Noise annoyance from road traffic

Psycho-Acoustics: Improved understanding of people's subjective reactions to road noise

CEDR Conference "Noise and Nuisance" June 2022, Liège, Belgium.

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LÄRMKONTOR GmbH

SINTEF

FORCE TECHNOLOGY

Outline

- Presentation of project and partners, HB
- Fundamentals of Noise annoyance, THP
- Moderator search, prioritisation criteria and qualification, THP

Presentation of project and partners

The FAMOS Consortium partners

Staff:

FORCE Technology in Denmark (Project leader)
Division Sense Lab and Acoustics:

- Perception of noise
- Laboratory testing and sound walks
- Noise annoyance studies and modelling
- Road traffic noise measurements, predictions and abatement

Søren Vase Legarth
Torben Holm Pedersen
Hans Bendtsen
Christer Volk

LÄRMKONTOR in Germany:

- Noise analysis and abatement
- Noise mapping
- Noise in road projects
- Public participation
- Noise measurements
- Building and room acoustics

Christian Popp
Sebastian Eggers

SINTEF in Norway:

- Noise annoyance surveys and analysis
- Huge international and historical experience
- Many aspects of road traffic noise abatement

Truls Gjestland

The FAMOS data

Budget:

300,000 €

Project period:

December 2019 to March 2022 during the Corona times

Homepage:

https://famos-study.eu/

Deliverables etc at:

https://www.cedr.eu/peb-research-programme-2018-noise-and-nuisance

FAMOS a CEDR project

Performed for:

- CEDR Conference of European Directors of Roads
- Transnational Road Research Programme Call 2018: Noise and Nuisance

Funded by the CEDR members of:

- Belgium – Wallonia
- Denmark
- Ireland
- Netherlands
- Norway
- Sweden
- United Kingdom

CEDR
Conférence Européenne des Directeurs des Routes
Conference of European Directors of Roads

The FAMOS challenge!

- National Road administrations:
  - Built new roads
  - Enlarge existing roads
  - Maintain and improve existing roads
- Noise abatement is often a challenge
- Technically feasible and economically possible measures are used to reduce the noise
- There might still be a need for a further reduction of annoyance to achieve acceptable conditions for people living along roads

The FAMOS method:

- To analyse and test if non-acoustic moderators for noise annoyance can be a promising tool to reduce the annoyance without further reducing the noise level

The FAMOS organisation

FAMOS
a CEDR project

WP0 Project management (FORCE Technology)

Today!

WP1 Moderator search and qualification (SINTEF)
International literature search
Contact to key researchers
List of moderators

WP2 Analysing data and hypotheses testing
(FORCE Technology)
Analyse effect of moderators
AudioVisual listening tests
Mini surveys
Sound walks

WP3 Modelling
(FORCE Technology)
Modelling of moderators based on data
Dose-response curves for moderators

Mainly yesterday!

WP4 Guidelines and report
(Lärmkontor)
Guidebook for National Road Administrations
Project report
Dissemination

LÄRMKONTOR GmbH
SINTEF
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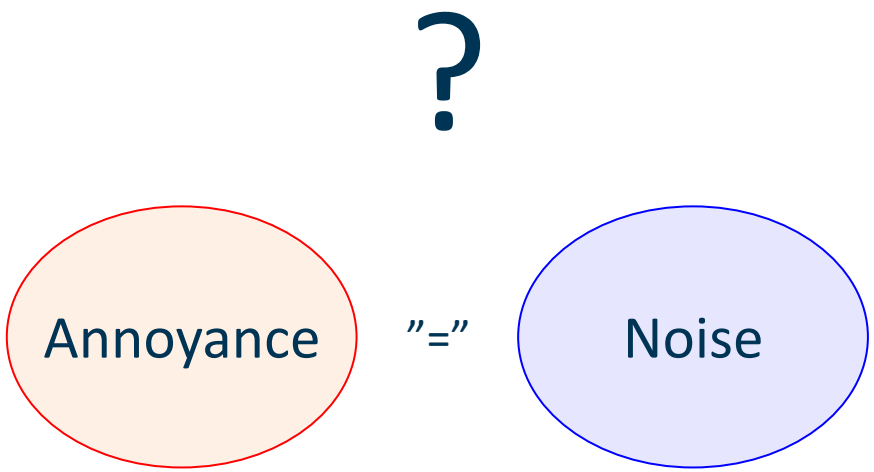
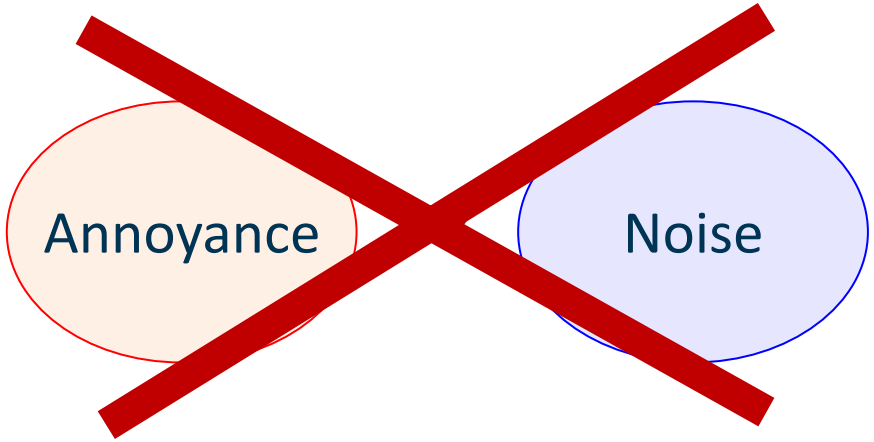
Fundamentals of Noise annoyance

Noise annoyance and noise level




Peder Skr

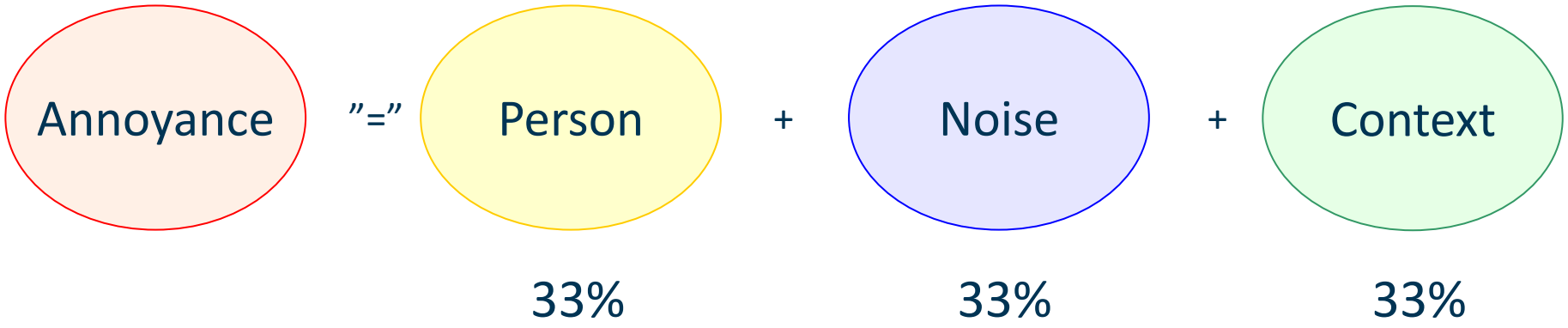
Noise annoyance and noise level



Noise annoyance

An emotional and attitudinal reaction

from a person exposed to noise in a given context.[1]



Noise annoyance: A feeling of displeasure, nuisance, disturbance or irritation caused by a specific sound [2]

1: Torben Holm Pedersen: The "Genlyd" Noise Annoyance Model

2: Ouis D (2001). Annoyance from road traffic noise: a review. J Environ Psychol.

