

Aircraft Noise as a Public Health Problem

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WHO

Guidelines for Community Noise

Geneva, 2000

Guidelines for Community Noise

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World Health Organization
Sustainable Development and Healthy Environments
Protection of the Human Environment
Occupational and Environmental Health



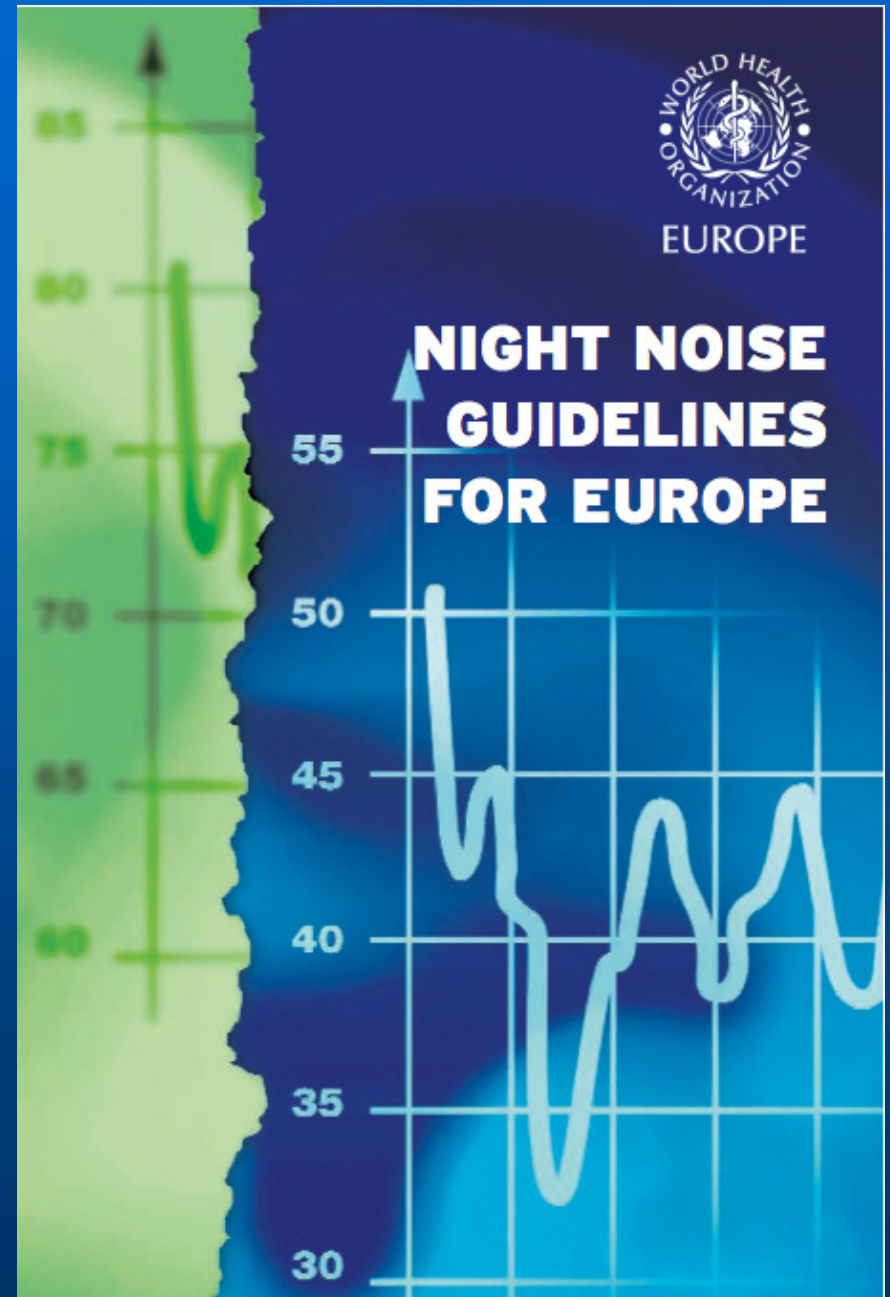
Ministry of the Environment
Institute of Environmental Epidemiology

Electronic version, 1999 at
www.who.int/docstore/peh/noise/guidelines2.html

WHO

Night Noise Guidelines for Europe (NNG)

Copenhagen, 2009



WHO's Definition of Health

World Health Organization (Constitution 1946):

- "A state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity."**
- "The first goal is to protect sensitive persons and the second goal is to protect the general population."**

WHO Guidelines Values for Community Noise

Organized according to:

- Critical health effect ("lowest level")
- Specific environment
- Vulnerable group
- Most exposed receiver
- Time base (day, night, or activity period)
- **New: END Lden, Lnight, not LAmax, 2 SEL**

Vulnerable Groups

- Children and young adults
- Persons with hearing impairment
- The elderly
- Shift- and nighttime workers
- Persons who are ill, and persons under rehabilitation
- Add: Pregnant women (NNG)
- Add: Noise sensitives/Mental health?

