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Road traffic noise induced health effects on children

Feasibility study of quantifying the health impacts

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Outline

▶ **Context**

▶ **Methods**

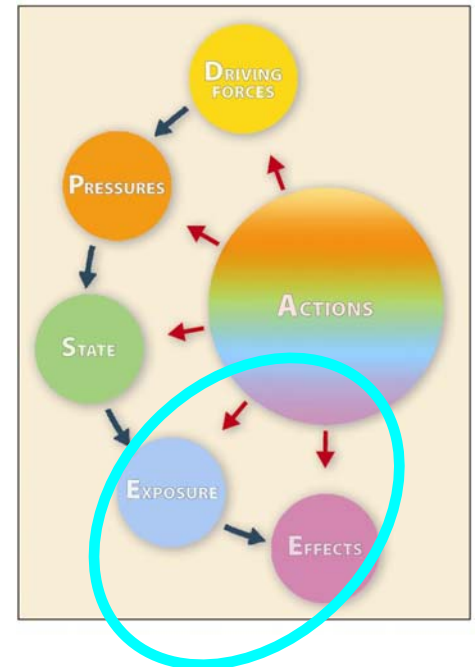
▶ **Results**

▶ **Conclusions**

Context - ENHIS

Environmental Health Information System

- ▶ Monitoring of the environment and health situation and trends in the countries in the European region and evaluation of the effectiveness of policies
- ▶ Scope of the system
 - **Environmental Health Indicators**
 - Focus on health related exposures, health effects and actions
 - Focus children (CEHAPE)
- ▶ EC DG Sanco co-sponsored project coordinated by WHO-ECEH Bonn (2004-2007)



European EH Information System

Methodology for 29 indicators

International and national data bases

Data from surveys

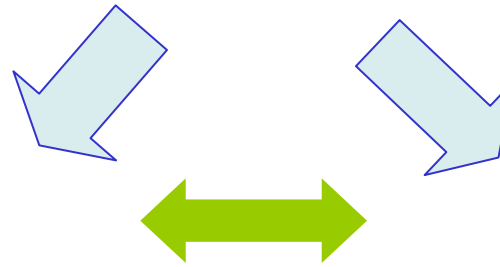


Analysis and assessment (including HIA)



26 FACT SHEETS

<http://www.enhis.org>



Policy Context I

Road traffic noise - Impact on European population:

- 32% are affected with noise levels > 55 dB(A) (L_{DN})
- 13% are affected with noise levels > 65 dB(A) (L_{DN})

[EEA, 2001; Roovers et al., 1998]

Number of passenger cars in Europe (EU-25) is increasing:

- 1995: 395 cars per 1000 inhabitants
- 2004: 463 cars per 1000 inhabitants

[EUROSTAT]

Policy Context II

EU - Environmental noise directive (END)

▶ 2007

MS have to produce **noise maps** for cities with > 250 000 inhabitants + for heavily trafficked roads (> 6 million vehicles/ yr)

▶ 2012

noise maps for all cities > 100 000 inhabitants, major roads (> 3 million vehicles), airports, major railways

▶ **Noise reduction plans**

▶ Goals:

- Harmonising EU noise methodology ($L_{(DEN)}$)
- Public availability of noise maps
- Communication about regional noise exposure situation

Context

Assessment of feasibility of conducting a quantitative HIA on road traffic noise induced health effects on **children**

- ▶ **Children** - Sensitive group
 - ▶ noise may affect them in critical development periods
 - ▶ less developed coping repertoire
 - ▶ not able to control their environment
- ▶ Epidemiological studies on child specific health effects due to road traffic noise are rare
- ▶ Insufficient data basis on European level (exposure- & outcome-data) mainly caused by stop of collecting data because of the current implementation of the END
- ▶ → Assessing of feasibility of HIA on regional level in North Rhine-Westfalia (NRW) = case studies in 2 cities

Methods: Steps of quantitative Health Impact Assessment

HIA-steps (in general):

1. Specify the measure of **exposure** to the indicated hazards and their **distribution** in the target population for which the assessment is requested
2. Define the appropriate **health outcomes** on the basis of the **epidemiological** evidence and the **availability** of necessary data
3. Specify the **exposure-response function (ERF)** as the key contribution of epidemiology to HIA
4. Derive **population baseline frequency** measures for the health outcomes under consideration
5. Calculate the **number of attributable cases**
6. Propose **scenarios** for **health benefits**

Step 1 – Exposure assessment

Specify the measure of **exposure** to the indicated hazards and their distribution in the target population for which the assessment is requested