Noise annoyance

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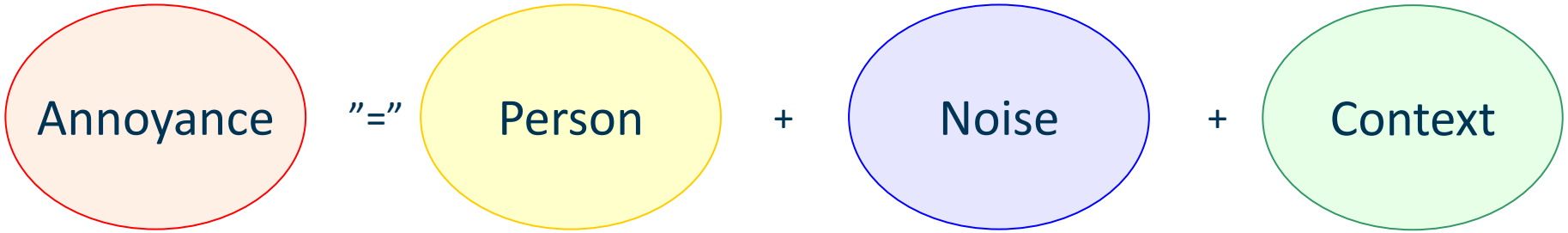

Person	Noise	Context
Noise sensitivity	Noise level	Access to silent side
Safety, fear for accidents	Level variations	Neighbourhood noise
Dependency of sound source	Spectrum	Visibility of the road
Age, gender, education, …	Other characteristics	Orientation of outdoor areas
Household size, children	Day, even. night distrib.	Vegetation and greenery
Length in residence	Traffic composition	Air pollution & vibrations

Noise annoyance

An emotional and attitudinal reaction

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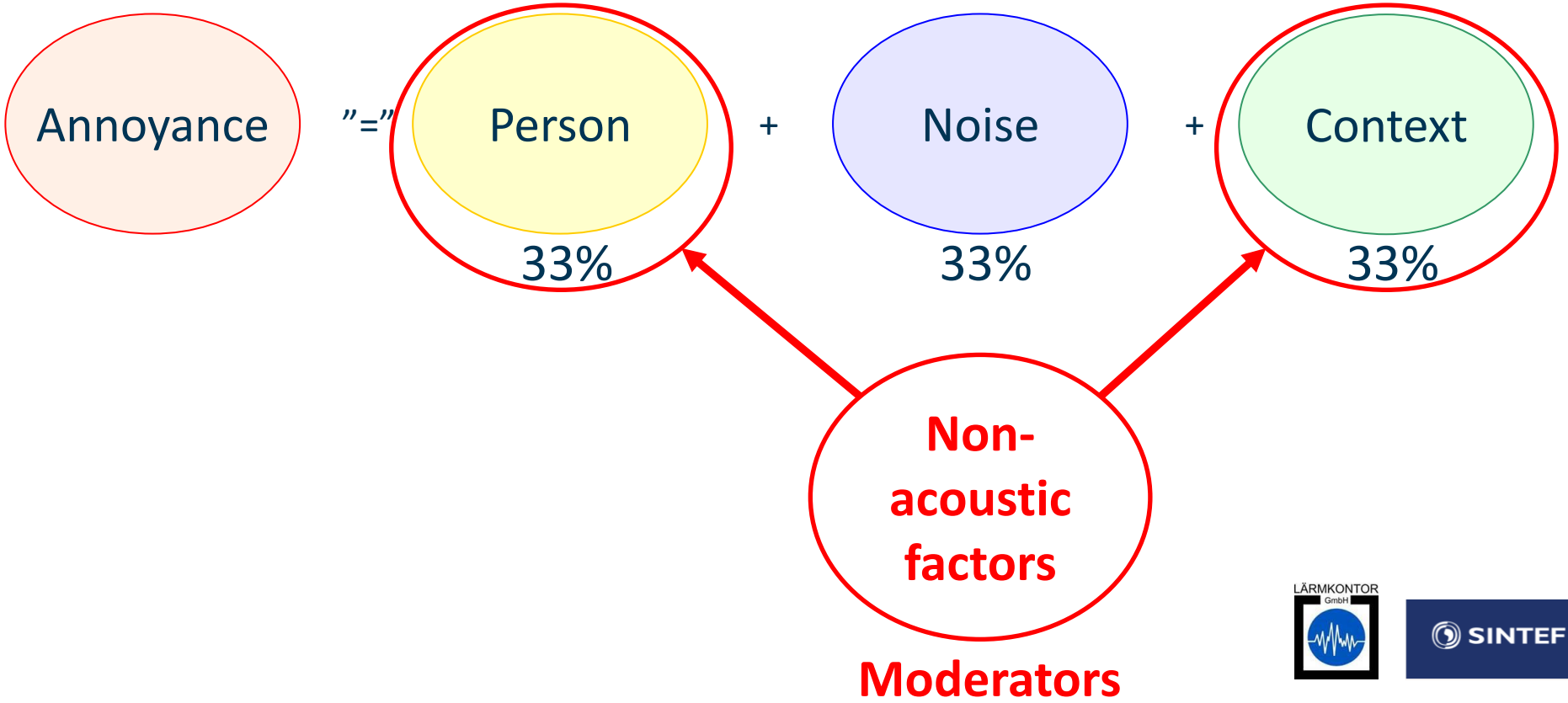
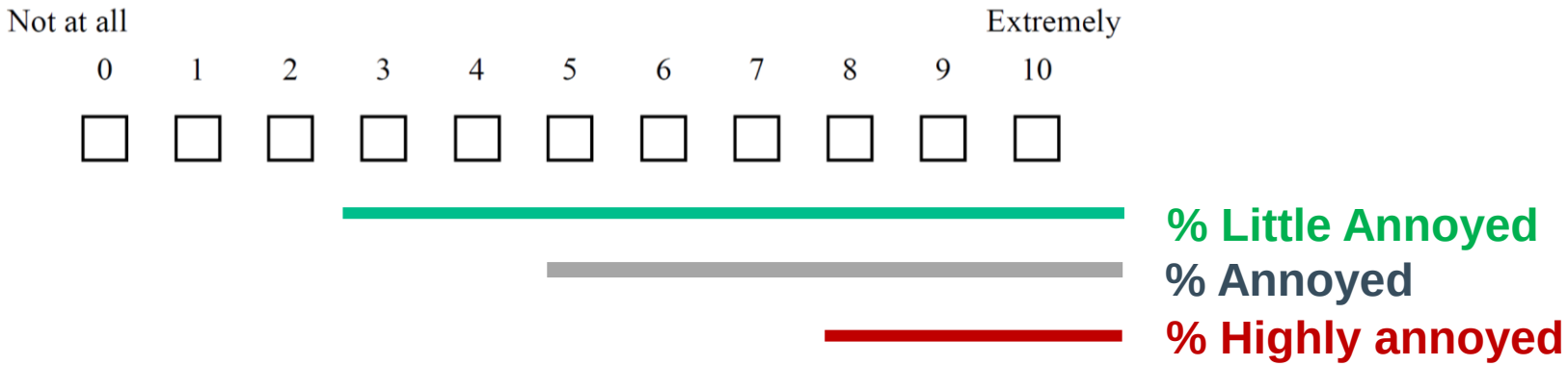