WHO (2000) Guideline Principles vs. END – Directive

□ □ 2002/49/EC

Health effects* are related to ...

- The total exposure of noise ("immission")
- vs. one type of transport ("emission-based")

Critical health effect* for different ...

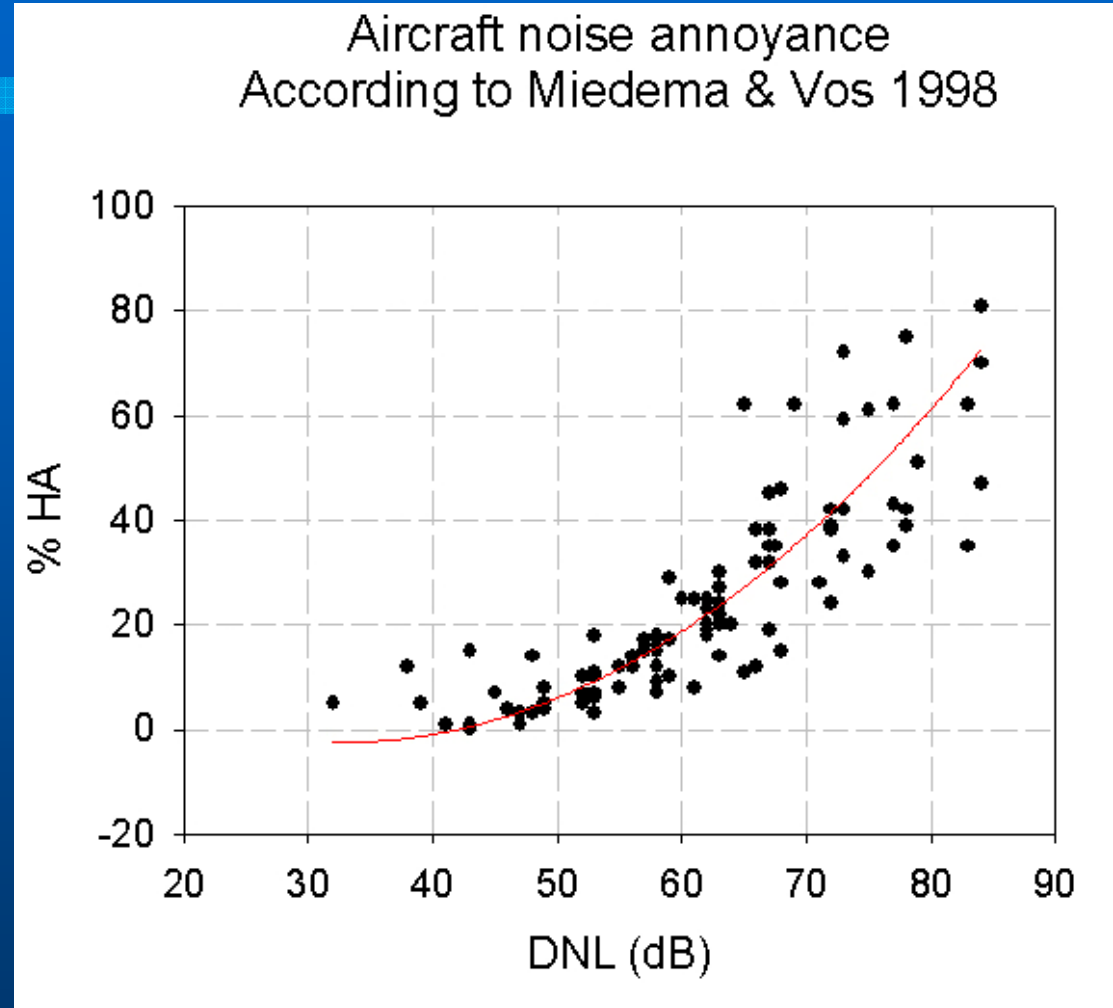
- Vulnerable groups (e g children)
- Sensitive time periods (e g evening, night, activities)
- Sensitive environments (e g bedroom, school, outside)

vs. END Lden, Lnight, not LAmax (or 2 SEL)