„**population exposed to various ranges of traffic noise levels**“

- ◆ **Exposure assessment on EU level poor: no routinely collection at country level yet**
 - ▶ Use of local data on **city level** for NRW collected before implementation of END
 - ▶ Noise level measured / modelled
highest level outdoors (4 m height at facade)
 - ▶ Use of noise and population maps -> exposure distribution

Results - the cities

▶ City A

- Area: 123 km²
- 7,7 km² (6 %) used for traffic
- Core city in an urbanised area, a typical situation for about 9 % of the cities in NRW
- 2007: 52 500 inhabitants, 8600 (16 %) children (0-14 years)



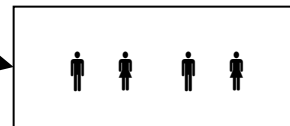
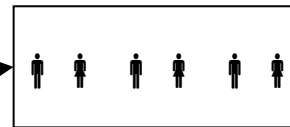
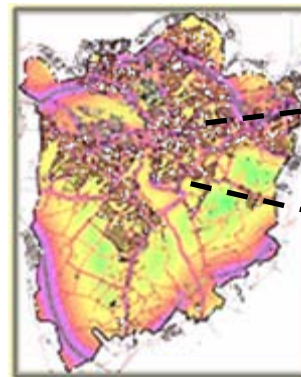
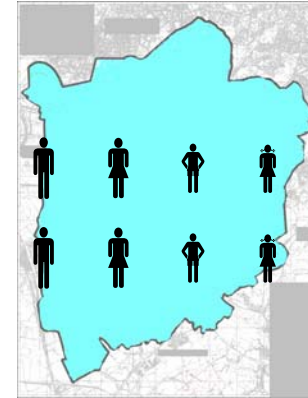
▶ City B

- Area: 91 km²
- 12 km² (13 %) used for traffic
- Core city in high-compressed urban agglomeration, a typical situation for about 4 % of the cities in NRW
- 2007: 170 000 inhabitants, 22 000 (13 %) children (0-14 years)

Noise mapping

noise map (road traffic)