Socio-acoustic survey according to ISO 15 666

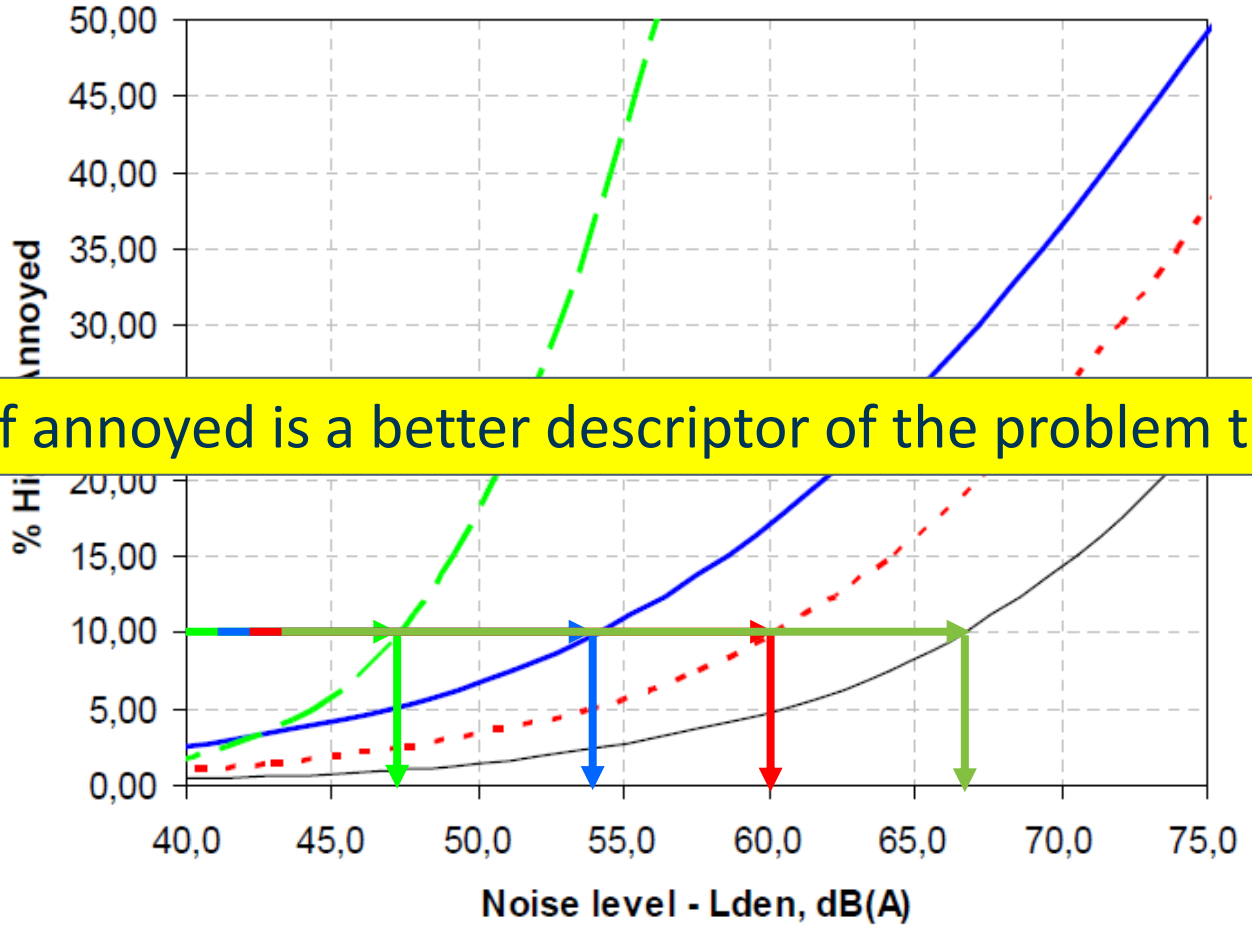
Questions – Answers – Noise Levels

Thinking about the last year or so, when you are here at home, how much does noise from road traffic bother, disturb, or annoy you?

Not at all - Slightly – Moderately - Very – Extremely



Noise annoyance from different sources



The percentage of annoyed is a better descriptor of the problem than the noise levels

Why is Annoyance important?

"Noise annoyance is a primary indication that noise is a problem, and by itself noise annoyance means that the quality of life is adversely affected."