*** WHO guideline values refer to lowest-effect value**

Aircraft Noise Annoyance

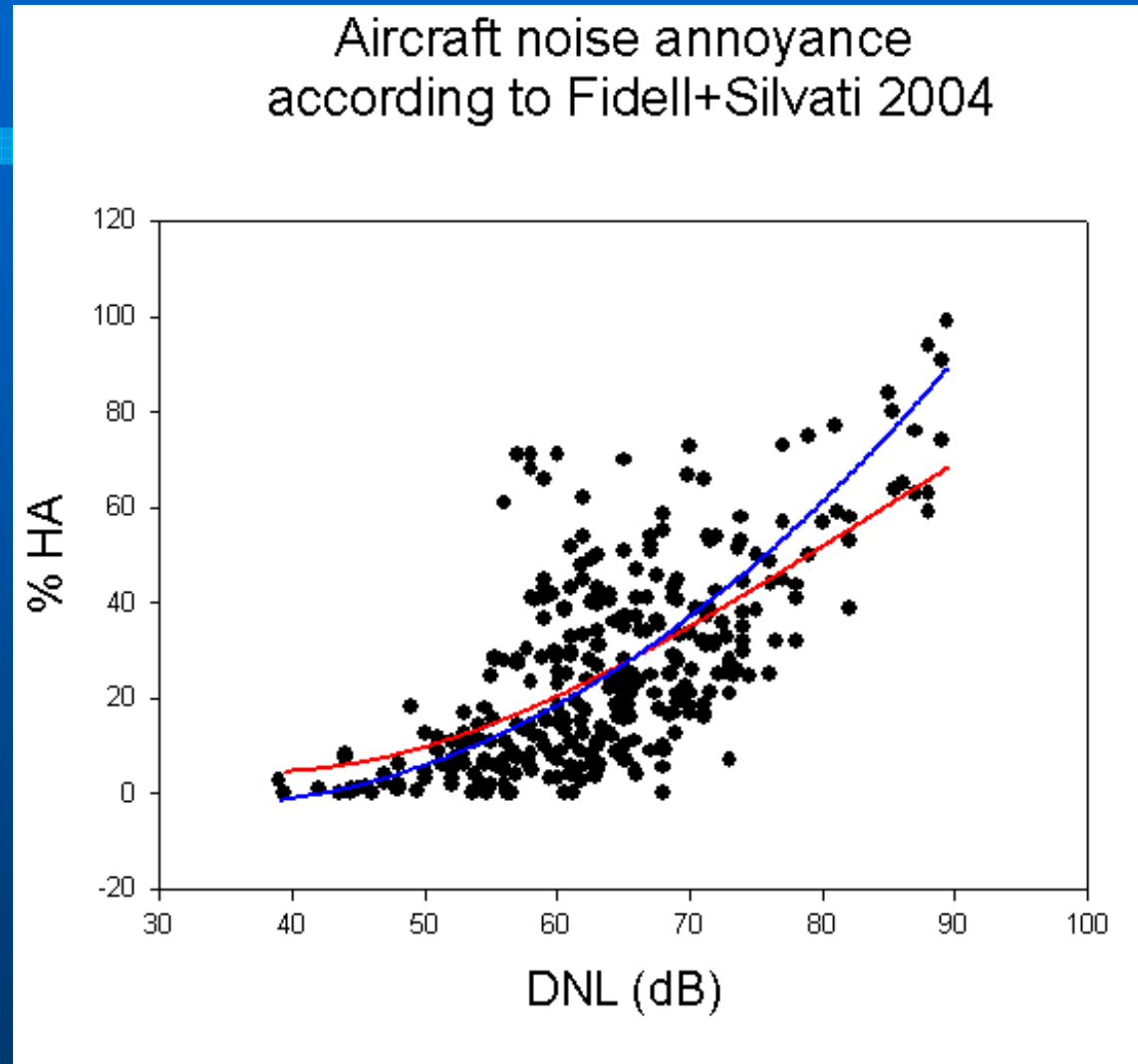
Miedema & Vos' (1998)
Synthesis Curve (red):
% Highly Annoyed (%HA)
persons as a function of
dB Ldn



Highly Annoyed was defined as 70-75% of the length of the participants response scale.

Aircraft Noise Annoyance

Fidell & Silvati's (2004)
Synthesis Curve (red):
% Highly Annoyed (%HA)
persons as a function of
dB Ldn
cf. Miedema & Vos's (1998)
Synthesis Curve (blue)



Highly Annoyed was defined as 60-80% of the length of the participants response scale.

Aircraft Noise Annoyance

Exposure-effect relationship:

