Environmental Noise and Health

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OUTLINE

- Noise and Health – concepts
- GLA project “Effects of Noise on Physical Health Risk in London”
  Estimating Dose-Response Relationships Between Noise Exposure And Human Health Impacts In The UK
- Issues and final thoughts
Why Health .................?

DIRECTIVE 2002/49/EC

Article 1:

"The aim of this Directive shall be to define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise. To that end, the following actions shall be implemented progressively:

(a) the determination of exposure to environmental noise through noise mapping…

(b) ensuring that information on environmental noise and its effects is made available to the public;

(c) adoption of action plans … with a view to preserving and reducing environmental noise where necessary and particularly where exposure levels can induce harmful effects on human health.
WHO definition of Health
Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.
What is Health ??
General aim of research on Noise and Health
Relate Exposure....to Effect...guide Policy
Noise Exposure (Sound Level)

Direct pathway
- Disturbance of activities, sleep, communication
- Cognitive and emotional response

Indirect pathway

Hearing loss

Annoyance

Stress Indicators

Physiological stress reactions (unspecific)
- Autonomic nervous system (sympathetic nerve)
- Endocrine system (pituitary gland, adrenal gland)

Risk Factors
- Blood pressure
- Blood lipids
- Blood viscosity
- Cardiac output
- Blood glucose
- Blood clotting factors

Manifest Disorders

Cardiovascular Diseases
- Hypertension
- Arteriosclerosis
- Ischaemic heart disease
Response modified by characteristics of noise. \textit{eg its intensity, loudness, frequency, duration, time of noise, whether the noise is intermittent or continuous.}

Response modified by non-acoustical factors including:

\textit{Personal factors: age, gender, fear of noise, coping strategies, noise sensitivity, genetic predisposition, general life style, status of health and well being, familiarity with noise, feeling that noise could be avoided, perceived level of control over noise, exposure to other stressors.}

\textit{Degree of openness by airport authority/government concerning developments at airport.}

\textit{Attitude of community towards noise source.}
GLA project “Effects of Noise on Physical Health Risk in London”

December 2007 – July 2008
EFFECT OF NOISE ON PHYSICAL HEALTH RISK IN LONDON

- Provide guidance on the robustness of published cardiovascular risk factors arising from ambient/environmental noise, using the latest available World Health Organisation (WHO) reviews, and other reviews of evidence/criteria, and to suggest best estimates of the factors from the range of published values.
- Use derived factors to generate estimates of the numbers of people at cardiovascular and related health risk, from road and air traffic noise, in London, from available population exposure data.

http://www.london.gov.uk/mayor/strategies/noise/
Cardiovascular disease
Disease of the heart and blood vessel system, such as coronary heart disease, heart attack, high blood pressure, stroke, angina and rheumatic heart disease.

Ischaemic heart disease. includes clinical symptoms of angina pectoris (chest pain), myocardial infarction (heart muscle damage), or electrocardiogram (ECG) abnormalities.

Myocardial infarction
Heart attack

Hypertension
Chronically elevated blood pressure
Table 1. Occurrence of Cardiovascular diseases in London, 2001 and 2006

<table>
<thead>
<tr>
<th>Disease</th>
<th>Persons</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular Disease (ICD10: I00 - I99)</td>
<td>77,489</td>
<td>86,943</td>
<td></td>
</tr>
<tr>
<td>Ischaemic Heart Disease (ICD10: I20 - I25)</td>
<td>27,550</td>
<td>28,791</td>
<td></td>
</tr>
<tr>
<td>Acute Myocardial Infarction (ICD10: I21 - I22)</td>
<td>5,991</td>
<td>6,313</td>
<td></td>
</tr>
<tr>
<td>Acute Myocardial Infarction (ICD10: I21)</td>
<td>5,482</td>
<td>5,716</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: this information was provided by the LHO solely for the purposes of this Report from Hospital Episode Statistics (Department of Health) for 2001/02 and 2005/06, and must not be used without permission of the LHO.
Figure 10. Polynomial curve fit (N-weighted data points) of the association between road traffic noise and incidence of myocardial infarction.

\[
OR = 1.629657 - 0.000613 \cdot \text{Noise}^2 + 0.000007356734623455 \cdot \text{Noise}^3; R^2 = 0.96
\]

(no significant linear term in the equation)
FIGURE 1. Correlation between individual long-term exposure to air pollution (NO$_2$ μg/m$^3$) and noise (dB $L_{A_{eq,24~hour}}$) from road traffic in a case-control study on MI from Stockholm.
### Population Exposure data – all roads