HME Miedema: Noise & Health: How Does Noise Affect Us? Internoise keynote 2001

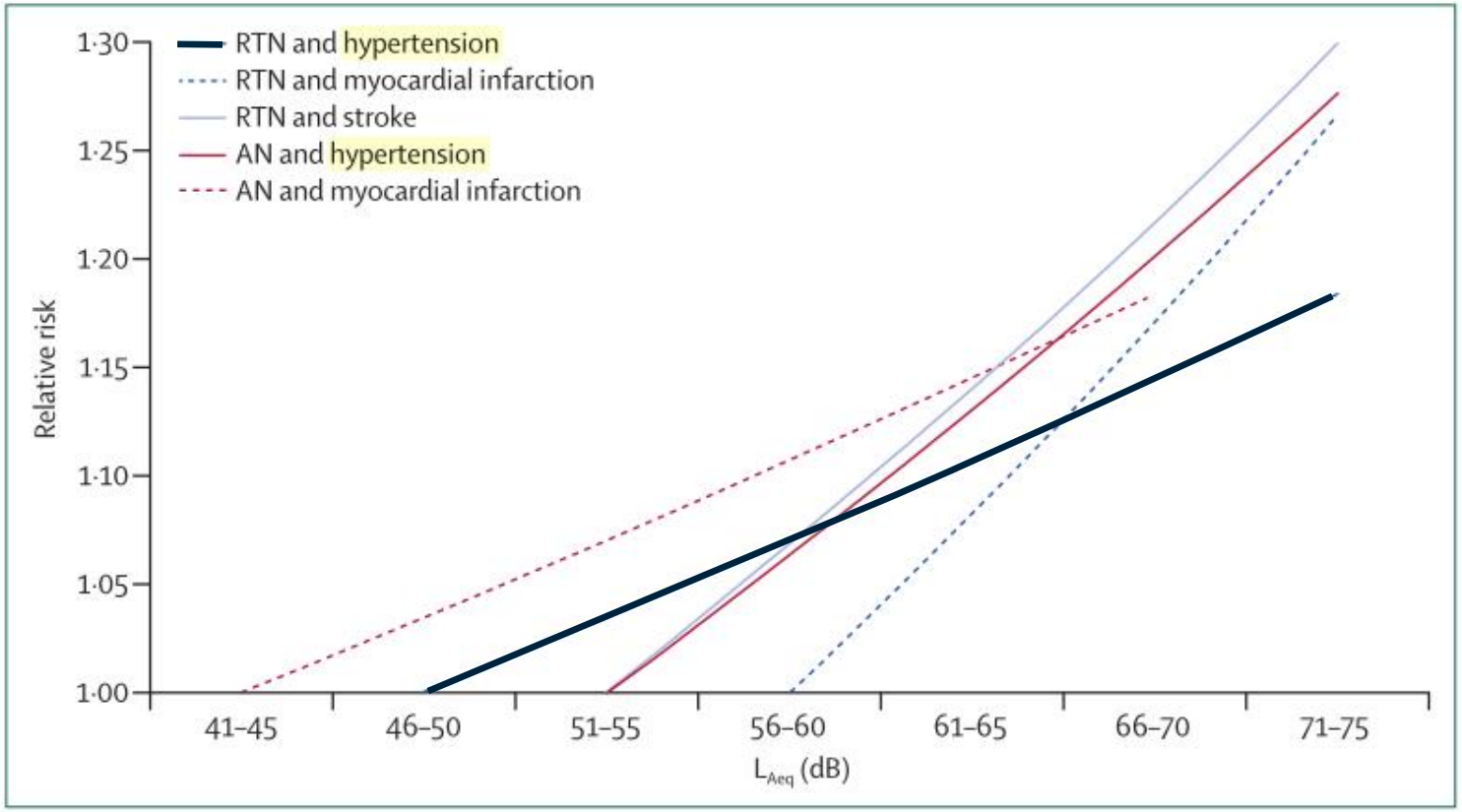
WHO Noise guidelines 2018

- Annoyance is a Critical health outcome
- Annoyance may be in the causal pathway to cardiovascular disease.

Health effects

EU, Good practise guide….

Cardiovascular diseases

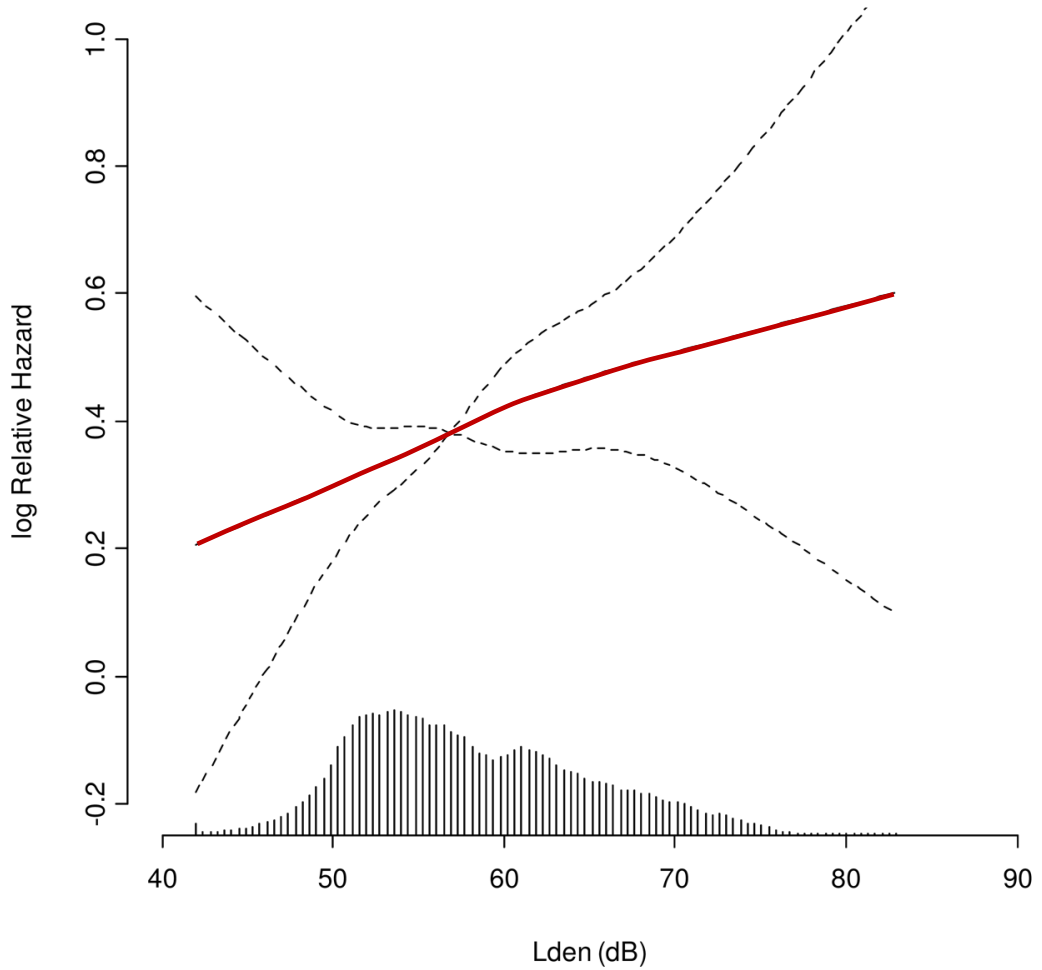


Exposure–response curves of road and aircraft noise and cardiovascular endpoints RTN and hypertension (24 studies, noise indicator LAeq16h); RTN and myocardial infarction (five studies, noise indicator LAeq16h); RTN and stroke (one study, noise indicator LDEN); AN and hypertension (five studies, noise indicator LDN); and AN and MI (one study, noise indicator LDN). RTN=road traffic noise. AN=aircraft noise.

Kilde: Mathias Basner, Wolfgang Babisch, Adrian Davis, Mark Brink, Charlotte Clark, Sabine Janssen, Stephen Stansfeld: Auditory and non-auditory effects of noise on health. Lancet 2014; 383: 1325–32

Incident Myocardial Infarction (Heart attack)