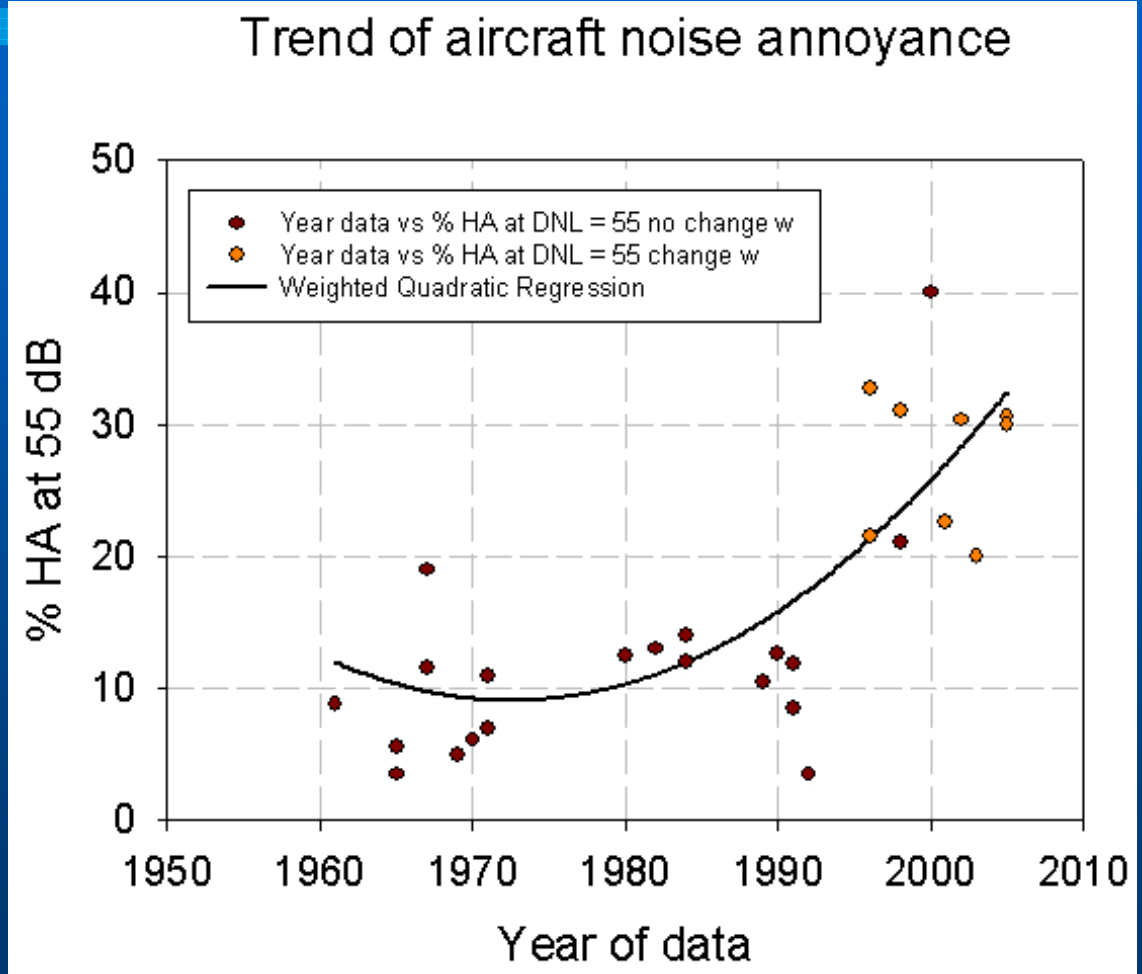
- New studies re Miedema & Vos's curves
- Meta-analyses: Larger variance among curves
- More annoyed for "equal exposure", but number of flights has increased (5%/year, 2000-2005)

Potential explanations:

- Ecological fallacy (not longitudinal data)
- ICAO "balanced approach" to minimize population affected (fly over recreational areas)

Aircraft Noise Annoyance Growth 1961-2005?

Quadratic regression curve, weighted according to sample size: Orange points show data from high-rate change studies.



Highly Annoyed was defined as 70-75% of the length of the participants response scale.

