UK Health Security Agency

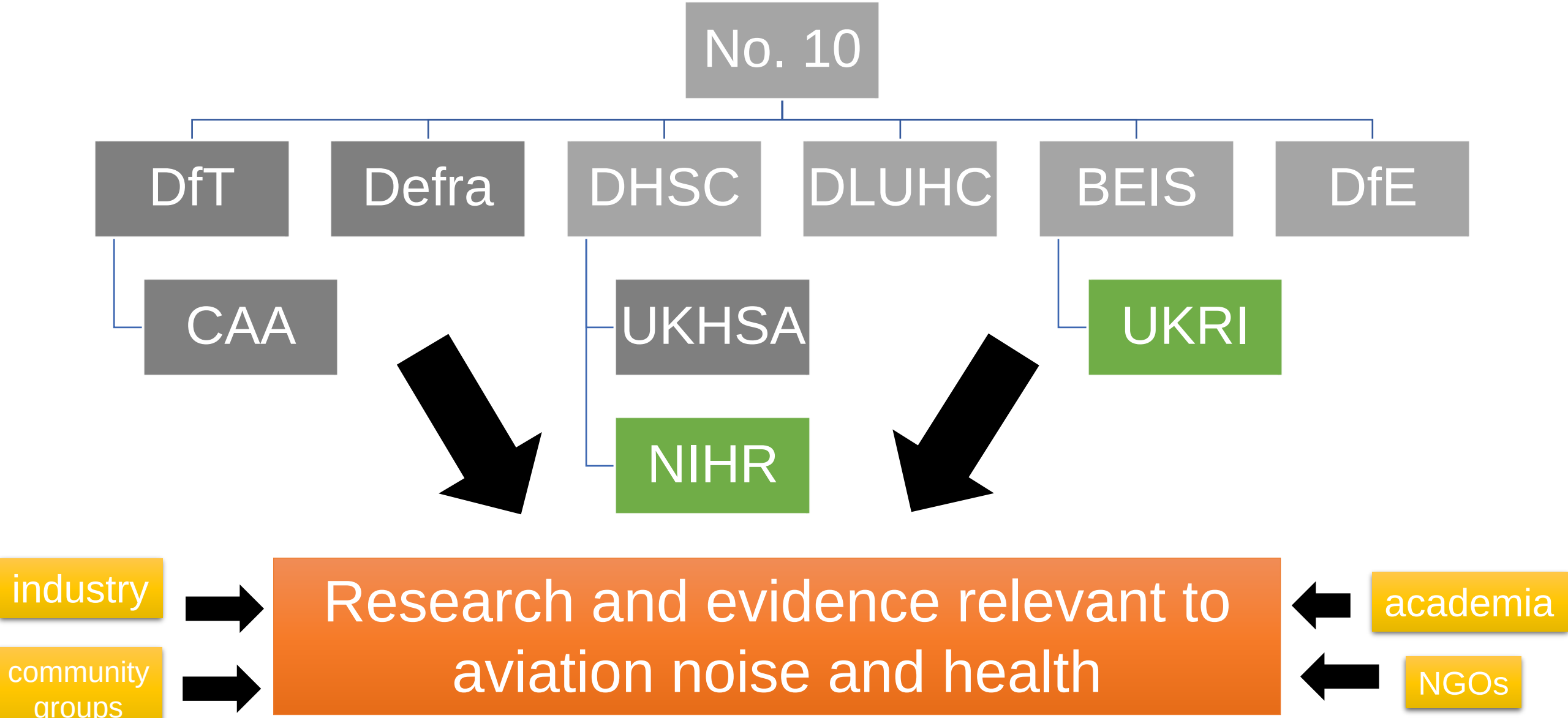
Aviation noise and health – research to policy and practice