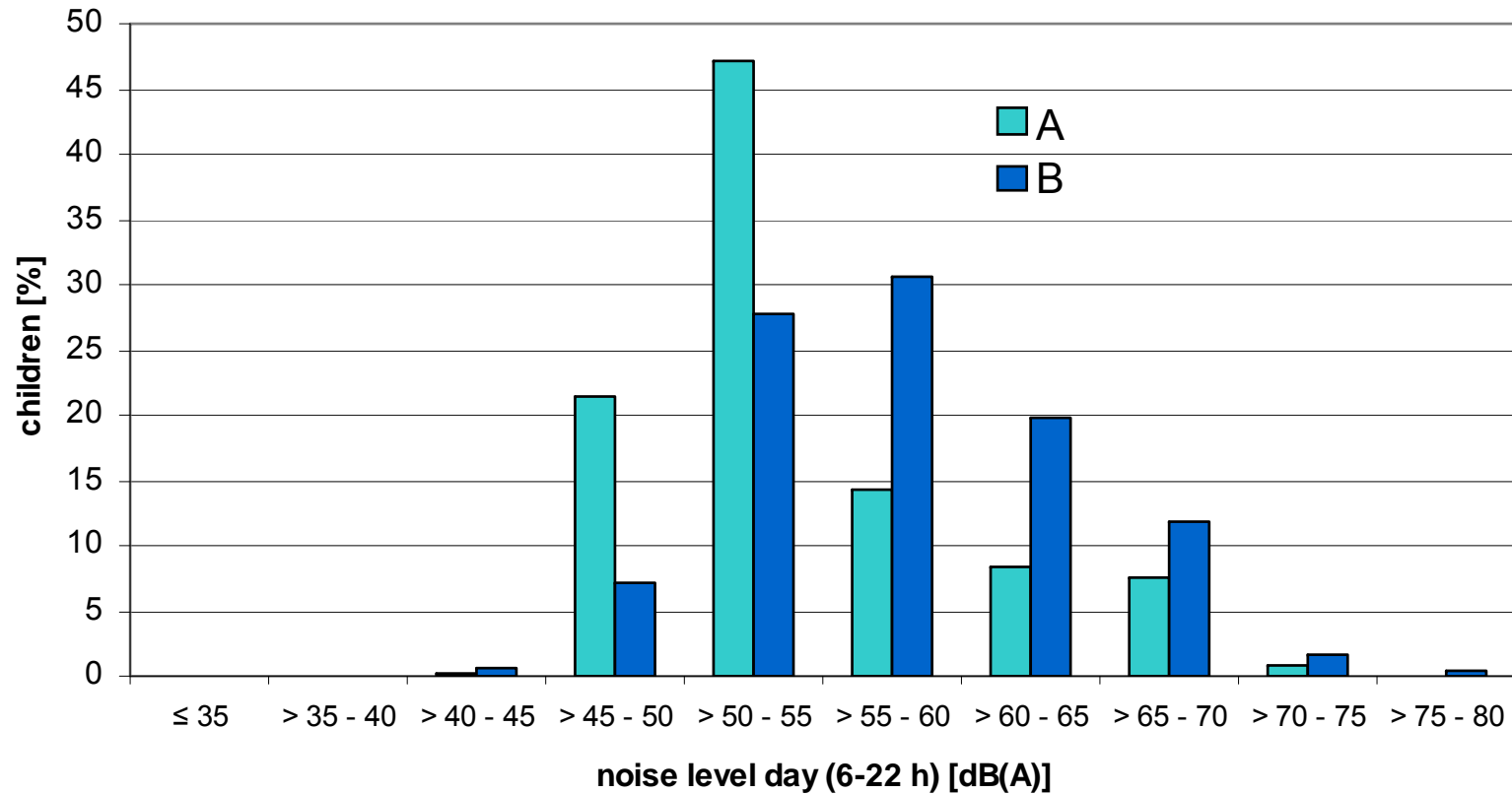
population map



population exposed to various ranges of road traffic noise

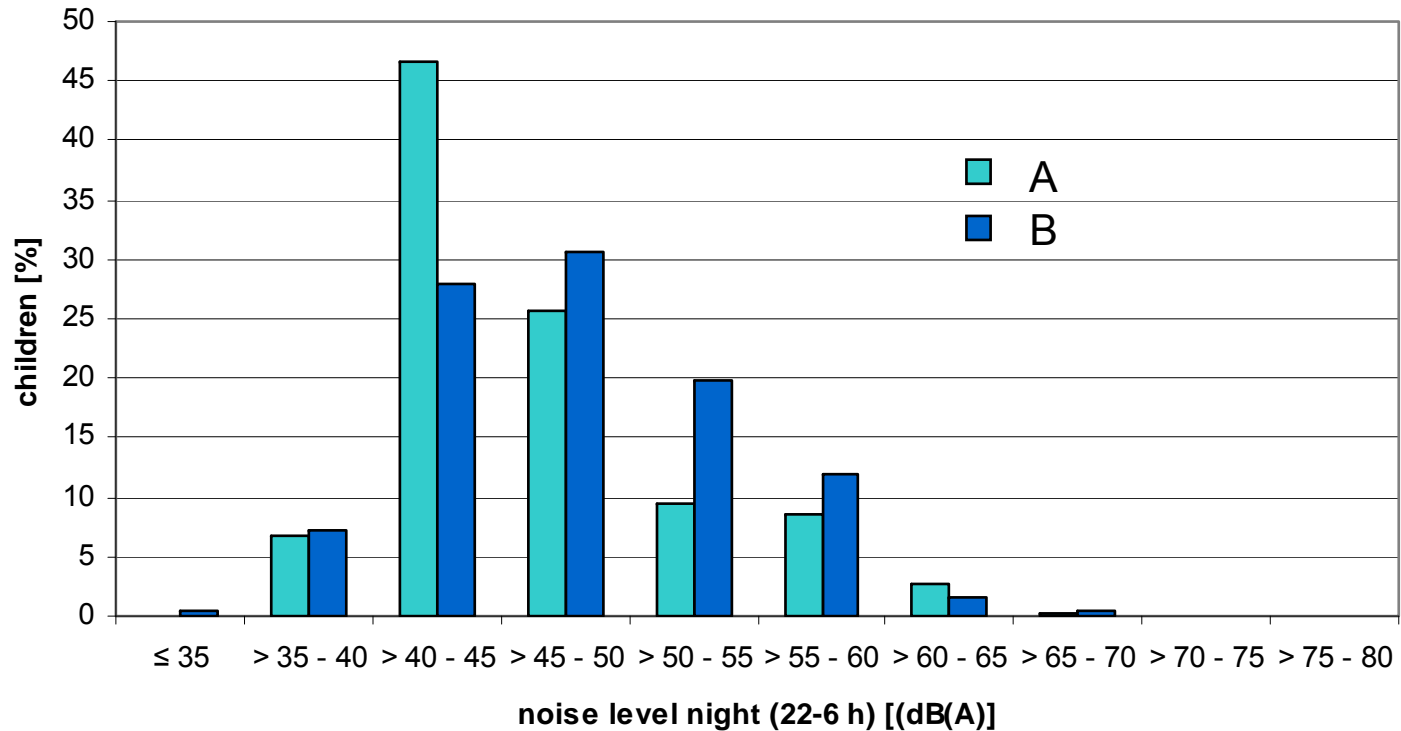
Results - Exposure I (day)