Sleep

S L E E P

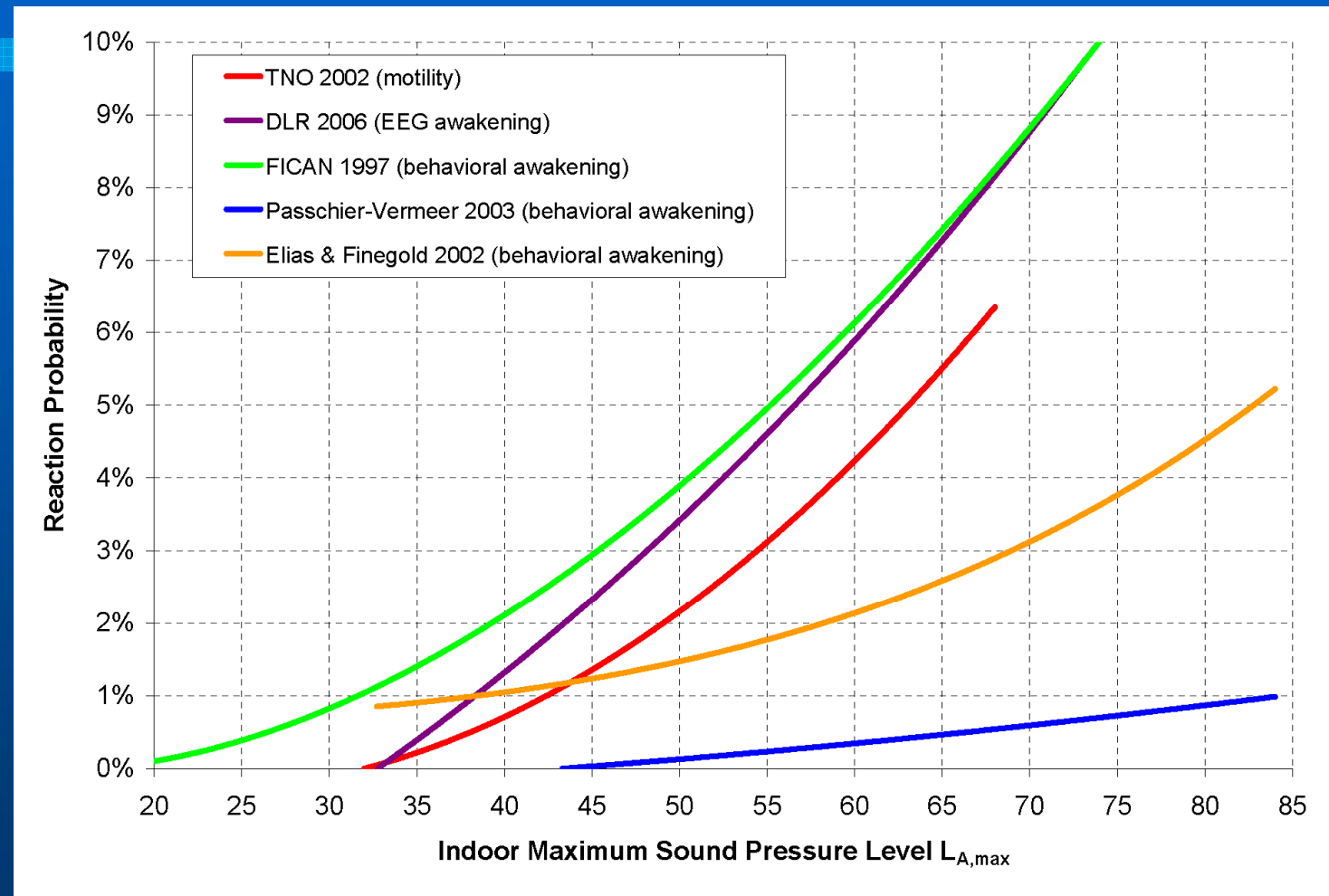
J. ALLAN HOBSON



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Aircraft Sleep Disturbance



SEL converted to $L_{A,max}$ for:
 FICAN, 1997
 Elias & Finegold, 2002
 Passchier-Vermeer, 2003

Conversion: $L_{A,max} = (SEL_{inside} - 16.4) / 0.877$

Aircraft Sleep Disturbance

Exposure-effect relationship

- Aircraft-noise induced EEG-awakenings show accelerated growth with $L_{night,inside}$
- $L_{night,outside}^*$ expected at 30-40 dBA (**NNG**) to protect the public, children, the chronically ill and the elderly.

Potential explanations

- Repeated activation results in “sleep fragmentation” which decreases restoration
- Shoulder periods not included in 8h

*END: $L_{night,outside}$ is the 1-year $L_{Aeq,8h}$ at the most exposed facade (height 4 m).

Aircraft Noise & Cognition

Exposure-effect relationship – Children:

- 3 epidemiological studies (Munich, RANCH, Tyrol)
- Aircraft noise worse than road noise (R & T, Hygge)
- Linear relationship for aircraft noise and impaired reading comprehension & recognition memory (RANCH)
- Dividing line 60 dB (LAeq, Munich; LAeq,16h RANCH)
- Road and rail noise effects occur at 60 dBA Ldn (Tyrol)

Disturbed Speech Communication

Important effects:

- Interference with communication
- Disturbed communication & language acquisition
- Distraction from social signals/ auditory incomprehension
- Consequential effects (impaired performance & productivity, risk of accidents, stress due to misunderstandings, tiredness, decreased helpfulness)