ANEG discussion group 28.04.2022

Benjamin Fenech

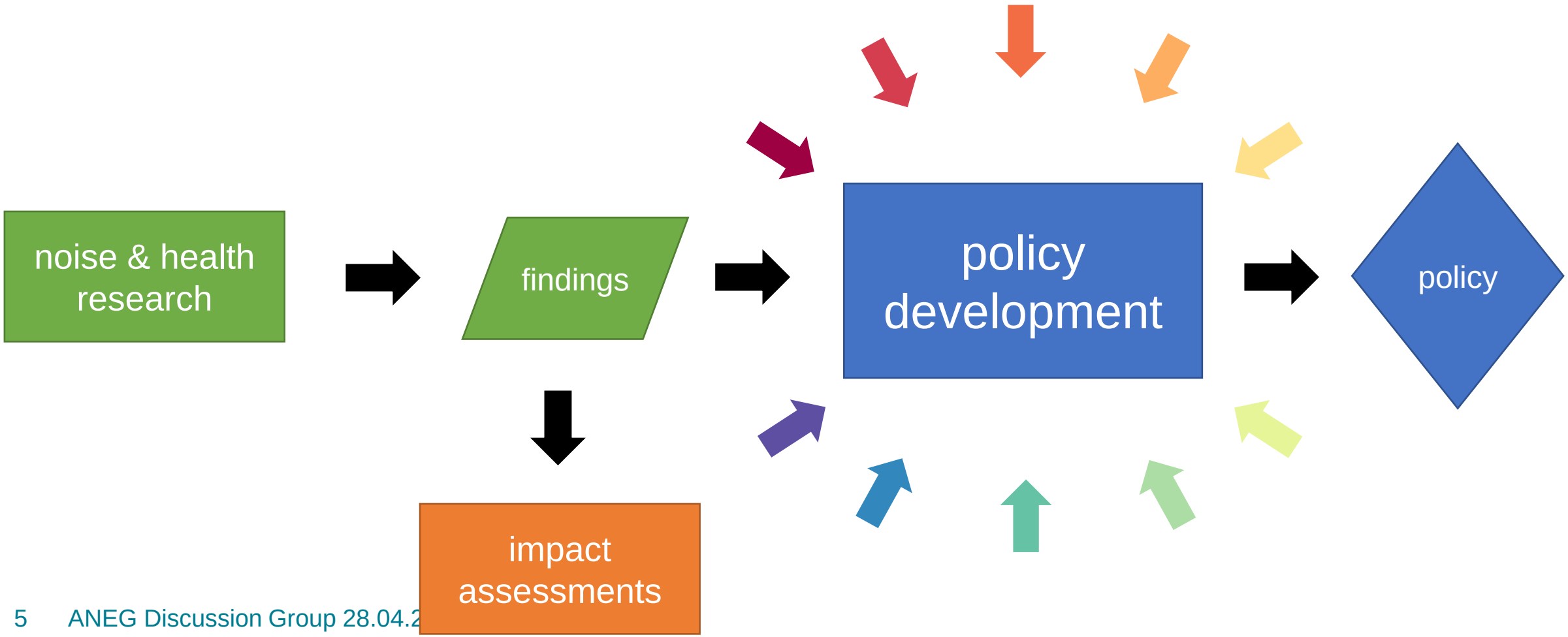
Team leader, Noise and Public Health

Research coordination



Note: Executive agencies, non-departmental public bodies and public corporations listed according to sponsoring government department.
Organisations shaded in green are research funding bodies

Translating research into policy and practice


noise & health research
findings
policy development
policy
impact assessments

Noise and health research translation

- Is there an association between noise and the relevant health outcome?
- Is it likely to be a causal relationship?
- What is the threshold of effect?
- What is the gradient (dose response shape)?
- Judgements of significance (in relation to noise policy and EIA regulations)

Noise policy and guidance

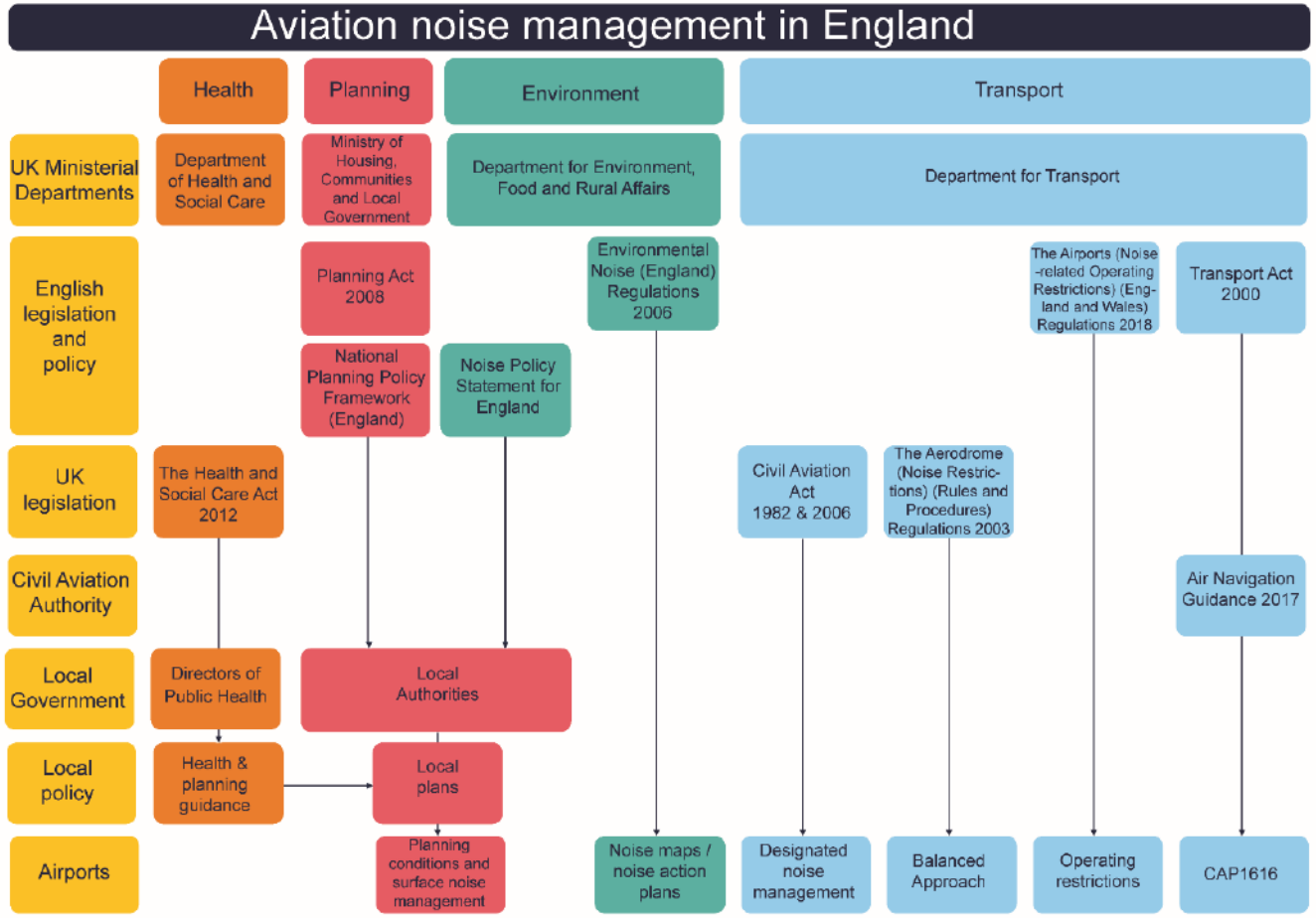
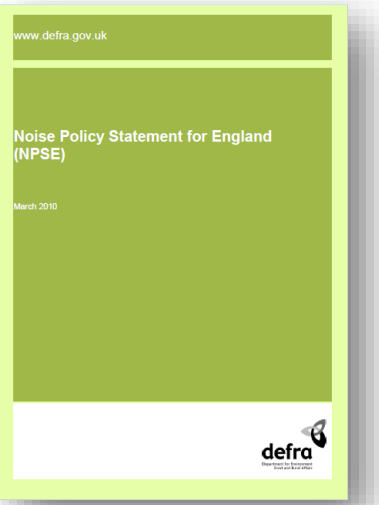
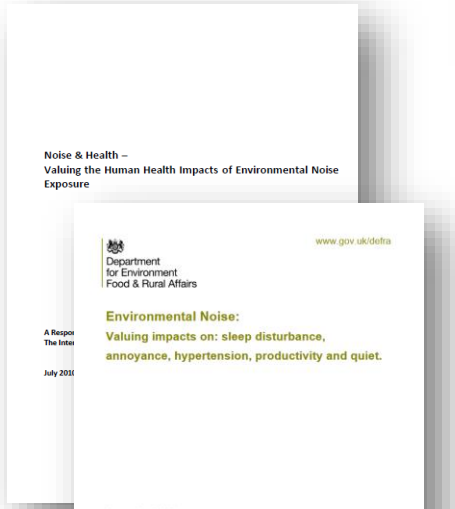
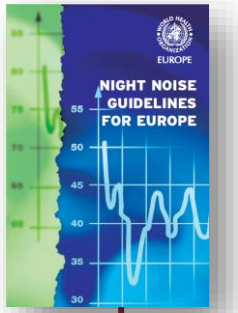