City A & B - Road traffic noise exposed children (0-14 years) - day



Results - Exposure II (night)

City A & B - Road traffic noise exposed children (0-14 years) - night



Results - Exposure III

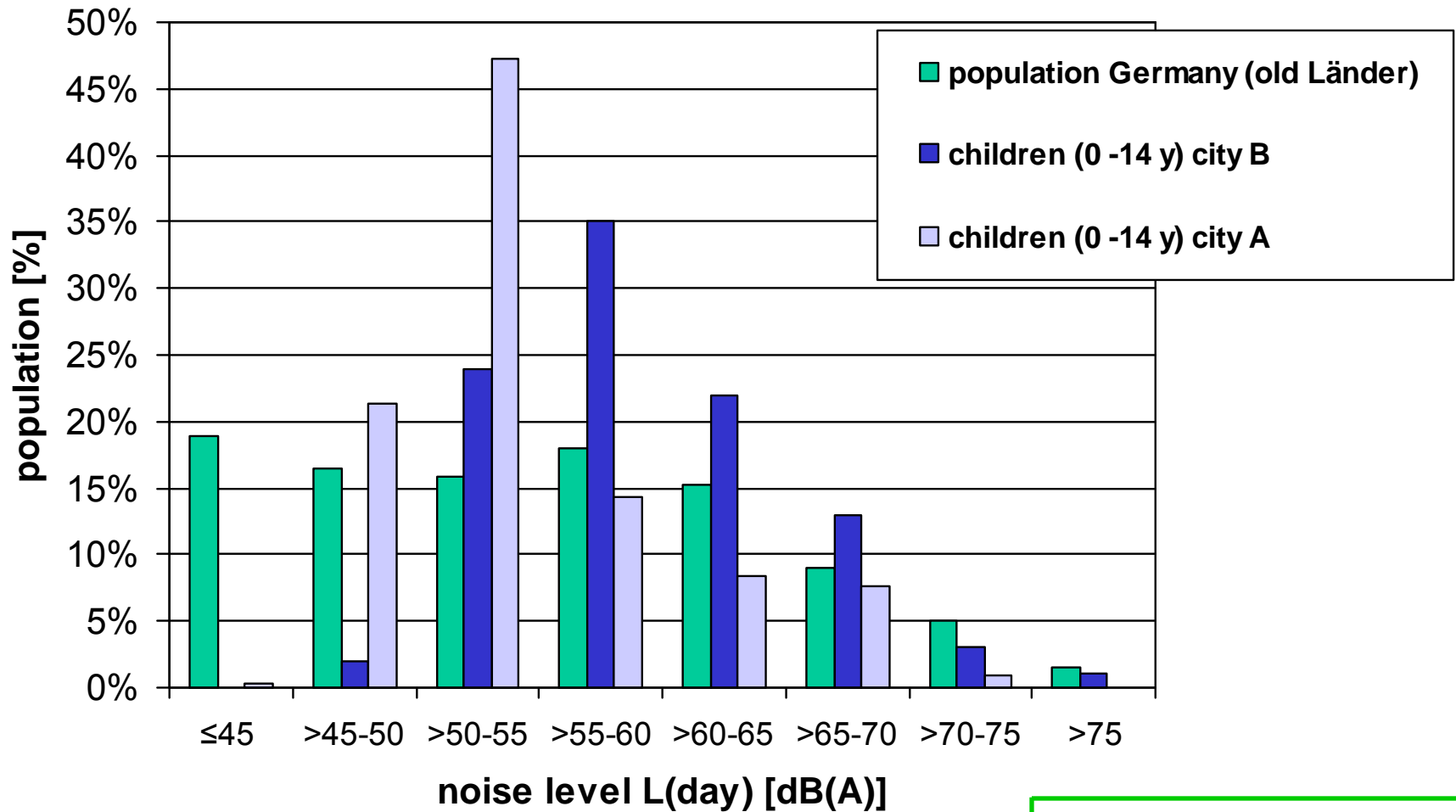
Comparison:

17 – 34 % of the children is estimated to be exposed to noise levels of more than 60 dB(A) during the day

21 – 34 % of the children is estimated to be exposed to noise levels of more than 50 dB(A) at night