DK, n = 57.053

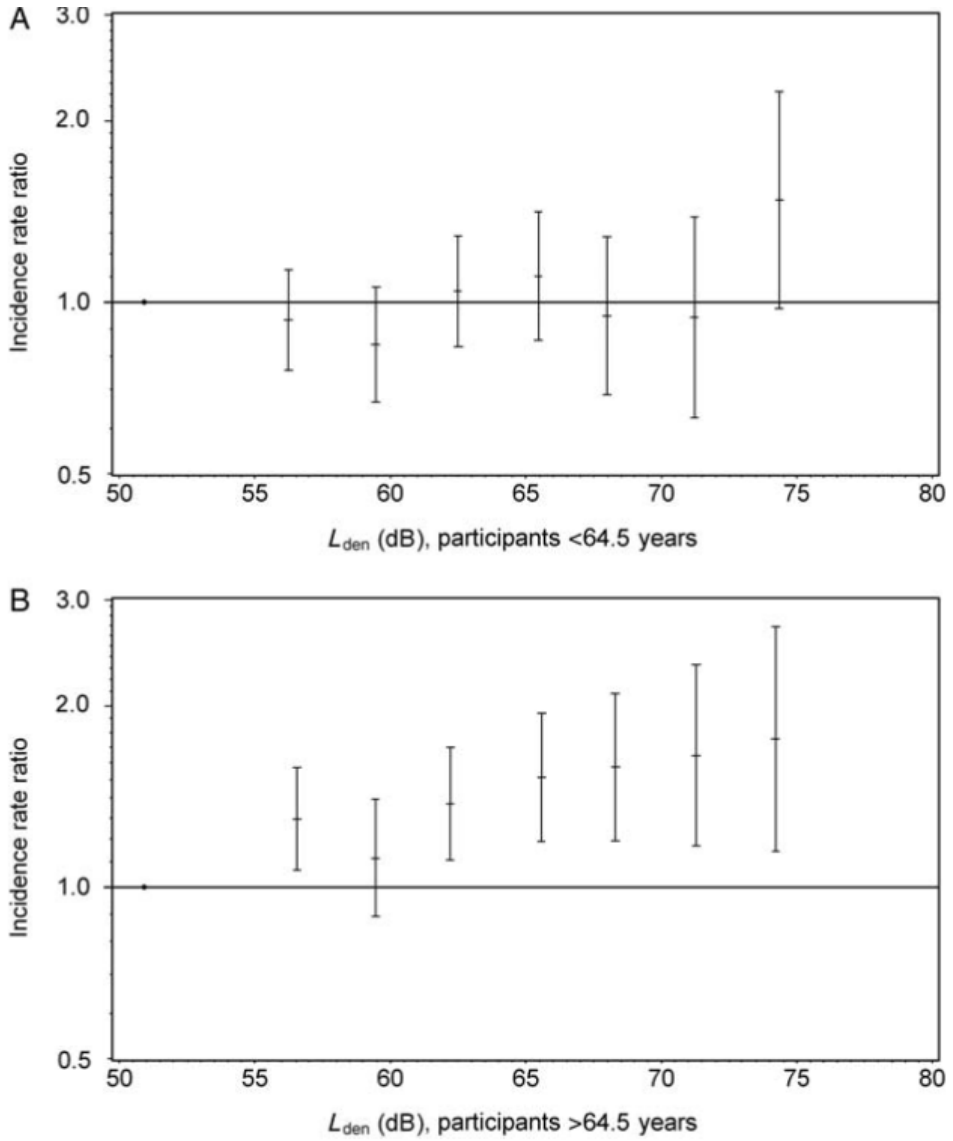


Association between exposure to road traffic noise (L_{den}) at the residence at the time of diagnosis and incident MI, adjusted for sex, smoking status, smoking duration, smoking intensity, intake of fruit, vegetables and alcohol, BMI, physical activity, calendar year, education, railway and airport noise, and air pollution. Solid line: incidence rate ratio, dashed lines: 95% confidence interval. The median (56.4 dB) is the reference. The columns at the x-axis show the distribution of exposure to road traffic noise.

Kilde: Sørensen M, Andersen ZJ, Nordsborg RB, Jensen SS, Lillelund KG, et al. (2012) Road Traffic Noise and Incident Myocardial Infarction: A Prospective Cohort Study. https://doi.org/10.1371/journal.pone.0039283

Stroke

(Blood clots in the brain)



Dose–response relation between exposure to road traffic noise (Lden) and incidence rate ratio (IRR) for stroke based on a Cox proportional hazards model with age as the underlying timescale among participants below (A) and above (B) 64.5 years of age. The analyses were stratified by gender and calendar-year and adjusted for smoking status and intensity, intake of fruits, intake of vegetables, intake of coffee, body mass index, alcohol intake, physical activity, education, municipality income, exposure to noise from railways and airports, and exposure to air pollution (NOx). The vertical whiskers show the IRRs with 95% confidence

Kilde: M.Sørensen, M. Hvidberg, Z. J. Andersen, R. B. Nordsborg, K. G. Lillelund, J. Jakobsen, A. Tjønneland, K. Overvad, and O. Raaschou-Nielsen: Road traffic noise and stroke: a prospective cohort study. European Heart Journal (2011) 32, 737–744

Diabetes

(Incident diabetes, DK, n = 57.053)