Aircraft Noise & Cardiovascular Effects

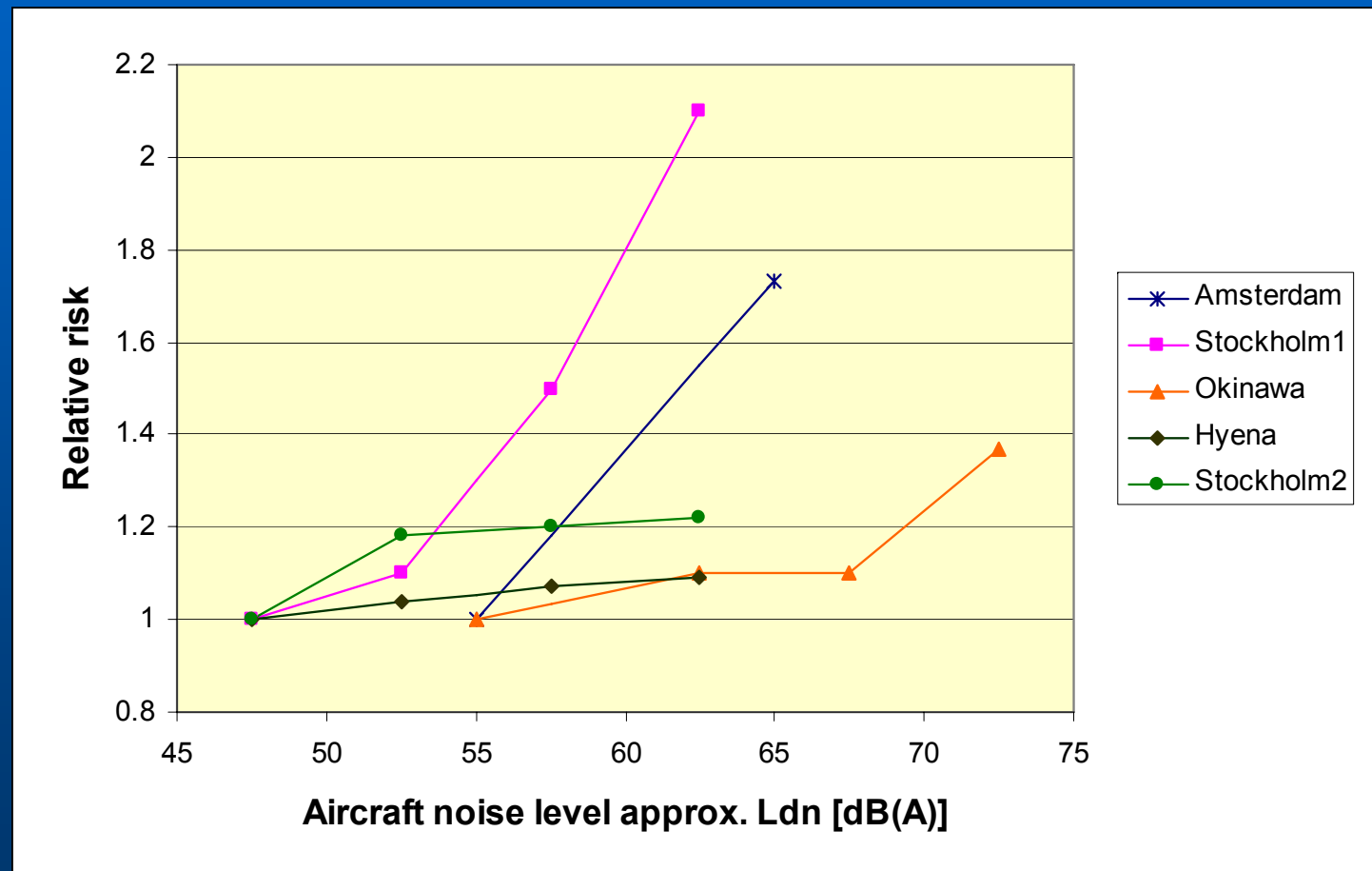
Exposure-effect relationship

- 5 studies on high blood pressure; large differences in methods of measurement
- Aircraft noise Ldn increases risk of hypertension
- Relative risk 1.13 per 10 dBA for aircraft sound levels between 47-67 dBA (Babisch, regression approach)

Potential explanations

- Blood pressure measurement differs between studies; also measurements of aircraft noise

Aircraft Noise and Hypertention



Prevalence or Incidence of Hypertention

Conclusions I

Evidence for Health Problems

- Exposure-response associations have been found between aircraft noise and annoyance, sleep disturbance and cognitive impairment in children
- Sufficient evidence of a positive association between aircraft noise and high blood pressure and cardiovascular medication
- Limited evidence for associations with mental health and hormonal responses to aircraft noise

Conclusions II

Needs for Further Research

- Annoyance – more contemporary studies on change and steady state situations
- Cardiovascular disease – studies with continuous or semi-continuous noise data and CVD risk
- Stress hormone response – more detailed, longer duration community studies
- Psychological disorders – longitudinal studies with structured psychiatric interview outcomes