Results - Exposure IV

noise exposure children vs. total population



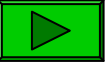
Step 2 - Health Outcomes

Define the appropriate **health outcomes** on the basis of the epidemiological evidence & the availability of necessary data

- ▶ Exposure to road traffic noise is associated e.g. with
 - ◆ Annoyance
 - ◆ Sleep disturbance
 - ◆ Stress related somatic effects
 - ◆ Impacts on cognition and performance
- ▶ **Selected health outcomes: annoyance & sleep-disturbance**
 - ◆ evidence is sufficient for adults
 - ◆ indications show a causal relationship for children
 - ◆ not collected on a routine basis, measured in health surveys (by questionnaires)
 - ◆ Only **high annoyance** (HA) and **high sleep-disturbance** (HSD)
 - ◆ Confirmation of chosen health outcomes by experts

Step 3 - Exposure-response function

Specify the **exposure-response function (ERF)** as the key contribution of epidemiology to the quantitative HIA

- ◆ **review:** studies noise exposure and resulting annoyance/ sleep disturbance
- ◆ ERFs known for **annoyance** and **sleep disturbance** in adults (curves by Miedema et al. 2001, 2003)
- ◆ $\% HA = 9.994 \cdot 10^{-4} (L_{DN}-42)^3 - 1.523 \cdot 10^{-2} (L_{DN}-42)^2 + 0.538 (L_{DN}-42)$ 

$$\% HSD = 20,8 - 1,05 L_{\text{night}} + 0,01486 (L_{\text{night}})^2$$

HA = highly annoyed people; HSD = highly sleep disturbed people

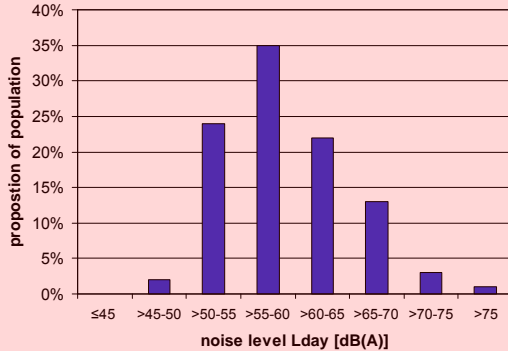
validity: A between 45 and 75 dB(A)

SD between 40 and 70 dB(A)

- ◆ Supporting information and adjustments for children 

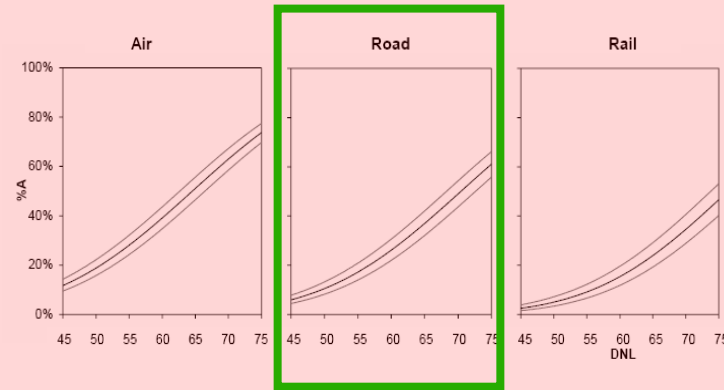
Step 5 - Quantification of health impacts

noise exposure children in city NRW



Exposure

Exposure-response



$$\text{e.g. \%HA} = 9.868 \cdot 10^{-4} (L_{\text{den}} - 42)^3 - 1.436 \cdot 10^{-2} (L_{\text{den}} - 42)^2 + 0.5118 (L_{\text{den}} - 42)$$