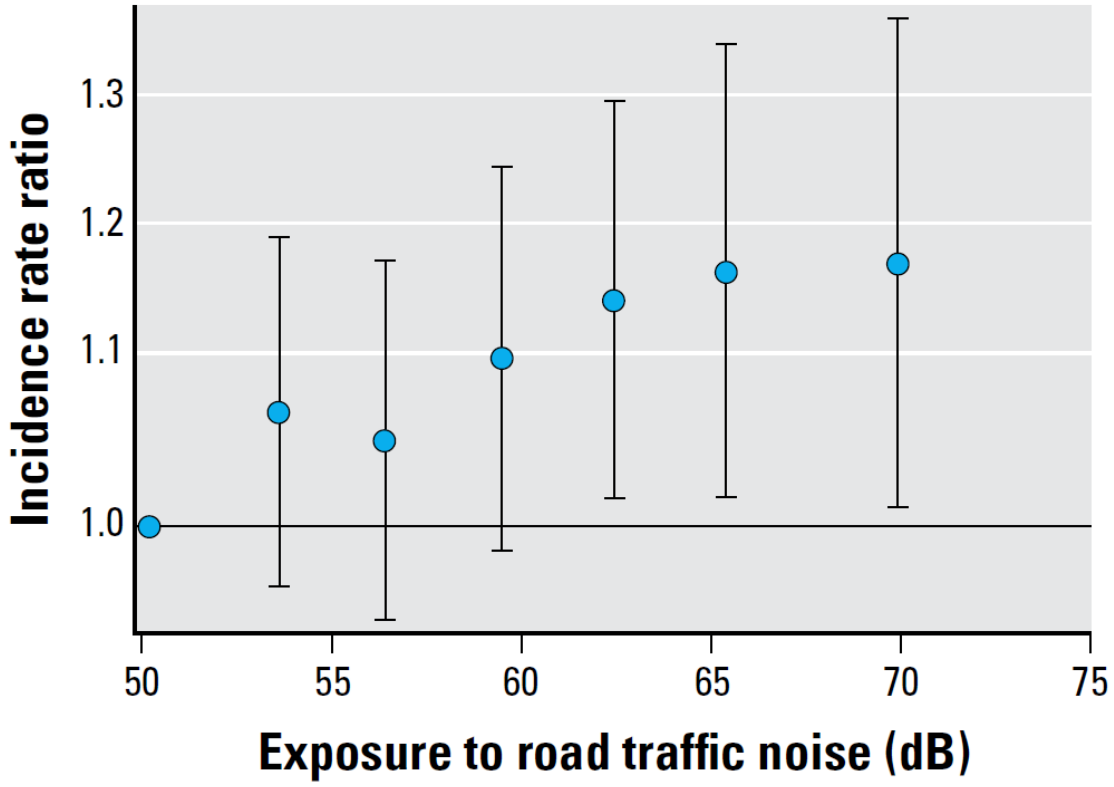
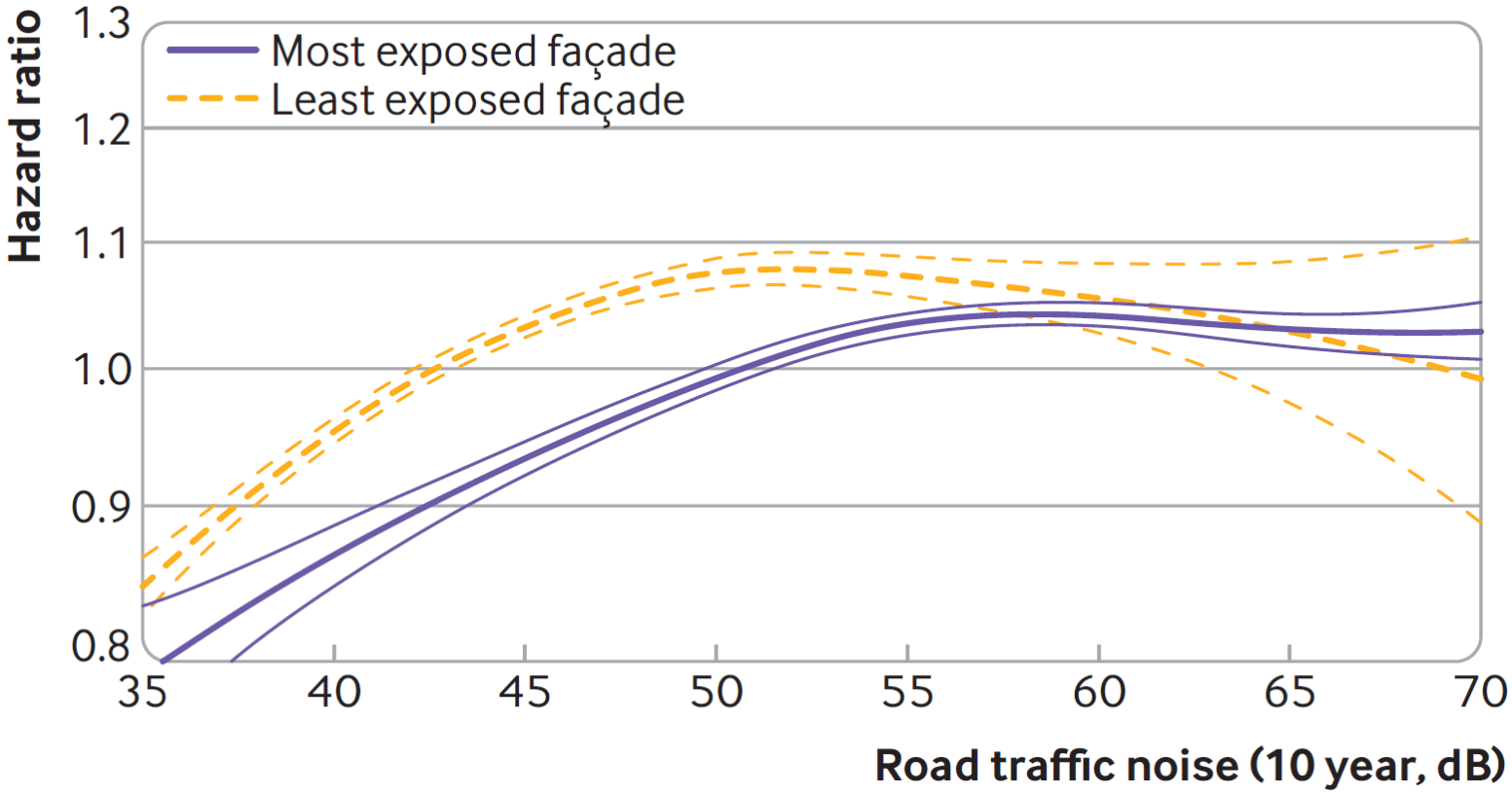


Figure 1. Association between exposure to road traffic noise (Lden) at the residence at the time of diagnosis and all incident diabetes adjusted for age; sex; BMI; waist circumference; smoking status, duration, and intensity; environmental tobacco smoke; intake of fruits, vegetables, saturated fat, and alcohol; sport; bicycling and walking; school attendance; occupational status; municipality socioeconomic status; railway and airport noise; air pollution; and calendar year. The vertical whiskers show incidence rate ratios (IRR) with 95% CIs at the median of six exposure categories (52–55, 55–58, 58–61, 61–64, 64–67, > 67 dB) when compared with the reference category of ≤ 52 dB.

Kilde: Mette Sørensen,1 Zorana J. Andersen,1,2 Rikke B. Nordsborg,1 Thomas Becker,3 Anne Tjønneland,1 Kim Overvad,4,5* and Ole Raaschou-Nielsen1* :Long-Term Exposure to Road Traffic Noise and Incident Diabetes: A Cohort Study. Environmental Health Perspectives vol. 212, 2013

Dementia

DK, n = 103 500)



Associations between 10 year mean exposure to road traffic, L_{den}, at the and least exposed façades of buildings and risk of all cause dementia, using the fully adjusted model. Hazard ratios and corresponding 95% confidence intervals

Source: Manuella Lech Cantuaria, Frans Boch Waldorff,Lene Wermuth, Ellen Raben Pedersen, Aslak Harbo Poulsen, Jesse Daniel Thacher, Ole Raaschou-Nielsen, Matthias Ketzel, Jibran Khan, Victor H Valencia, Jesper Hvass Schmidt, Mette Sørensen: **Residential exposure to transportation noise in Denmark and incidence of dementia: national cohort study.**