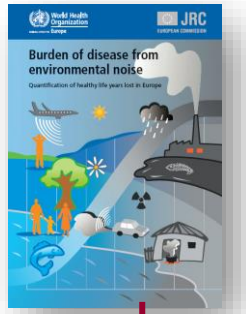
Diagram 1 Aviation noise management in England

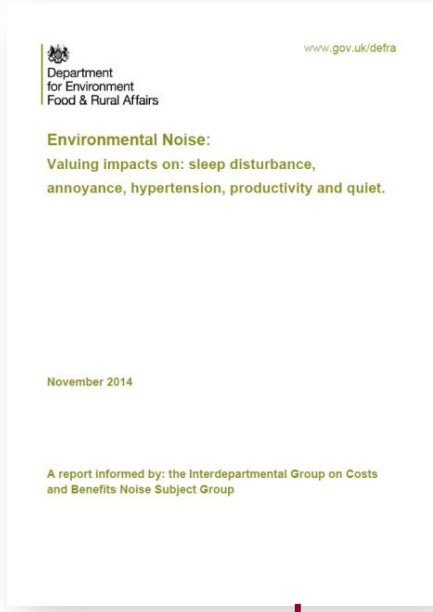


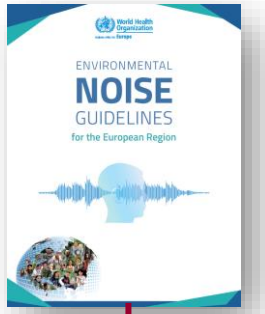


https://www.gov.uk/guidance/noise-pollution-economic-analysis
https://iccan.gov.uk/iccan-report-future-noise-management/
https://www.gov.uk/government/publications/tag-unit-a3-environmental-impact-appraisal
https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent









valuation of transport-related noise in Birmingham
Bateman *et al.* 2004

IGCB(N)
1st report 2008

IGCB(N)
2nd report 2010

Transport Analysis Guidance TAG Unit 3.3.2 2003

dose response relationships review
Berry & Flindell 2009

hypertension review
Berry 2014

ITS / TSG review
Nellthorp *et al.* 2005

revised TAG Unit 3.3.2

noise-related hypertension
Harding *et al.* 2011

productivity impacts of noise
Muirhead *et al.* 2011

economic value quiet areas
URS Scott Wilson 2011

Note: timeline represents publication dates

WHO ENG 2018 – aviation

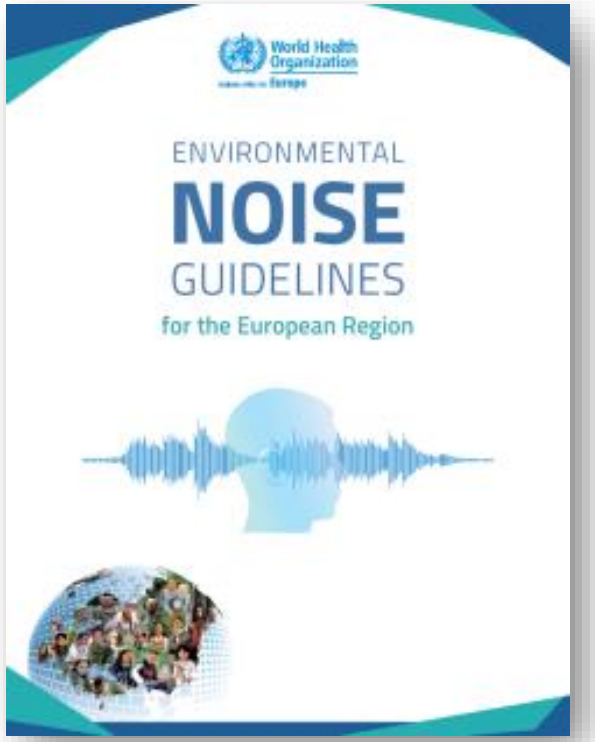


Table 29 .Summary of findings for health effects from exposure to aircraft noise (L_{den})

Noise metric	Priority health outcome measure	Quantitative risk for adverse health	Lowest level of exposure across studies	Number of participants (studies)[a]	Quality of evidence
Cardiovascular disease					
L_{den}	Incidence of IHD	RR = 1.09 (95% CI: 1.04–1.15) per 10 dB increase	47 dB	9 619 082[a] (2)	Very low (downgraded for risk of bias; upgraded for dose-response)
L_{den}	Incidence of hypertension	RR = 1.00 (95% CI: 0.77–1.30) per 10 dB increase	N/A	4712 (1)	Low (downgraded for risk of bias and because only one study available)
Annoyance					
L_{den}	%HA	OR = 4.78 (95%	33 dB	17 094	Moderate (downgraded
Cog					
L_{den}					
Hea					
L_{den}					

Note: [a] Results are partly derived from population-based studies.