HA

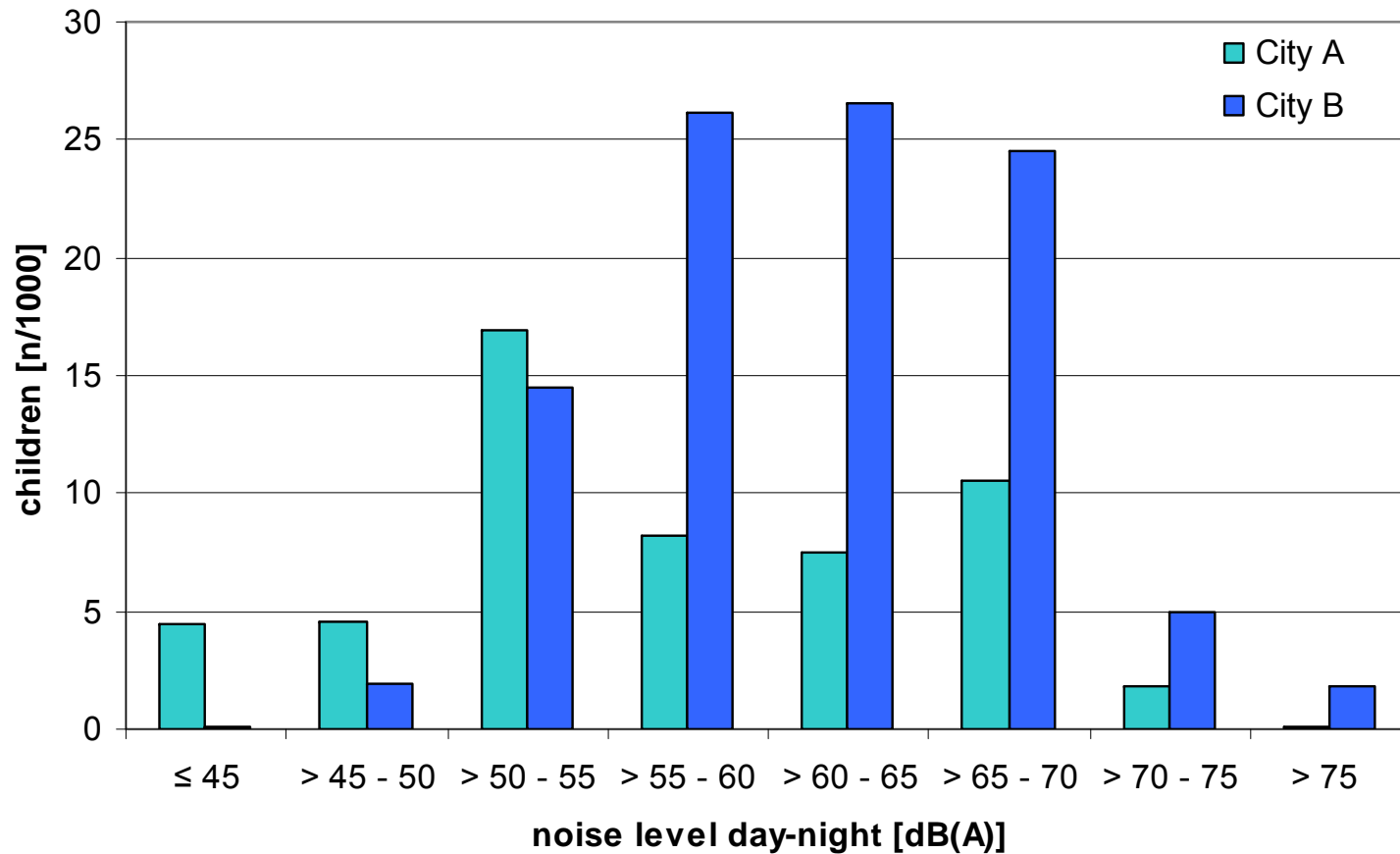
L_{den}

= highly annoyed people

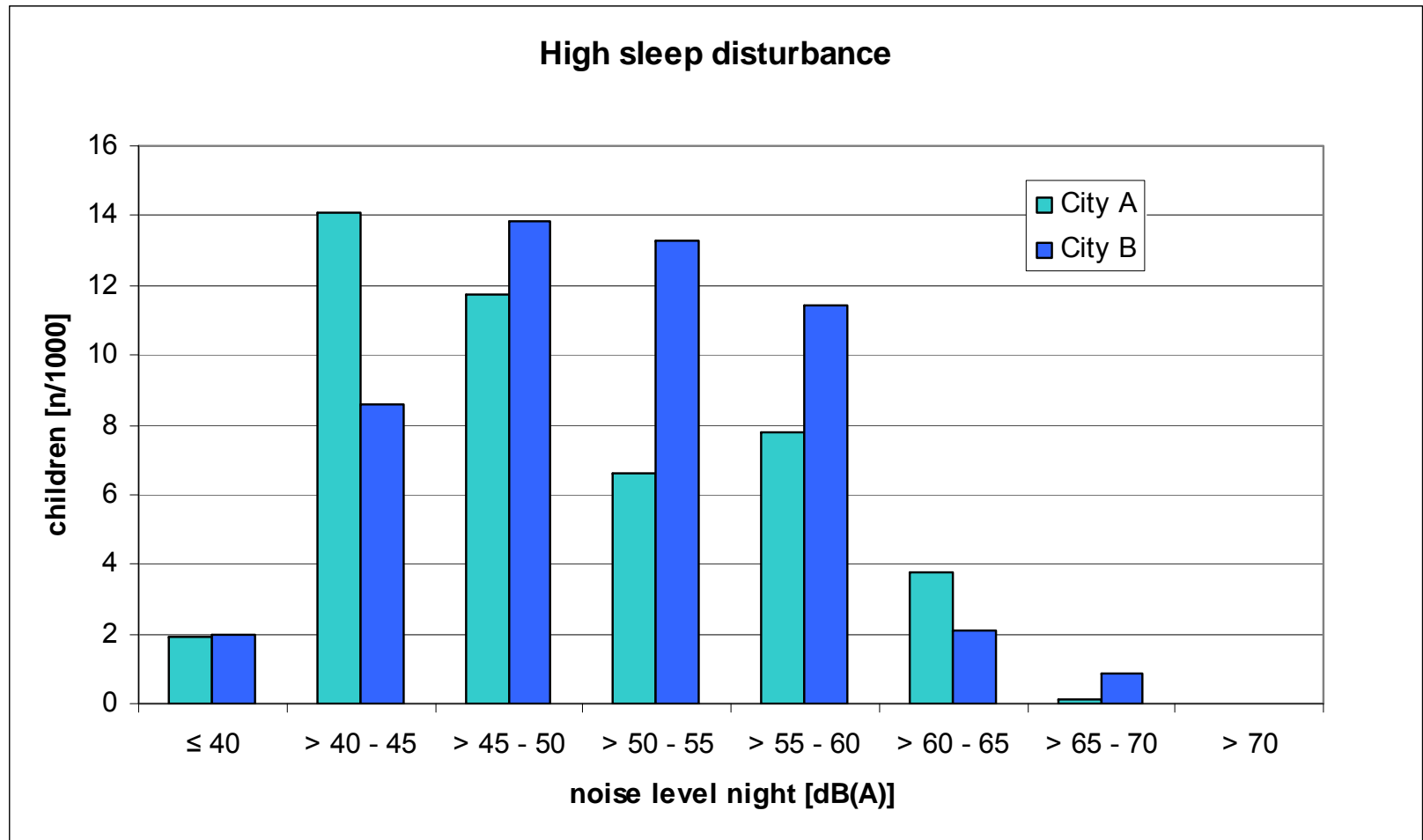
= mean noise level for day, evening and night-time

Results - Annoyance

Estimated number of children (per 1000) highly annoyed by road traffic noise, by noise level category



Results - Sleep disturbance



Results - Health impacts

Summary

Health outcome	City		Total
	A	B	
Annoyance			
Highly annoyed children (%)	5.4 <i>(4.0 - 6.5)</i>	10.1 <i>(7.9 - 12.2)</i>	
Highly annoyed children (n)	471 <i>(345 – 569)</i>	2217 <i>(1742 – 2695)</i>	2688
Sleep disturbance			
Highly sleep disturbed children (%)	4.6 <i>(3.3 – 7.5)</i>	5.2 <i>(3.7 – 8.2)</i>	
Highly sleep disturbed children (n)	395 <i>(281 – 640)</i>	1149 <i>(804 – 1802)</i>	1544

Step 6 - Scenarios

Propose **scenarios** for **health benefits**

- ◆ Calculating the proportion of children HA and children HSD under the assumption
 - ▶ noise exposure levels are not exceeding 50 dB(A) at night and 60 dB(A) daytime (national guideline-values)
 - ▶ a decrease of 5 dB(A) in all noise level classes (use of low-noise asphalt)
- ◆ Calculating the potential health gain
 - ▶ differences in numbers of HA or HSD children between current situation and scenario situations
 - ▶ percentage of HA or HSD children which can be avoided by the exposure reduction measures

Results - scenario

Scenario 1

Assumption of noise exposure not exceeding 50 dB(A) (at night) and 60 dB(A) (daytime)

Health outcome			
annoyance			
Highly annoyed children (%)			
Highly annoyed children (n)			
Sleep disturbance			
highly sleep disturbed children (%)			
highly sleep disturbed children (n)			

* Proportion (in %) of the HA or HSD children which can be avoided by the exposure reduction measure