<table>
<thead>
<tr>
<th>Noise level</th>
<th>$L_{\text{day, 12h}}$</th>
<th>$L_{\text{den}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50 dB</td>
<td>72.76 %</td>
<td>67.34 %</td>
</tr>
<tr>
<td>50 -55</td>
<td>7.19%</td>
<td>10.44 %</td>
</tr>
<tr>
<td>55 -60</td>
<td>7.82 %</td>
<td>8.01 %</td>
</tr>
<tr>
<td>60 -65</td>
<td>9.23 %</td>
<td>9.74 %</td>
</tr>
<tr>
<td>65 -70</td>
<td>2.91 %</td>
<td>4.25 %</td>
</tr>
<tr>
<td>70 -75</td>
<td>0.10 %</td>
<td>0.22 %</td>
</tr>
<tr>
<td>&gt; 75 dB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CALCULATING NUMBERS OF PEOPLE POTENTIALLY AFFECTED BY ACUTE MYOCARDIAL INFARCTION AMI [Heart attack]

Pe = Percentage exposed.
PAR% = \[\frac{Pe}{100} \times (RR - 1)\] / \[\frac{Pe}{100} \times (RR - 1) + 1\] * 100

<table>
<thead>
<tr>
<th>NOISE SOURCE ROAD TRAFFIC NOISE ALL ROADS</th>
<th>Relative Risk OR</th>
<th>Percentage Exposed %</th>
<th>PAR%</th>
<th>PAR = number affected per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOISE LEVEL ( L_{\text{day, 12h}} ) dB From ( L_{\text{day, 16h}} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 55</td>
<td>1</td>
<td>72.76</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>55-60</td>
<td>1</td>
<td>7.19</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>60-65</td>
<td>1.05</td>
<td>7.82</td>
<td>0.39</td>
<td>23</td>
</tr>
<tr>
<td>65-70</td>
<td>1.09</td>
<td>9.23</td>
<td>0.82</td>
<td>49</td>
</tr>
<tr>
<td>70-75</td>
<td>1.19</td>
<td>2.91</td>
<td>0.55</td>
<td>33</td>
</tr>
<tr>
<td>&gt; 75 dB</td>
<td>1.47</td>
<td>0.1</td>
<td>0.05</td>
<td>3</td>
</tr>
<tr>
<td>SUM</td>
<td></td>
<td></td>
<td>1.81</td>
<td>108</td>
</tr>
</tbody>
</table>
Mortality

- **AMI** 46% [2006 Health statistics, 2926/6313]

- **Potential Deaths**
  
  [46% of 108, Road Traffic] 50

- **Traffic Accidents 2006** 243

- **Air Pollution PM10** 1031

- **GLA Population** 8,000,000
NEW Research project for Defra Natural Environment Economics NEE Team. September 2008 – March 2009

Estimating Dose-Response Relationships Between Noise Exposure And Human Health Impacts In The UK
AIMS

• **Identify** the potential adverse health impacts and **review the current state of evidence for each of the impacts**.

• Where a robust evidence base exists, to **develop robust dose-response functions for the impacts of noise and health which could be applied to policy appraisal** in the UK.
NOTE - will feed in to Defra Methodology

Economic Valuation of Health Impact

£ £ £ £ £ £ £ £ £ £ £ £ £ £ £ £
AIMS [2]

- Identify emerging adverse health impacts that should be kept under review; and
- Identify any structural challenges to developing a robust dose-response function
HEALTH EFFECTS
UNDER REVIEW IN PHASE 1

- Annoyance
- Mental health
- Cardiovascular – IHD, Acute myocardial AMI
- Awakenings/sleep
- Self-rated sleep disturbance
- Cognitive Performance by School Children
- Hearing Impairment/tinnitus
ASSESSMENT CRITERIA - PHASE 1

- Strength of evidence from research studies
- Availability of dose-response relationship
- Direct effects, as opposed to indirect effects?
- Nature of the effect/endpoint – subjective?
- Relevance at typical environmental noise levels?
- How “generally applicable” is the Dose-effect relationship?
- Use of noise-exposure metrics in the dose-response relationships, which relate to EU policy / END etc.
PHASE 2

- Cardiovascular – IHD, Acute myocardial AMI
- Awakenings/sleep
ALSO

• REVIEW OF SIMILAR VALUATION METHODS IN 25 EU COUNTRIES

• For example

Rotterdam MSR Report
Noise, Health and Money
The price of noise
June 2008
Official Swiss Appraisal Method

Ischämische Herzkrankehiiten

Belastungsreferenzwert: 65 dB(A) tags

Inkrement: 0.066 pro 5 dB(A)

95%-Vertrauensbereich

Lärmklassen:
- < 60
- 60 - 64
- 65 - 69
- 70 - 74
- > 74

Beurteilungspegel tags in dB(A)
### Table 3: Overview of years of life lost and illness caused by noise in the year 2000