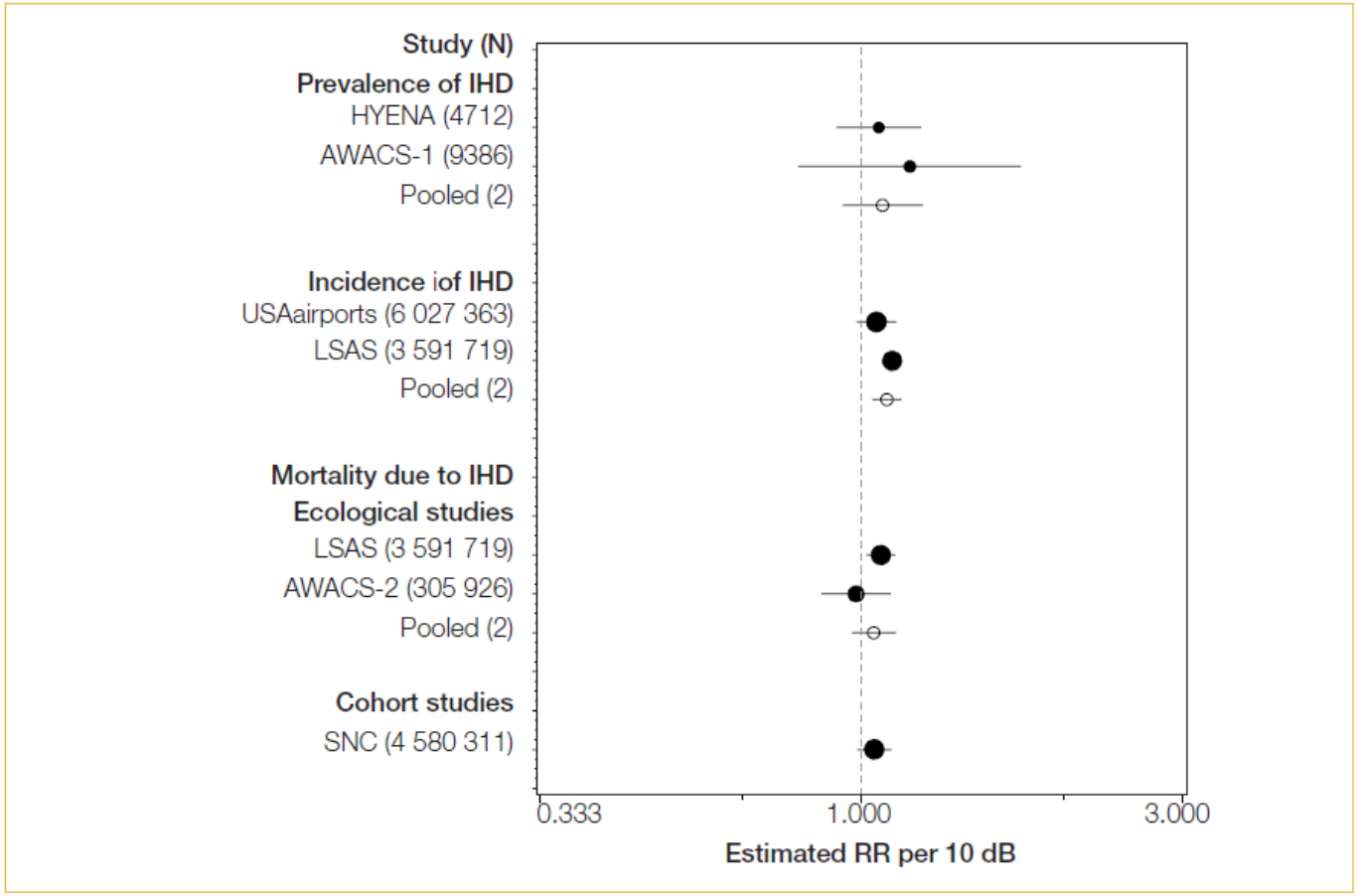
Box 1 GRADE interpretations of quality of evidence

- **High quality:** further research is very unlikely to change the certainty of the effect estimate
- **Moderate quality:** further research is likely to have an important impact on the certainty of the effect estimate and may change the estimate
- **Low quality:** further research is very likely to have an important impact on the certainty of the effect estimate and is likely to change the estimate
- **Very low quality:** any effect estimate is uncertain

Case study: Ischaemic heart disease

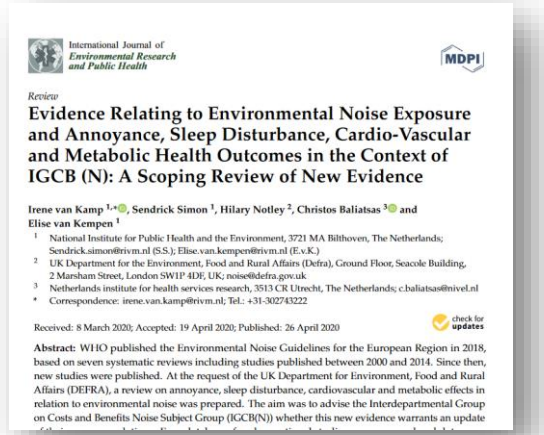
Ischaemic heart disease – WHO ENG2018

Fig. 10. The association between exposure to aircraft noise (L_{den}) and IHD



Notes: The dotted vertical line corresponds to no effect of exposure to aircraft noise. The black circles correspond to the estimated RR per 10 dB and 95% CI. The white circles represent the pooled random effect estimates and 95% CI. For further details on the studies included in the figure please refer to the systematic review on environmental noise and cardiovascular and metabolic effects (van Kempen et al., 2018).

Ischaemic heart disease – RIVM scoping review 2020



International Journal of Environmental Research and Public Health

MDPI

Review

Evidence Relating to Environmental Noise Exposure and Annoyance, Sleep Disturbance, Cardio-Vascular and Metabolic Health Outcomes in the Context of IGCB (N): A Scoping Review of New Evidence

Irene van Kamp [1,*], Sendrick Simon [1], Hilary Notley [2], Christos Baliatsas [3] and Elise van Kempen [1]

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check for updates

Abstract: WHO published the Environmental Noise Guidelines for the European Region in 2018, based on seven systematic reviews including studies published between 2000 and 2014. Since then, new studies were published. At the request of the UK Department for Environment, Food and Rural Affairs (DEFRA), a review on annoyance, sleep disturbance, cardiovascular and metabolic effects in relation to environmental noise was prepared. The aim was to advise the Interdepartmental Group on Costs and Benefits Noise Subject Group (IGCB(N)) whether this new evidence warrants an update

"The association between aircraft noise and the incidence of IHD was investigated in two cohort studies [52,78] and in one case control study [57,76]. As part of the WHO evidence review, no cohort nor case control studies were included that investigated the association between aircraft noise exposure and the incidence of IHD."