Results - Scenario

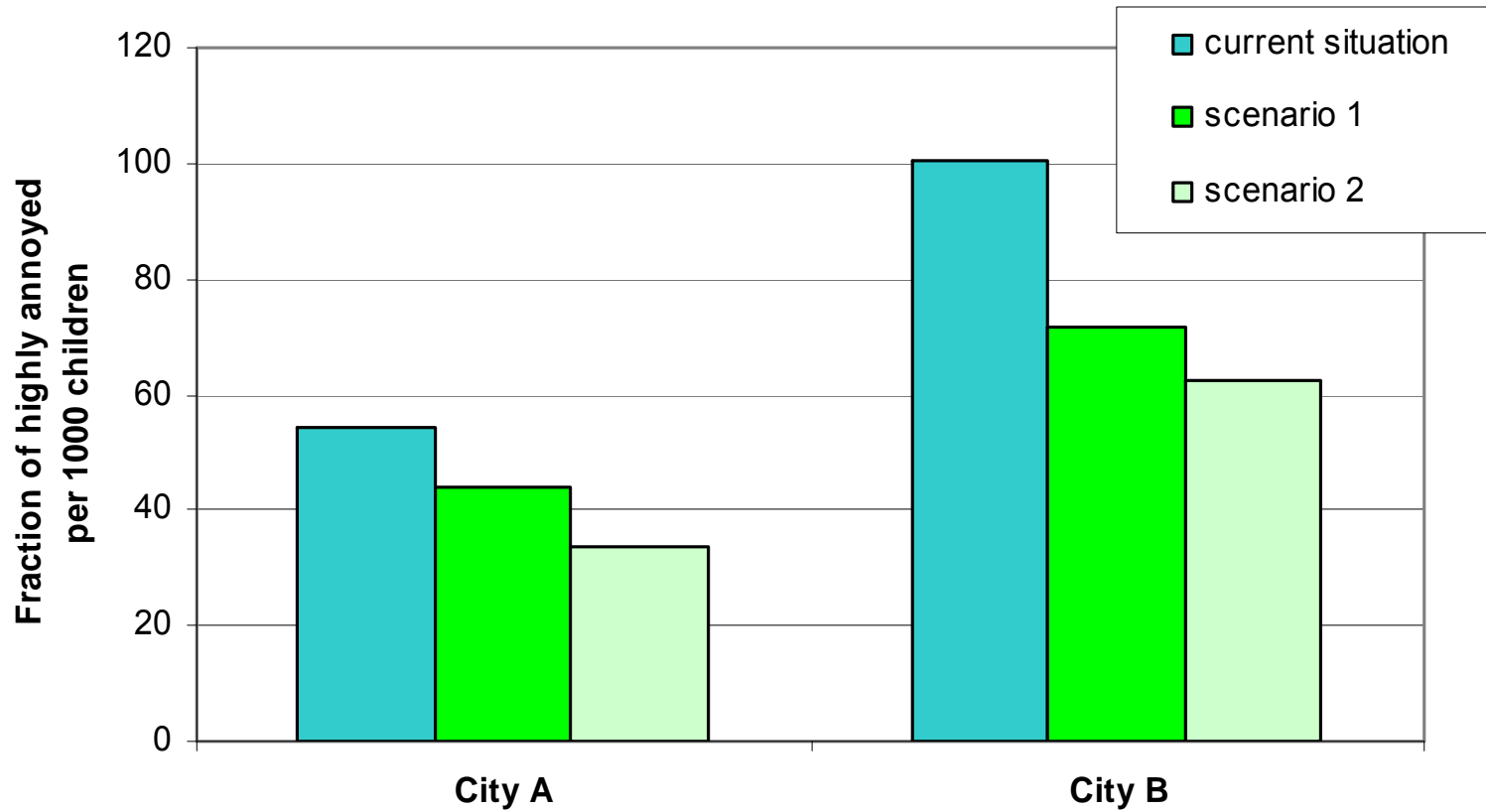
Scenario 2

Assumption of a noise level decreasing for 5 dB(A) (low noise asphalt) for all categories

Health outcome			
annoyance			
Highly annoyed children (%)			
Highly annoyed children (n)			
Sleep disturbance			
highly sleep disturbed children (%)			
highly sleep disturbed children (n)			

* Proportion (in %) of the HA or HSD children which can be avoided by the exposure reduction measure

Scenarios - Summary



Conclusions I

- ▶ **Case studies on a city level: feasible**
- ▶ **Results of the case studies**
 - Good estimate for the two cities
 - Not possible to extrapolate on NRW / Germany, but some NRW-cities are comparable (13 % of all cities in NRW)
- ▶ **HIA not feasible on European level yet**
 - Missing adequate data

Conclusions II

- ◆ HIA calculations should be updated as soon as END-results become available
- ◆ More research on exposure-response-relationship for road traffic noise induced health effects in children is needed