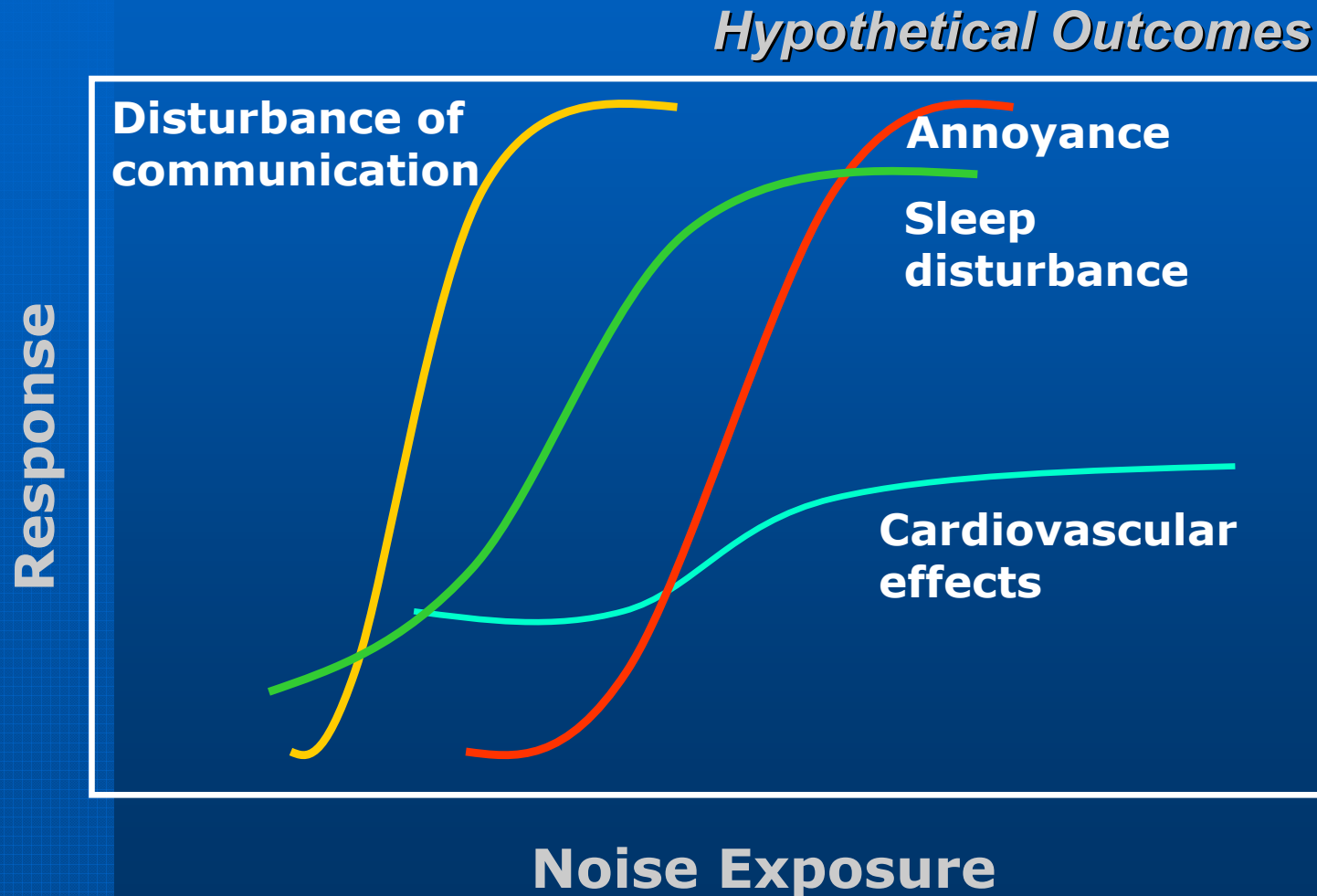
Implications: Noise Management I

- Fundamental principles of precaution, polluter pays and prevention
- Integrated noise policy: limit noise at source, noise control in sound transmission path, protection at the receivers site, land use planning, education and raising public awareness
- Sufficient distance between residential areas and airport reduces noise exposure
- Insulation of houses can help reduce exposure

Implications: Noise Management II

- New building plans should include overflight paths and require sound insulation of facades
- Control options must include technical, financial, social, health and environmental factors, speed of implementation and enforceability
- Environmental noise impact assessment is a major tool available for managing the risks associated with exposure to aircraft noise by foreseeing and preventing environmental noise problems

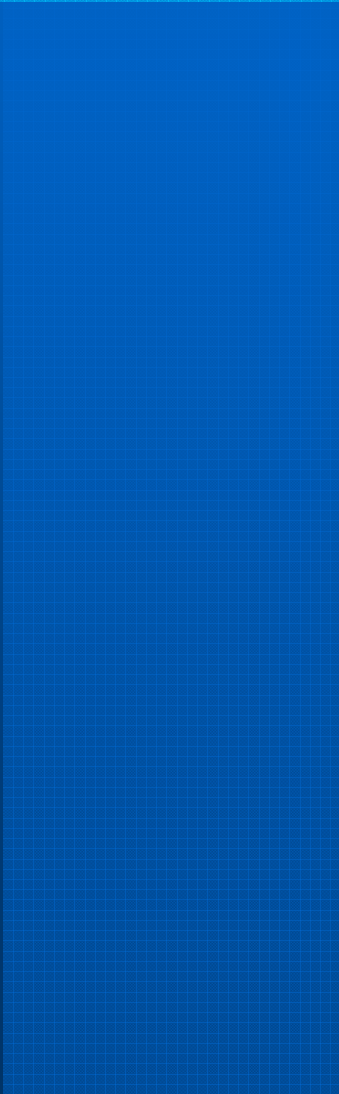
Future: Combined Noise, but also Combined Effects