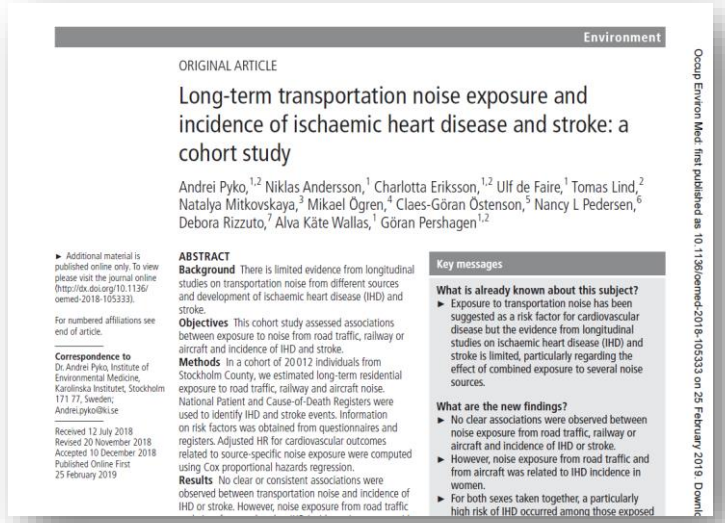
https://www.mdpi.com/1660-4601/17/9/3016

Swedish cohort study (Stockholm)

Table 2 Overall and sex-specific HRs of IHD incidence in relation to transportation noise exposure 1–5 years preceding the event from different sources in fully adjusted model*

	Road traffic noise exposure years 1–5			Railway noise exposure years 1–5			Aircraft noise exposure years 1–5		
Exposure	Person-years	No. of cases	HR* (95% CI)	Person-years	No. of cases	HR* (95% CI)	Person-years	No. of cases	HR* (95% CI)
Overall									
Categorical dB, L_{den}									
<45	125 126	542	1 (ref.)	210 185	1111	1 (ref.)	207 957	1110	1 (ref.)
45–49	44 516	245	1.05 (0.91 to 1.23)	15 940	123	0.98 (0.81 to 1.18)	21 949	144	0.98 (0.82 to 1.17)
50–54	36 413	254	1.02 (0.87 to 1.19)	9832	67	0.97 (0.75 to 1.24)	12 153	91	1.05 (0.84 to 1.31)
55–60	39 045	322	0.86 (0.73 to 1.01)	9143	62	1.02 (0.79 to 1.31)	2949	17	1.23 (0.76 to 2.00)
Continuous per 10 dB, L_{den}	245 100	1363	0.96 (0.90 to 1.03)	245 100	1363	1.01 (0.93 to 1.09)	245 008	1362	1.04 (0.94 to 1.15)
Women									
Categorical dB, L_{den}									
<45	68 743	171	1 (ref.)	119 340	463	1 (ref.)	119 944	458	1 (ref.)
45–49	26 387	96	1.11 (0.86 to 1.43)	9745	70	1.15 (0.89 to 1.49)	12 533	67	1.04 (0.80 to 1.35)
50–54	21 912	133	1.36 (1.08 to 1.73)	6291	33	0.97 (0.68 to 1.38)	6727	53	1.28 (0.95 to 1.72)
55–60	23 715	189	1.19 (0.95 to 1.50)	5381	23	0.82 (0.54 to 1.25)	1484	10	2.05 (1.09 to 3.84)
Continuous per 10 dB, L_{den}	140 757	589	1.11 (1.00 to 1.22)	140 757	589	1.02 (0.91 to 1.14)	140 688	588	1.25 (1.09 to 1.44)
Men									
Categorical dB, L_{den}									
<45	56 383	371	1 (ref.)	90 845	648	1 (ref.)	88 013	652	1 (ref.)
45–49	18 129	149	1.04 (0.86 to 1.26)	6195	53	0.82 (0.62 to 1.09)	9416	77	0.94 (0.73 to 1.19)
50–54	14 501	121	0.83 (0.67 to 1.02)	3541	34	0.96 (0.68 to 1.36)	5426	38	0.85 (0.61 to 1.19)
55–60	15 330	133	0.65 (0.52 to 0.81)	3762	39	1.18 (0.85 to 1.63)	1465	7	0.78 (0.37 to 1.65)
Continuous per 10 dB, L_{den}	104 343	774	0.86 (0.79 to 0.94)	104 343	774	1.00 (0.90 to 1.11)	104 320	774	0.90 (0.78 to 1.03)

*Adjusted for sex, enrolment year and year of the event, smoking status, alcohol consumption, occupation, educational level, physical activity during leisure time, marital status and working status with age as underlining time scale.
IHD, ischaemic heart disease.



Environment

ORIGINAL ARTICLE

Long-term transportation noise exposure and incidence of ischaemic heart disease and stroke: a cohort study

Andrei Pyko,[1,2] Niklas Andersson,[1] Charlotta Eriksson,[1,2] Ulf de Faire,[1] Tomas Lind,[2] Natalya Mitkovskaya,[3] Mikael Ögren,[4] Claes-Göran Östenson,[5] Nancy L Pedersen,[6] Debora Rizzuto,[7] Alva Käte Wallas,[1] Göran Pershagen[1,2]

► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/oemed-2018-105333).

For numbered affiliations see end of article.