<table>
<thead>
<tr>
<th></th>
<th>Ischaemic heart diseases owing to daytime noise</th>
<th>Hypertension-related diseases owing to nighttime noise</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Road</td>
<td>Rail</td>
</tr>
<tr>
<td>Years of life lost</td>
<td>274</td>
<td>56</td>
</tr>
<tr>
<td>Working years lost</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Hospital admissions (inpatient)</td>
<td>82</td>
<td>17</td>
</tr>
<tr>
<td>Hospital admissions (part-inpatient)</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Number of days in hospital (inpatient)</td>
<td>757</td>
<td>153</td>
</tr>
<tr>
<td>Lost working days (hospital inpatient days only)</td>
<td>192</td>
<td>39</td>
</tr>
<tr>
<td>Outpatient treatments</td>
<td>101</td>
<td>20</td>
</tr>
<tr>
<td>Daily doses of medication (1000s per year)</td>
<td>13,370</td>
<td>3,542</td>
</tr>
</tbody>
</table>

*) Deviations of ±1 are caused by rounded figures
Possible UK valuations - GLA example

• 108 cases of AMI are potentially related to noise exposure.

• 2001 mortality data – number of deaths=78
  number of non-fatal cases would be 30..

• Thus to calculate Disability Adjusted Life Year DALYs;

• Years of Life Lost YLL = 78

• Years of Life with Disability YLD = 30 X 0.405
  [using WHO figure for Disability weight]

• DALYs= 78+ 12 = 90
Hypothetical Action Plan

• ZERO population exposed above $L_{\text{day}}$ 70dBA
### Calculating Numbers of People Potentially Affected by Acute Myocardial Infarction (AMI) [Heart attack]

<table>
<thead>
<tr>
<th>Noise Source</th>
<th>Noise Level</th>
<th>Relative Risk OR</th>
<th>Percentage Exposed %</th>
<th>PAR%</th>
<th>PAR = number affected per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Traffic Noise</td>
<td>L_{day, 12h} dB</td>
<td>From L_{day, 16h}</td>
<td></td>
<td></td>
<td>Number of cases N_c = 5991</td>
</tr>
<tr>
<td>All Roads</td>
<td>&lt; 55</td>
<td>1</td>
<td>72.76</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td></td>
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Effect of Action Plan- GLA example

• 108 cases of AMI potentially related to noise exposure – reduced to 72. number of deaths=52 [78]
• number of non-fatal cases would be 20.
• Years of Life Lost YLL = 52
• Years of Life with Disability YLD = 20 X 0.405 [using WHO figure for Disability weight]
• DALYs= 52+ 8 = 60....was 90
• 30 X 78,500 euros per life year = 2.355 million euro.
GENERAL ISSUES ??
Issues

• Evidence on Noise and Health, and related Exposure-response relationships are mainly based on studies of Road Traffic Noise and Aircraft Noise

• Very limited information on Railway Noise [e.g. Austria], Industry [NL]

• but see www.defra.gov.uk/environment/noise/research/industrial/index.htm

• The role of Air Pollution in Cardiovascular disease effects?

• Can we assess “Total Health Impact” – not just “components” – annoyance, sleep, cardiovascular etc??
FINAL THOUGHTS

- Various ongoing projects – research, guidance, policy etc, in UK and worldwide, e.g. WHO Working Groups and Reports

- Noise Action Plans CAN take Health Effects into account

- Health effects of noise increasingly a PRIORITY issue

- UK and EU Noise Policy should reflect this.

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Noise and Health Issues
Bernard Berry. Hon FIOA

• KEY DOCUMENTS AND WEBSITES
  • http://ec.europa.eu/environment/noise/health_effects.htm
  • http://www.london.gov.uk/mayor/strategies/noise/
  • http://www.london.gov.uk/mayor/strategies/noise/docs/technical-report1.pdf
  • http://www.london.gov.uk/mayor/strategies/noise/docs/technical-report2.pdf

• IGCB Interdepartmental Group on Costs and Benefits
  • http://www.defra.gov.uk/environment/airquality/panels/igcb/index.htm
Other documents, websites

• DfT NATA New Approach To Appraisal - Refresh project


• **Health Effect Based Noise Assessment Methods: A Review and Feasibility Study**
  *NPL REPORT September 1998*


  • Berry and Porter 2005. Review and analysis of published research into the adverse effects of industrial noise, in support of the revision of policy planning guidance

• RIVM report 630400001/2005.
  • http://rivm.openrepository.com/rivm/bitstream/10029/7412/1/630400001.pdf

http://www2.gsu.edu/~wwwscp/ijcp-vol20-2-3-2007/06.Clark_PDF.pdf
Noise, Health and Money
The price of noise

June 2008


http://www.hetmilieuinderegiorotterdam.nl/nl/themarapport/index.html