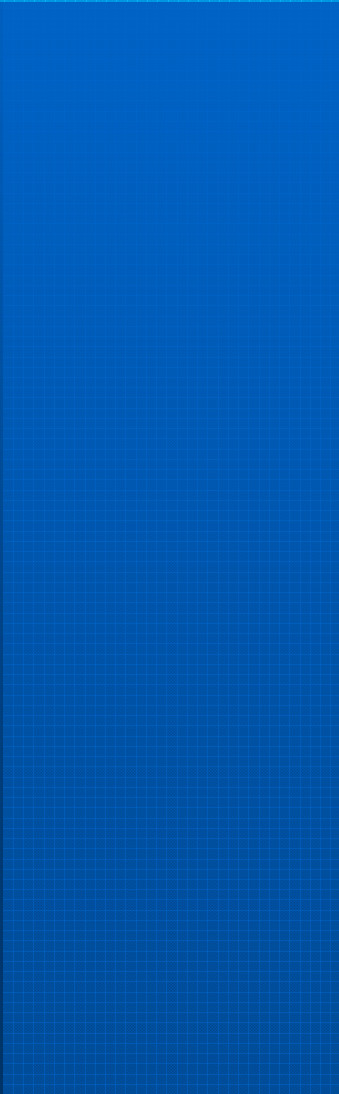


Target 24 of Health for All Strategy

“By the year 2000 cities, towns and rural communities through the region should offer physical and social environments supportive to the health of their inhabitants”

(WHO European Member States, 1991)





WHO Guideline Values (2000)

| Specific environment | | Critical health effects | LAeq dB | Time base, hrs | LAmix dB fast |
|---------------------------------|----------------|--|---------|----------------|---------------|
| Outdoor | living areas | Serious annoyance | 55 | 16 | - |
| | | Moderate annoyance (daytime and evening) | 50 | | |
| Schools & Preschools | Indoors | Speech intelligibility | 35 | During class | - |
| | | | | | |
| Dwellings bedrooms | indoors | Sleep disturbance night-time | 30 | 8 | 45 |

WHO's Guideline Values (2000)

| Specific environment | Critical health effects | LAeq dB | Time base, hrs | LAmix dB fast |
|---|-----------------------------|-----------------------|----------------|---------------|
| Industrial, commercial shopping and traffic areas, indoors & outdoors | Hearing impairment | 70 | 24 | 110 |
| Music through head-/earphones, impuls ljud från leksaker, fyrverkerier och skjutvapen | Hearing impairment children | - | - | 120# |
| Outdoor in parkland & conservation areas | Disruption of tranquility | Quiet areas preserved | - | - |

Peak sound pressure (not LAmix, fast) measured 100 mm from the ear.

Table 1: Night Noise Guideline $L_{\text{night, outside}}$ ranges and the associated expected effects.

| $L_{\text{night, outside}}$ | Expected Effects |
|-----------------------------|---|
| up to 30 dB | Although individual sensitivities and circumstances differ, it appears that up to this level no substantial biological effects are observed. |
| 30 to 40 dB | A number of effects are observed to increase: body movements, awakening, self-reported sleep disturbance, arousals. With the intensity of the effect depending on the nature of the source and on the number of events, even in the worst cases the effects seem modest. It cannot be ruled out that vulnerable groups (for example children, the chronically ill and the elderly) are affected to some degree. |
| 40 to 55 dB | There is a sharp increase in adverse health effects, and many of the exposed population are now affected and have to adapt their lives to cope with the noise. Vulnerable groups are now severely affected. |
| above 55 dB | The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a high percentage of the population is highly annoyed and there is limited evidence that the cardiovascular system is coming under stress. |

Cardiovascular effects of aircraft noise:

Hypertension

| | Noise level Ldn | CHD | Hypertension |
|-----------------------------------|--------------------|---------|---|
| Older Studies | > 62dBA | 1.1-1.4 | 1.7(95% CI, 1.4-2.2) |
| New Studies | | | 1.8 (for 10 dBA difference in noise level) |
| HYENA | L _{night} | | 1.1 (95% CI 1.0-1.3 for 10 dBA difference in noise level) |
| | L _{den} | | 1.1 (95% CI 0.9-1.3 for 10 dBA difference in noise level) |
| Rosenlund et al 2001 | | | 1.3 (95% CI 0.8-2.2 for 5 dBA) |
| Eriksson et al 2007 (prospective) | | | 1.2 (95% CI 1.0-1.2) |

VISION



**A Society with Supportive
Sound Environments**



Sustainable Development

Effects of noise:

- Direct and cumulative adverse effects of noise on health
- Adverse effects of noise on future generations
- Sociocultural, esthetical and economic effects

Annex 1, Evidence for Links between Transport, Environment & Health

- Children in vicinity of airports show impaired acquisition of reading skills, attention and problem-solving ability
- Noise can interfere with mental activities/ adaptation strategies and efforts to maintain performance are associated with stress
- Emerging evidence of association with hypertension and ischaemic heart disease

Annex 1, Evidence for Links between Transport, Environment & Health

- **Noise Increases:** 1980 to 1990 an increase from 15 % to 26 % of pollution in European Region above 65 dB LAeq,24h
- 65 % of European population exposed to levels leading to serious annoyance, speech interference and sleep disturbance (55-65 dB LAeq,24h).