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Published Online First 25 February 2019

ABSTRACT
Background There is limited evidence from longitudinal studies on transportation noise from different sources and development of ischaemic heart disease (IHD) and stroke.
Objectives This cohort study assessed associations between exposure to noise from road traffic, railway or aircraft and incidence of IHD and stroke.
Methods In a cohort of 20 012 individuals from Stockholm County, we estimated long-term residential exposure to road traffic, railway and aircraft noise. National Patient and Cause-of-Death Registers were used to identify IHD and stroke events. Information on risk factors was obtained from questionnaires and registers. Adjusted HR for cardiovascular outcomes related to source-specific noise exposure were computed using Cox proportional hazards regression.
Results No clear or consistent associations were observed between transportation noise and incidence of IHD or stroke. However, noise exposure from road traffic

Key messages

What is already known about this subject?
- Exposure to transportation noise has been suggested as a risk factor for cardiovascular disease but the evidence from longitudinal studies on ischaemic heart disease (IHD) and stroke is limited, particularly regarding the effect of combined exposure to several noise sources.

What are the new findings?
- No clear associations were observed between noise exposure from road traffic, railway or aircraft and incidence of IHD or stroke.
- However, noise exposure from road traffic and from aircraft was related to IHD incidence in women.
- For both sexes taken together, a particularly high risk of IHD occurred among those exposed

Occup Environ Med: first published as 10.1136/oemed-2018-105333 on 25 February 2019. Downlo

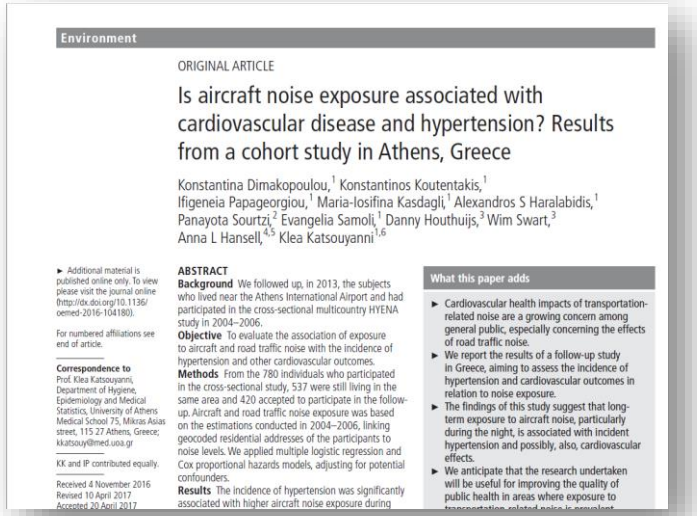
Pyko et al. (2019) https://oem.bmj.com/content/76/4/201

Greek cohort study (Athens)

Table 4 OR and 95% CI for hypertension and cardiovascular disease outcomes associated with a 10 dB increase in noise exposure at the subjects' residence

Outcome	Noise exposure (per 10 dB)	Model 1* OR (95% CI)	Model 2* OR (95% CI)
Hypertension†	Lnight aircraft	1.69 (1.01 to 2.82)	2.63 (1.21 to 5.71)
	LAeq,16hr aircraft	1.45 (1.05 to 1.99)	1.46 (0.89 to 2.39)
	LAeq,24hr road traffic	1.07 (0.90 to 1.27)	1.18 (0.92 to 1.52)
Doctor-diagnosed cardiac arrhythmia	Lnight aircraft	2.09 (1.07 to 4.08)	1.88 (0.85 to 4.19)
	LAeq,16hr aircraft	1.28 (0.85 to 1.94)	1.33 (0.80 to 2.21)
	LAeq,24hr road traffic	1.01 (0.81 to 1.26)	0.96 (0.74 to 1.26)
Doctor-diagnosed myocardial infarction	Lnight aircraft	0.83 (0.31 to 2.20)	0.37 (0.10 to 1.42)
	LAeq,16hr aircraft	1.03 (0.55 to 1.92)	0.69 (0.29 to 1.63)
	LAeq,24hr road traffic	0.89 (0.64 to 1.24)	0.96 (0.60 to 1.53)
Doctor-diagnosed stroke	Lnight aircraft	1.30 (0.32 to 5.31)	1.99 (0.23 to 17.2)
	LAeq,16hr aircraft	0.84 (0.36 to 1.95)	1.02 (0.30 to 3.54)
	LAeq,24hr road traffic	0.93 (0.56 to 1.54)	1.33 (0.59 to 3.03)
Doctor-diagnosed diabetes	Lnight aircraft	1.09 (0.58 to 2.07)	0.92 (0.35 to 2.44)
	LAeq,16hr aircraft	0.95 (0.64 to 1.41)	0.87 (0.48 to 1.58)
	LAeq,24hr road traffic	1.00 (0.80 to 1.24)	1.18 (0.85 to 1.65)
Self-reported hearing problems	Lnight aircraft	1.47 (0.88 to 2.47)	1.97 (1.05 to 3.71)
	LAeq,16hr aircraft	1.23 (0.89 to 1.70)	1.39 (0.93 to 2.07)
	LAeq,24hr road traffic	1.13 (0.95 to 1.34)	1.05 (0.86 to 1.29)
Doctor-diagnosed hearing impairment	Lnight aircraft	2.04 (1.06 to 3.91)	3.51 (1.46 to 8.44)
	LAeq,16hr aircraft	1.75 (1.13 to 2.70)	2.33 (1.26 to 4.30)
	LAeq,24hr road traffic	0.98 (0.80 to 1.21)	1.01 (0.78 to 1.32)

*Model 1: logistic regression including prevalent and incident cases of hypertension; model 2: logistic regression including only incident cases (both after adjusting for age, sex, body mass index, alcohol intake, education, exercise, smoking habits and salt intake at baseline).
†As defined by doctor diagnosis and medication use and/or high blood pressure measurements during the interview.
Lnight aircraft, A-weighted equivalent continuous aircraft noise level over the night (night defined as the hours between 23:00 and 07:00); LAeq,16hr aircraft, A-weighted equivalent continuous aircraft noise level over the day (day defined as the hours between 07:00 and 23:00); LAeq,24hr road traffic, A-weighted equivalent continuous road traffic noise level over 24 hours.