Breast cancer

DK, n= 22.453

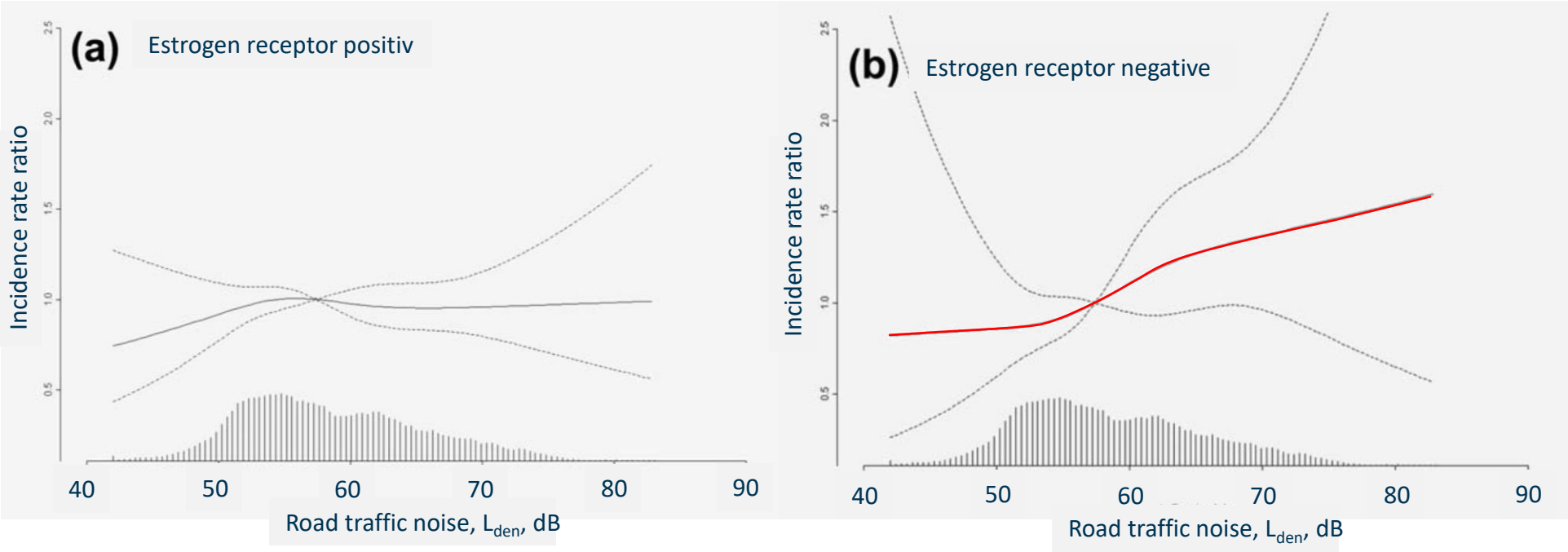


Figure 1. Association between residential exposure to road traffic noise (L_{den}, 1-year mean) and (*a*) estrogen receptor positive breast cancer and (*b*) estrogen receptor negative breast cancer. Analyses were adjusted for age, parity, age at first birth, hormone replacement therapy status and duration, age at menarche, length of school attendance, BMI, alcohol consumption, alcohol intake, smoking status, intake of vegetables, physical activity (MET score), calendar-year and railway and airport noise. Solid line: incidence rate ratio, dashed lines: 95% confidence interval. The median (57.4 dB) is the reference. The columns at the x-axis show the distribution of exposure to road traffic noise.

Kilde: Sørensen, M., Ketzel, M., Overvad, K., Tjønneland, A., Raaschou-Nielsen, O.: Exposure to road traffic and railway noise and postmenopausal breast cancer: A cohort study. International Journal of Cancer 2014

Atrial fibrillation

DK, n = 57.053

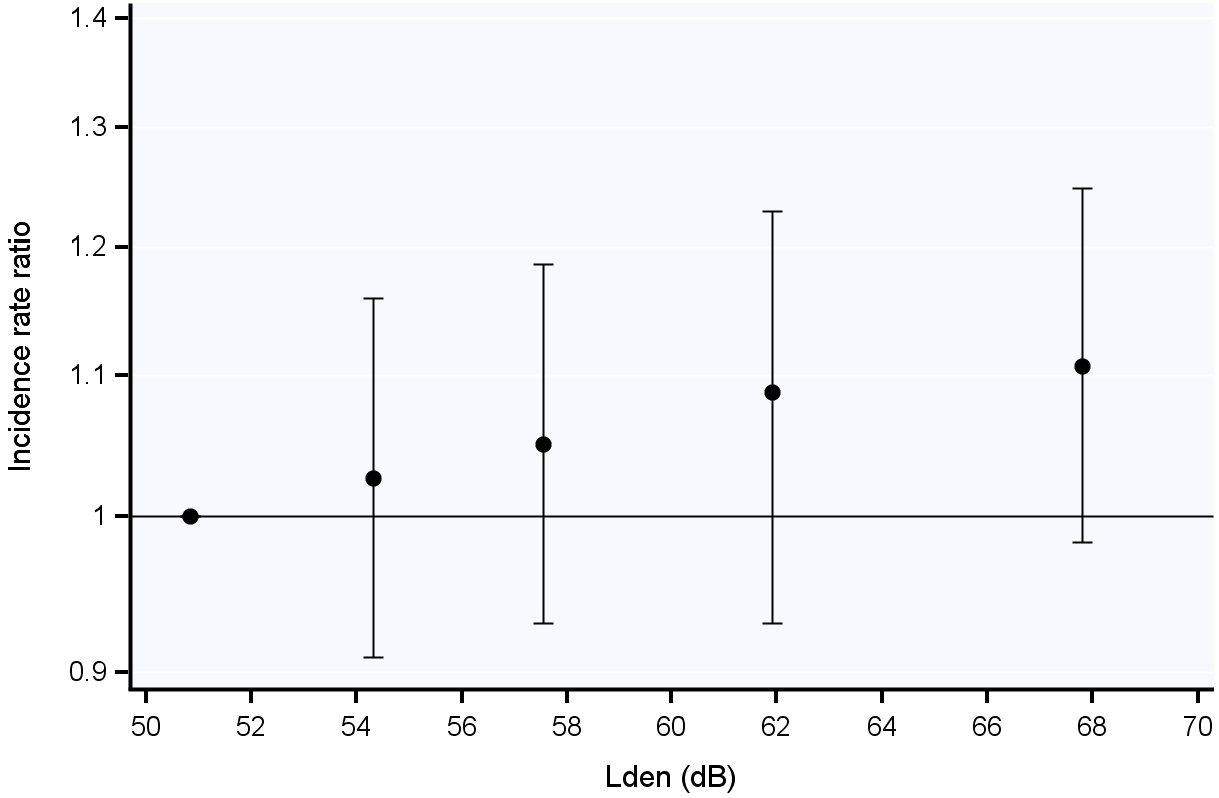


Figure 1 Association between exposure to road traffic noise at the residence 5-years preceding diagnosis and risk for atrial fibrillation in the fully adjusted model. The vertical whiskers show incidence rate ratios with 95 % confidence interval at the median of exposure categories (Q2: 52.7-55.9, Q3: 55.9-59.7, Q4: 59.7- 64.2 and Q5: ≥ 64.2 dB) compared with the reference category (Q1: < 52.7 dB).

Kilde: Sørensen, M. Monrad, M., Sajadieh, A., Christensen, J.: Traffic noise and risk for incident atrial fibrillation. Internoise 2016

Moore…

- ***Childrens health and learning***
  - *Traffic noise at school-> poorer reading and memory*
  - *Traffic noise at school and at home- -> hyperactivity symptoms*

- ***Lymphoma cancer (Non-Hodgkin's lymphoma)***
  - *Persons exposed to > 65 L_{den} has 18 % increased risk*

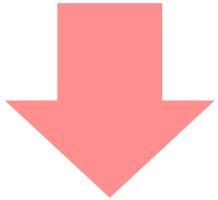
- *…?*

Kilde: Sørensen M., Harbo Poulsen A., Ketzel M., Oksbjerg Dalton S., Friis S., Raaschou-Nielsen O.: Residential exposure to traffic noise and risk for non-hodgkin lymphoma among adults. Environ Res. 2015 Oct;142:61-5. doi: 10.1016/j.envres.2015.06.016. Epub 2015 Jun 23

Conclusion

- The road administrations should use all the technically feasible and economically possible measures to reduce the noise

