HEALTH IMPACT ASSESSMENT OF TRANSPORT NOISE EFFECTS ON CHILDREN

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Introduction This paper provides guidance for the assessment of transport-related health impacts caused by noise. It was drafted within the framework of a joint exercise by Austria, France, Malta, Sweden, Switzerland and the Netherlands to expand and further develop the methodology for cost-benefit analyses of transport-related health impacts with a special focus on children. It was discussed in an international review workshop in April 2003.

Impact assessment We propose the following approach to assess the health impacts of traffic noise, which is based on general procedures for environmental health risk assessment:
(1) Select a set of health endpoints for which there is sufficient evidence for an association with the risk factor under study. For each of these indicators do the following steps:
(2) Exposure assessment: Combine data on (sub) population density with concentration distributions, e,g, by means of GIS. Noise levels may be based on monitoring data, legally required noise propagation models or simple models taking into account degree of urbanisation, traffic or vehicle density and emission data;
(3) Identify coefficients and confidence intervals of exposure-response relationships and thresholds of effects;
(4) Estimate the proportion of cases observed in the study population that is attributable to the risk factor under study. This is a function of the population exposure distribution, exposure-response relations and the observed incidence and prevalence rates of the health end-point in the study population.
(5) Calculate the total (aggregated) noise-related health loss or disease burden, if desirable.

Health endpoints Table 1 gives an overview of exposure-response relations that can be used to assess health effects of traffic noise in the European region. These relations are based on studies in adults. Data for children are insufficient. Effects on cognition, however, are mainly observed in children and mainly for aircraft noise. Recently, some hypothetical exposure-response curves for recall and reading in children were developed which may provide some insight though in the slope of the curves for different noise levels and outcomes, but which should be validated by new empirical studies. Only limited information on sleep disturbance in children is available. Studies, mainly conducted in laboratory-controlled environments show changes in sleep quality and quantity when a child is exposed to noise during sleep. Young children are less prone to awakenings than adolescents. In a few studies among children a noise-related increase in blood pressure and hormone levels has been observed.
For annoyance we propose to use the relations as described in the EU-guidelines (see table 1) but with more attention for modifying factors such as noise sensitivity and cultural differences. For sleep disturbance (perceived sleep quality) some curves are available (road traffic and railway noise), but they should be used with great care since they may not be generally applicable. For cardiovascular diseases only risk estimates for road traffic and aircraft noise are available.

Table 1 Exposure response relationships which can be used to assess health effects of traffic noise in the European Region (Sources: Annoyance: Miedema et al., 2001, CVD: van Kempen et al., 2002, sleep and CVD: Passchier-Vermeer et al., 2002)