Environment

ORIGINAL ARTICLE

Is aircraft noise exposure associated with cardiovascular disease and hypertension? Results from a cohort study in Athens, Greece

Konstantina Dimakopoulou,[1] Konstantinos Koutentakis,[1] Ifigeneia Papageorgiou,[1] Maria-Iosifina Kasdagli,[1] Alexandros S Haralabidis,[1] Panayota Sourtzi,[2] Evangelia Samoli,[1] Danny Houthuijs,[3] Wim Swart,[3] Anna L Hansell,[4,5] Klea Katsouyanni[1,6]

► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/oemed-2016-104180).

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KK and IP contributed equally.

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ABSTRACT
Background We followed up, in 2013, the subjects who lived near the Athens International Airport and had participated in the cross-sectional multicountry HYENA study in 2004–2006.
Objective To evaluate the association of exposure to aircraft and road traffic noise with the incidence of hypertension and other cardiovascular outcomes.
Methods From the 780 individuals who participated in the cross-sectional study, 537 were still living in the same area and 420 accepted to participate in the follow-up. Aircraft and road traffic noise exposure was based on the estimations conducted in 2004–2006, linking geocoded residential addresses of the participants to noise levels. We applied multiple logistic regression and Cox proportional hazards models, adjusting for potential confounders.
Results The incidence of hypertension was significantly associated with higher aircraft noise exposure during

What this paper adds

- Cardiovascular health impacts of transportation-related noise are a growing concern among general public, especially concerning the effects of road traffic noise.
- We report the results of a follow-up study in Greece, aiming to assess the incidence of hypertension and cardiovascular outcomes in relation to noise exposure.
- The findings of this study suggest that long-term exposure to aircraft noise, particularly during the night, is associated with incident hypertension and possibly, also, cardiovascular effects.
- We anticipate that the research undertaken will be useful for improving the quality of public health in areas where exposure to

Dimakopoulou et al. (2017) https://oem.bmj.com/content/74/11/830

German case-control study (Rhine-Main)

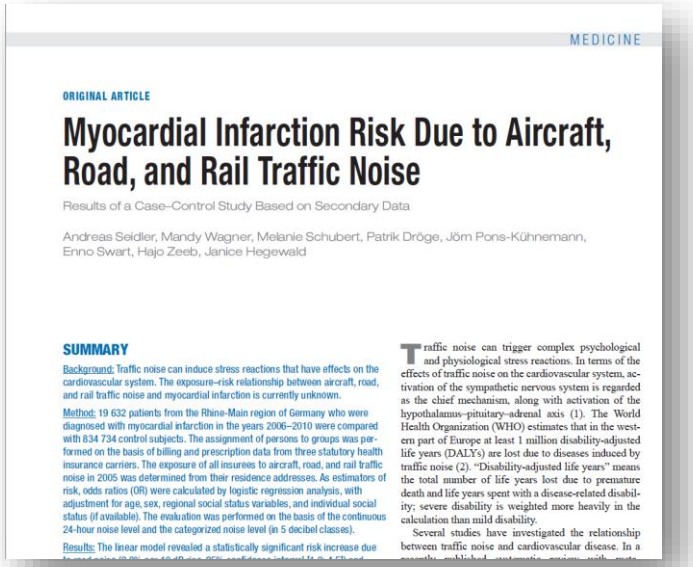
Deutsches Ärzteblatt International | Dtsch Arztebl Int 2016; 113: 407–14

TABLE 3

Traffic noise ($L_{pAeq,24h}$, $L_{pAeq,night}$) and incident myocardial infarction

	Aircraft noise				
Exposure	Cases	Controls	OR	95% CI	Cases
24h continuous noise level					
<40 dB, max. <50 dB	7885	328 815	1.00	–	2167
<40 dB, max. ≥ 50 dB	1346	52 825	1.05	[0.98; 1.11]	
≥ 40 – <45 dB	5839	249 666	1.01	[0.97; 1.05]	4308
≥ 45 – <50 dB	3029	134 464	1.00	[0.95; 1.05]	4627
≥ 50 –<55 dB	1151	52 923	0.97	[0.91; 1.04]	3340
≥ 55 – <60 dB	376	15 845	1.06	[0.95; 1.18]	2171
≥ 60 –<65 dB	6	196	1.42	[0.62; 3.25]	1637
≥ 65 – <70 dB	–	–	–	–	1069
≥ 70 dB	–	–	–	–	313
Continuous (pro 10 dB)			0.993	[0.966; 1.020]	
				p = 0.606	
Night hours 10 p.m. to 6 a.m.					
<40 dB, max. <50 dB	9073	380 331	1.00	–	8139
<40 dB, max. ≥ 50 dB	5211	222 319	1.00	[0.96; 1.03]	
≥ 40 – <45 dB	3319	140 511	0.99	[0.95; 1.04]	3879
≥ 45 – <50 dB	1382	65 738	0.95	[0.89; 1.01]	2999
≥ 50 – <55 dB	623	24 693	1.07	[0.98; 1.17]	2302
≥ 55 – <60 dB	24	1142	0.99	[0.66; 1.49]	1557
≥ 60 dB	0	0	–	–	756
Night hours 11 p.m. to 5a.m.					
<40 dB, max. <50 dB	9114	382 121	1.00	–	
<40 dB, max. ≥ 50 dB	6025	257 513	0.99	[0.96; 1.03]	
≥ 40 – <45 dB	2848	123 392	0.99	[0.95; 1.03]	
≥ 45 – <50 dB	1256	55 504	0.98	[0.92; 1.05]	
≥ 50 – <55 dB	381	15 955	1.05	[0.94; 1.17]	
≥ 55 – <60 dB	8	249	1.50	[0.73; 3.07]	
≥ 60 dB	0	0	–	–	

OR: odds ratio, adjusted for age, sex, education, and occupation (from occupation code), SGB-II rate(quintile); $L_{pAeq,24h}$: unweighted 24h
CI: 95% confidence interval



MEDICINE

ORIGINAL ARTICLE

Myocardial Infarction Risk Due to Aircraft, Road, and Rail Traffic Noise

Results of a Case–Control Study Based on Secondary Data

Andreas Seidler, Mandy Wagner, Melanie Schubert, Patrik Dröge, Jörn Pons-Kühnemann, Enno Swart, Hajo Zeeb, Janice Hegewald

SUMMARY

Background: Traffic noise can induce stress reactions that have effects on the cardiovascular system. The exposure–risk relationship between aircraft, road, and rail traffic noise and myocardial infarction is currently unknown.