- Further reduction of the annoyance may be obtained by dealing with the non-acoustic factors



FAMOS
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FActors MOderating people's Subjective reactions to noise

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Quantification and qualification of moderators

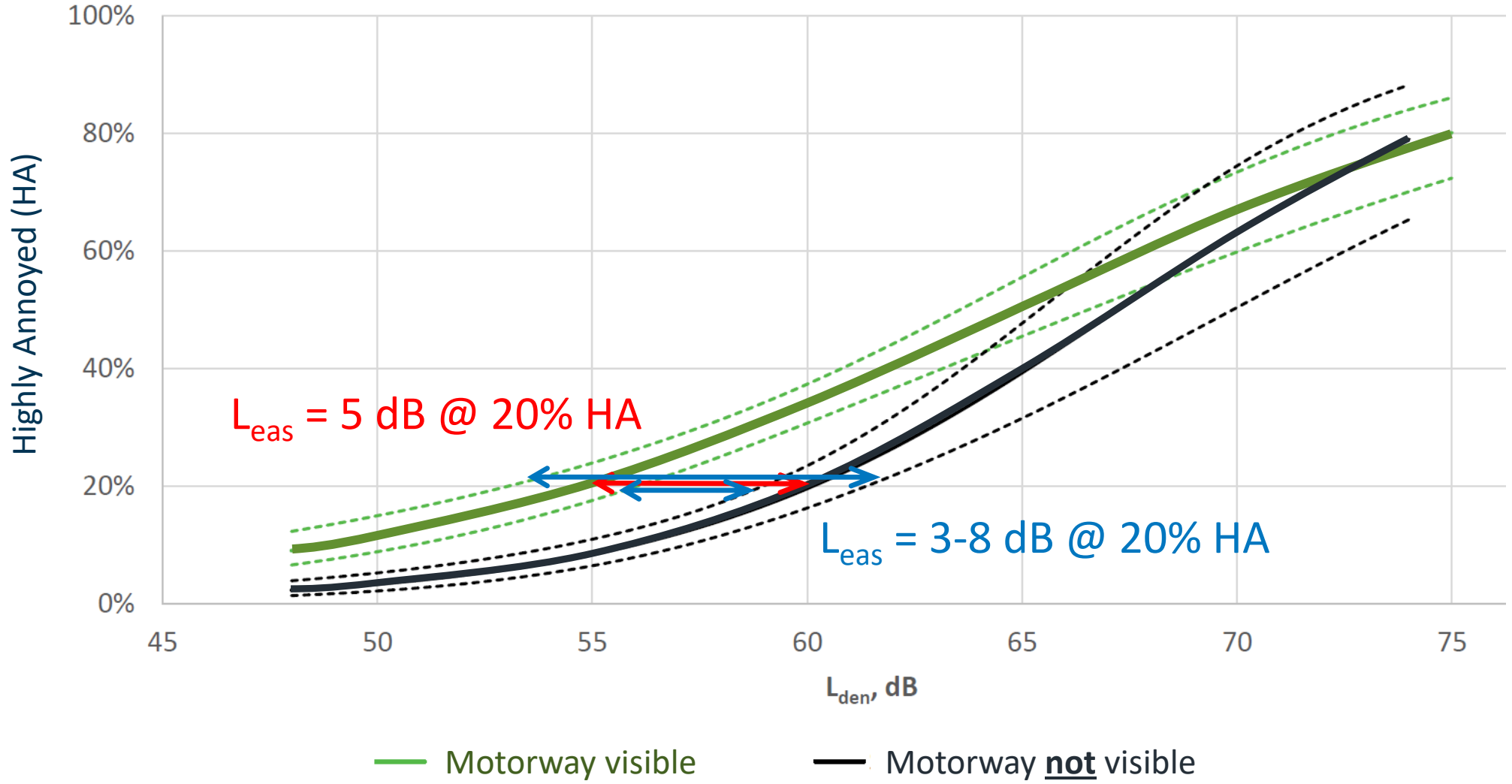
Quantification of non-acoustic factors

The "Annoyance equivalent noise level shift", L_{eas}:

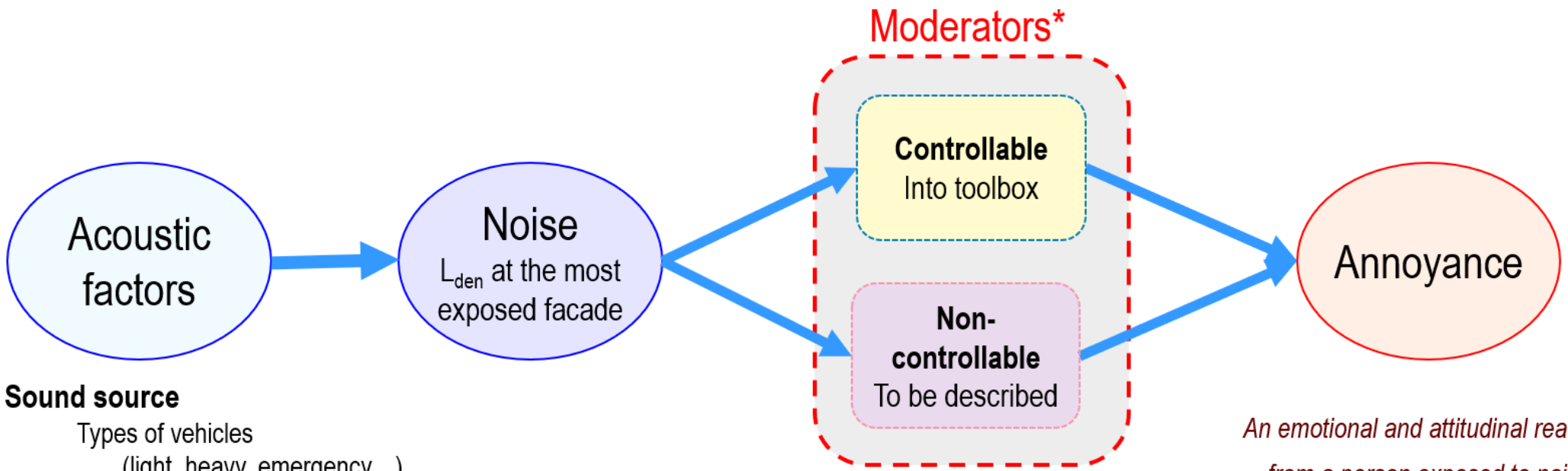
The (hypothetical) shift in noise level that will give the same change in annoyance as the presence or absence of a moderator.

Annoyance equivalent noise level shift, L_{eas}, motorway visible

(DK, n=3446)



Selection of moderators to work with



Sound source

- Types of vehicles
  - (light, heavy, emergency…)
- Speed
- Road surface
- Tyres
- Day, evening, night distibution

Sound propagation

- Distance
- Noise barriers

An emotional and attitudinal reaction from a person exposed to noise in a given context.

*Non-noise dose factors,
also called non-acoustic factors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Thanks for listening!
Do you have any comments or questions?
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Torben Holm Pedersen: thp@forcetechnology.com
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