td>
<td>1.3</td>
<td>23.4</td>
</tr>
<tr>
<td>Respiratory hospital admissions</td>
<td>1.9</td>
<td>1.9</td>
<td>0.1</td>
<td>3.8</td>
</tr>
<tr>
<td>Cardiac hospital admissions</td>
<td>2.1</td>
<td>2.7</td>
<td>0.1</td>
<td>4.9</td>
</tr>
<tr>
<td>Total</td>
<td>862.2</td>
<td>4.6</td>
<td>49.7</td>
<td>916.5</td>
</tr>
</tbody>
</table>
Example Switzerland (5): results

- This underestimates the true costs:
  - Many health end-points are not considered
  - Only costs due to PM10
  - Only short-term morbidity effects considered.
    For mortality, the long-term effects are 7 times larger than short-term effects
  - The WTP for years of life lost must possibly be doubled:
    • It is taken from the accident context. But possibly individuals are willing to pay twice (or even three times) as much for the involuntary and uncontrollable risk of air pollution
  - Increasing life expectancy is not taken into account when calculating years of life lost
## Applicability in other countries

<table>
<thead>
<tr>
<th>State of the art</th>
<th>Second best</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road traffic characteristics by each type of vehicle and each mode of transport</td>
<td>(Numbers from a similar country)</td>
</tr>
<tr>
<td>Emissions of each vehicle type of each mode of transport (air pollution indicators)</td>
<td>-</td>
</tr>
<tr>
<td>Dispersion and transformation models</td>
<td>-</td>
</tr>
<tr>
<td>Weather data</td>
<td>-</td>
</tr>
<tr>
<td>Demographics</td>
<td>-</td>
</tr>
<tr>
<td>Baseline health data</td>
<td>-</td>
</tr>
<tr>
<td>Concentration–response functions</td>
<td>-</td>
</tr>
<tr>
<td>Economic cost figures (willingness to pay, cost of illness, value of life-years lost)</td>
<td>Cost figures from a similar country</td>
</tr>
</tbody>
</table>
Bringing it all together

Total health costs due to transportation

- Total health costs due to traffic crashes
- Total health costs due to air pollution
- Total health costs due to noise

Total health costs due to physical inactivity

Total health costs due to "other" health effects

A: possible double counting (cardiovascular effects)
## Example data from Switzerland

<table>
<thead>
<tr>
<th></th>
<th>Passenger transport</th>
<th>Freight transport</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Car</td>
<td>Public bus</td>
<td>Trolley</td>
</tr>
<tr>
<td>Road crashes</td>
<td>3675</td>
<td>53(^a)</td>
<td>119</td>
</tr>
<tr>
<td>Air pollution</td>
<td>461</td>
<td>33</td>
<td>3</td>
</tr>
<tr>
<td>Noise</td>
<td>365</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>4470</td>
<td>108(^a)</td>
<td>135</td>
</tr>
</tbody>
</table>

### Costs in millions of US dollars

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road crashes</td>
<td>0.071</td>
</tr>
<tr>
<td>Air pollution</td>
<td>0.009</td>
</tr>
<tr>
<td>Noise</td>
<td>0.007</td>
</tr>
<tr>
<td>Total</td>
<td>0.087</td>
</tr>
</tbody>
</table>

### Costs in US dollars per vehicle-km

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road crashes</td>
<td>0.076</td>
</tr>
<tr>
<td>Air pollution</td>
<td>0.038</td>
</tr>
<tr>
<td>Noise</td>
<td>0.022</td>
</tr>
<tr>
<td>Total</td>
<td>0.087</td>
</tr>
</tbody>
</table>

\(^a\) Extra costs
\(^b\) Public-benefit costs
Conclusions

- Sufficient evidence available for a range of health endpoints related to road traffic crashes, air pollution, noise and insufficient physical activity
- Still lack of specific estimates for children for many health endpoints -> further research needed
- Other, non-monetizable effects should be acknowledged
- Uncertainties and assumptions should be clearly stated / sensitivity analysis
- Harmonized method for economic valuation developed (modular or in combination) based on best available evidence that provides dimension of costs of transport-related health effects
- More work needed on approach for insufficient physical activity
WHO/UNECE guidance and tool for economic assessment of health benefits from cycling and walking

Download the guidance document, HEAT for cycling and user guide from www.euro.who.int/transport/policy/20070503_1
Thank you very much!