Method: 19 632 patients from the Rhine-Main region of Germany who were diagnosed with myocardial infarction in the years 2006–2010 were compared with 834 734 control subjects. The assignment of persons to groups was performed on the basis of billing and prescription data from three statutory health insurance carriers. The exposure of all insurees to aircraft, road, and rail traffic noise in 2005 was determined from their residence addresses. As estimators of risk, odds ratios (OR) were calculated by logistic regression analysis, with adjustment for age, sex, regional social status variables, and individual social status (if available). The evaluation was performed on the basis of the continuous 24-hour noise level and the categorized noise level (in 5 decibel classes).

Results: The linear model revealed a statistically significant risk increase due

Traffic noise can trigger complex psychological and physiological stress reactions. In terms of the effects of traffic noise on the cardiovascular system, activation of the sympathetic nervous system is regarded as the chief mechanism, along with activation of the hypothalamus–pituitary–adrenal axis (1). The World Health Organization (WHO) estimates that in the western part of Europe at least 1 million disability-adjusted life years (DALYs) are lost due to diseases induced by traffic noise (2). "Disability-adjusted life years" means the total number of life years lost due to premature death and life years spent with a disease-related disability; severe disability is weighted more heavily in the calculation than mild disability.

Several studies have investigated the relationship between traffic noise and cardiovascular disease. In a

Seidler et al. (2016) https://pubmed.ncbi.nlm.nih.gov/27380755/

Consolidating results – meta-analysis

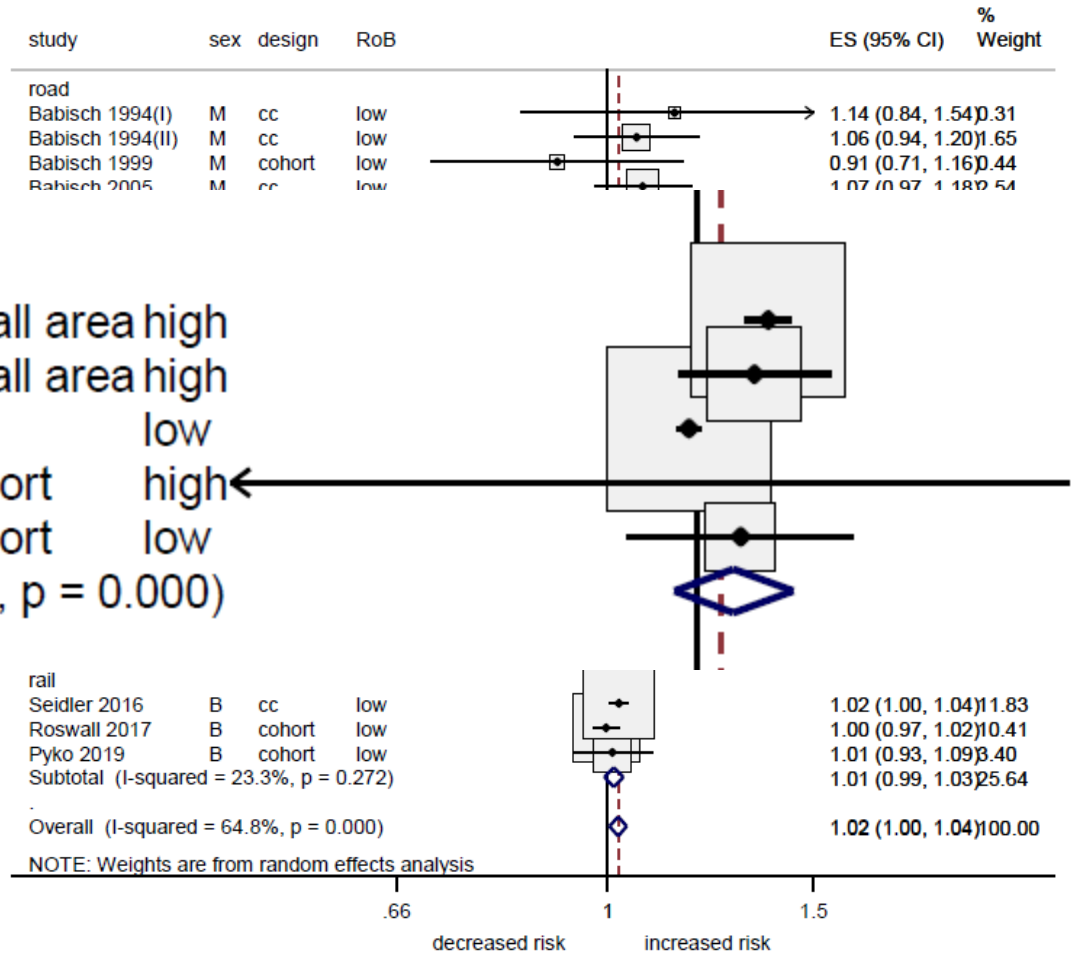


Figure 2 – Pooled association between IHD incidence and transportation noise (per 10 dB Lden) by source

(*Dimakopoulou indicates point estimate is off the scale)

Vienneau et al. (2019) http://pub.dega-akustik.de/ICA2019/data/articles/000783.pdf

TAG allows for sensitivity testing

"2.1.2 *Defra's guidance and associated toolkit highlight several key areas of uncertainty in the appraisal of noise impacts.*

…

Where noise impacts are particularly significant, sensitivity testing to reflect these various uncertainties may be required and further advice should be sought from the Department on an appropriate range of sensitivity tests."

TAG Unit A.3 July 2021

Observations/Questions

- Research funding by UKRI and NIHR is highly competitive
- Whilst some argue that the industry should fund the research, questions would arise about actual and perceived conflicts of interests
- How can we work better as a cross-cutting stakeholder group to prioritise research questions and strengthen the case for funding?
- Effectiveness of interventions remains a key evidence gap – how do we bridge the gap between statistically significant results and locally-relevant findings?

Discussion