Gesundheitsbelastung, Fluglärm, Feinstaub, NOx. Wie hoch ist der Kollateralschaden, wie vermindert man ihn?

UNIVERSITÄTSmedizin.
MAINZ

Zentrum für Kardiologie

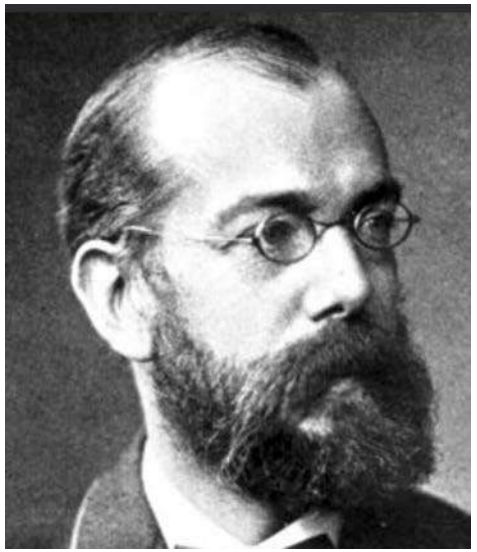
Thomas Münzel

Universitätsmedizin Mainz,

Münchner Lärmverkehrsschutztag

Prophezeihung:Robert Koch

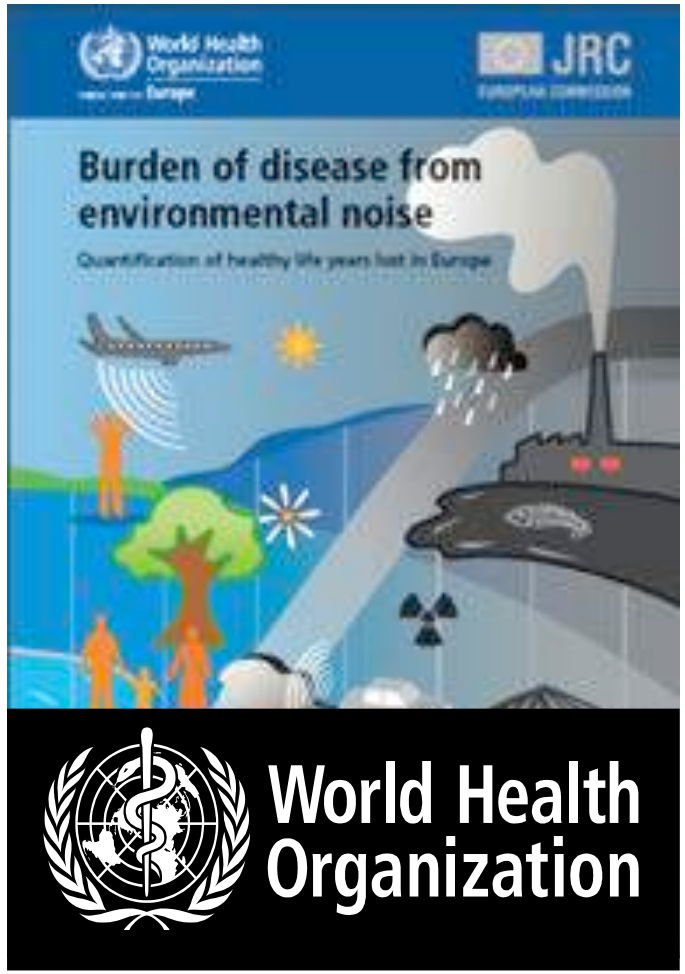
„Eines Tages wird der Mensch den Lärm ebenso unerbittlich bekämpfen müssen wie die Cholera und die Pest“,
schrieb Robert Koch im Jahre 1910.