Effect	Noise metric[a]	Source	Population	Exposure-response relationship
Annoyance				
- Percentage annoyed (A)	Lden	Aircraft	Adults	$\%A = 8.588*10^{-6}$ $(Lden-37)^3 + 1.777*10^{-2}$ $(Lden-37)^2 + 1.221$ (Lden-37);
	Lden	Road		$\%A = 1.795*10^{-4}$ $(Lden-37)^3 + 2.110*10^{-2}$ $(Lden-37)^2 + 0.5353$ (Lden-37);
	Lden	Rail		$\%A = 4.538*10^{-4}$ $(Lden-37)^3 + 9.482*10^{-3}$ $(Lden-37)^2 + 0.2129$ (Lden-37);
- Percentage highly annoyed (HA)	Lden	Aircraft	Adult	$\%HA=-9.199*10^{-5}$ $(Lden-42)^3 + 3.932*10^{-2}$ $(Lden-42)^2 + 0.2939$ (Lden-42);
	Lden	Road		$\%HA = 9.868*10^{-4}$ $(Lden-42)^3 - 1.436*10^{-2}$ $(Lden-42)^2 + 0.5118$ (Lden-42);
	Lden	Rail		$\%HA = 7.239*10^{-4}$ $(Lden-42)^3 - 7.851*10^{-3}$ $(Lden-42)^2 + 0.1695$ (Lden-42)
Sleep disturbance				
- Motility (mean)	L_{night}	Aircraft	Adults	$M_{night} = 0.000192 \times (L_{night}$ - Ldiff1-Ldiff2)[b]
- Percentage highly sleep disturbed (HSD) sleep disturbed (SD) a little sleep disturbed (LSD)	L_{night}	Road	Adults	$\%HSD = 20.8 – 1.05L_{night} + 0.01486L_{night}^2$ $\%SD = 13.8 – 0.85L_{night} + 0.01670L_{night}^2$ $\%LSD = -8.4 + 0.16L_{night} + 0.01081L_{night}^2$.
- Highly sleep disturbed sleep disturbed a little sleep disturbed	L_{night}	Rail	Adults	$\%HSD = 11.3 – 0.55L_{night} + 0.00759L_{night}^2$ $\%SD = 12.5 – 0.66L_{night} + 0.01121L_{night}^2$ $\%LSD = 4.7 – 0.31L_{night} + 0.01125L_{night}^2$.
Cardiovascular diseases				
- Hypertension	$L_{Aeq.7-19}$	Air	Adults	RR = 1.26 (CI = 1.0-1.13)
	L_{den}	Road/ Air		RR = 0.5 + 0.007 * L_{den} (between 70-80 dB(A))
-Ischaemic heart disease-total	$L_{Aeq.6-22}$	Road	Adults	RR = 1.09 (CI = 1.05 – 1.13)
Hospital admissions Myocardial infarction	L_{den}	Road/ Air		RR = 0.5 + 0.008 * L_{den} (between 70-80 dB(A))

a outdoor at the most exposed façade

b Ldiff1 : difference between L_{night} en L_{Aeq} most exposed façade. default = 0 dB(A)
Ldiff2 : difference between L_{Aeq} outdoor and in the bedroom. default = 21 dB(A)

Exposure assessment In Europe, road traffic is the main cause of noise exposure. Noise exposure is usually assessed by national noise calculation methods. Noise indices and calculation methods differ per country and per transport mode. When comparing noise exposure data from different countries, one should be aware of (a) possible methodological artefacts, which may lead to undesired differences in the outcome of 10 – 15 dB(A) and of (b) possible country-specific, source dependent noise reductions. Untill noise indices and calculation methods are harmonised on an EU-level one has to deal with individual national noise indices and noise calculation methods. To enhance comparison it is recommended to use L_{den} and L_{night}. If national calculation methods are used, a minimum requirement is that it is clear whether specific country-specific, source dependent noise reductions have been applied. It is recommended to refrain from these reductions. If feasible, different national noise situations should be estimated not only with the national calculation method, but also with one 'common' method, preferably the designated interim-method. When population exposure models combining detailed source information at street, grid and city level with population and built environment data are not available, a more crude approach might be used.

Discussion In health impact assessment we may limit ourselves to outdoor noise levels, since most exposure-response relations are based on outdoor noise levels. In the case of policy-evaluation, however, we may want to know more about the most relevant locations and periods of exposure (e.g. children: noise levels school or at home). In that case we do need to know more about the effect of behavior and time-activity patterns on noise exposure.
We also have to take into account that traffic noise is caused by different noise sources, which have a different impact on e.g. annoyance-levels. It is possible to calculate the overall exposure of rail and road traffic and aircraft noise using a cumulative noise-index taking into account the different annoyance responses Whether this is needed for categories such as heavy lorries, motorcycles etc needs further investigation.
Another question is whether we only model those health effects for which there is sufficient evidence for causality (annoyance, sleep disturbance) or that we also include effects for which the evidence is limited (cognition, cardiovascular diseases). The transferability of risk-ratios/exposure response relationships from one population to another (differences in susceptibility, base-line risk) is another source of uncertainty. Most risk estimates for noise are based on studies in adults. At the moment it is not deemed feasible to include separate curves for risk groups such as children.

Keywords: health impact assessment, transportation noise, exposure, exposure-response relations, children

References

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