Begründer der modernen Bakteriologie

Nobelpreis 1905

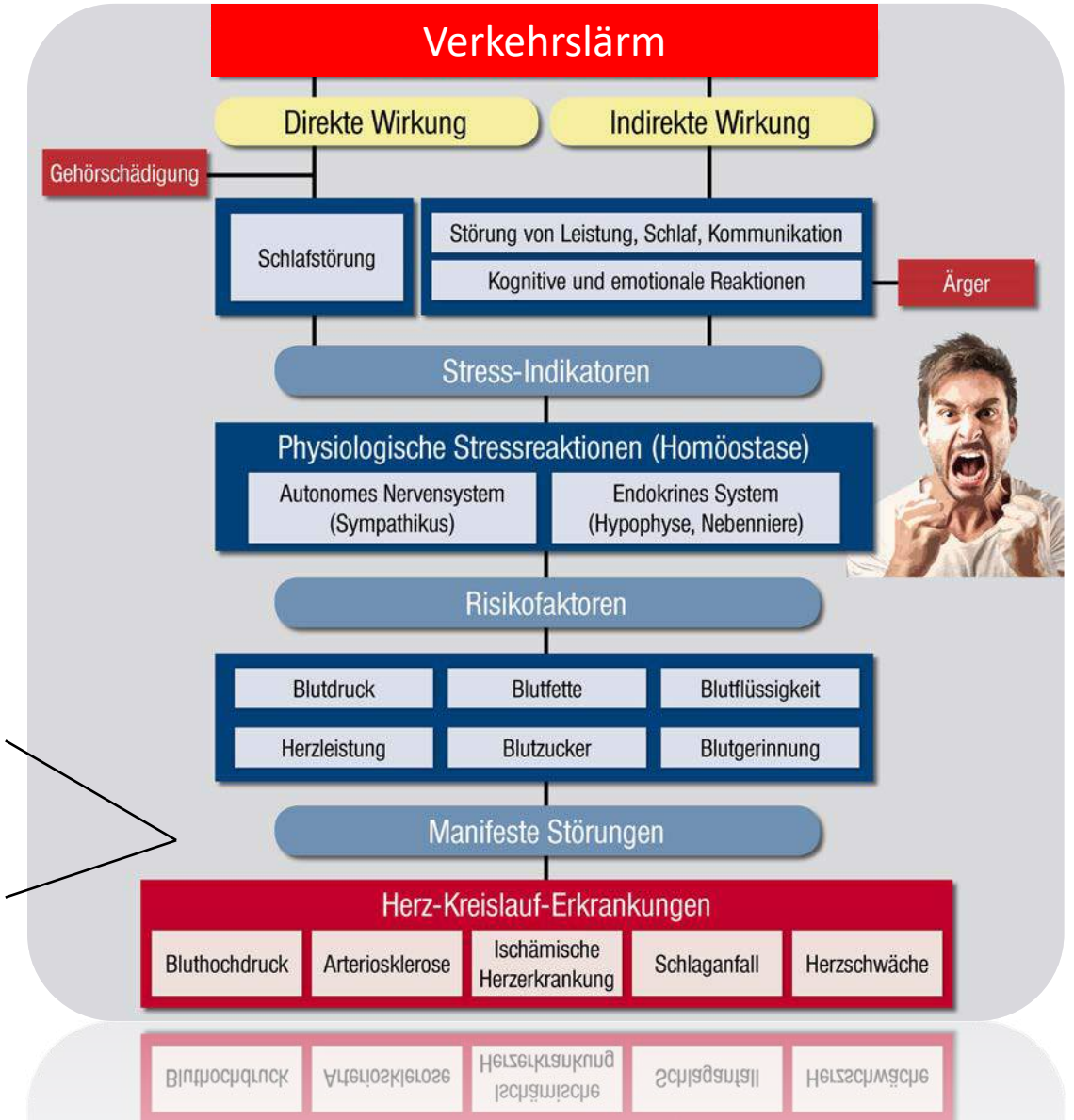
WHO and Noise



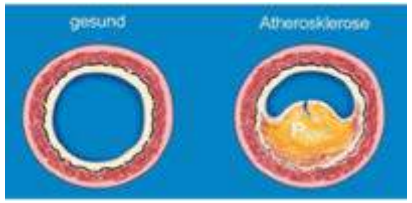
- **At least 1.6 Mio healthy life years are lost every year from traffic related noise in the western part of Europe**
- each day nearly **70 million Europeans** in towns and cities **are exposed to noise levels in excess of 55 decibels** just from traffic.

  - DALY`s lost from ischemic heart disease: 61.000 Years
  - 45 000 years for cognitive impairment of children
  - 903 000 years for sleep disturbance
  - 22 000 years for tinnitus
  - 654 000 years for annoyance

Wie macht Lärm krank ?

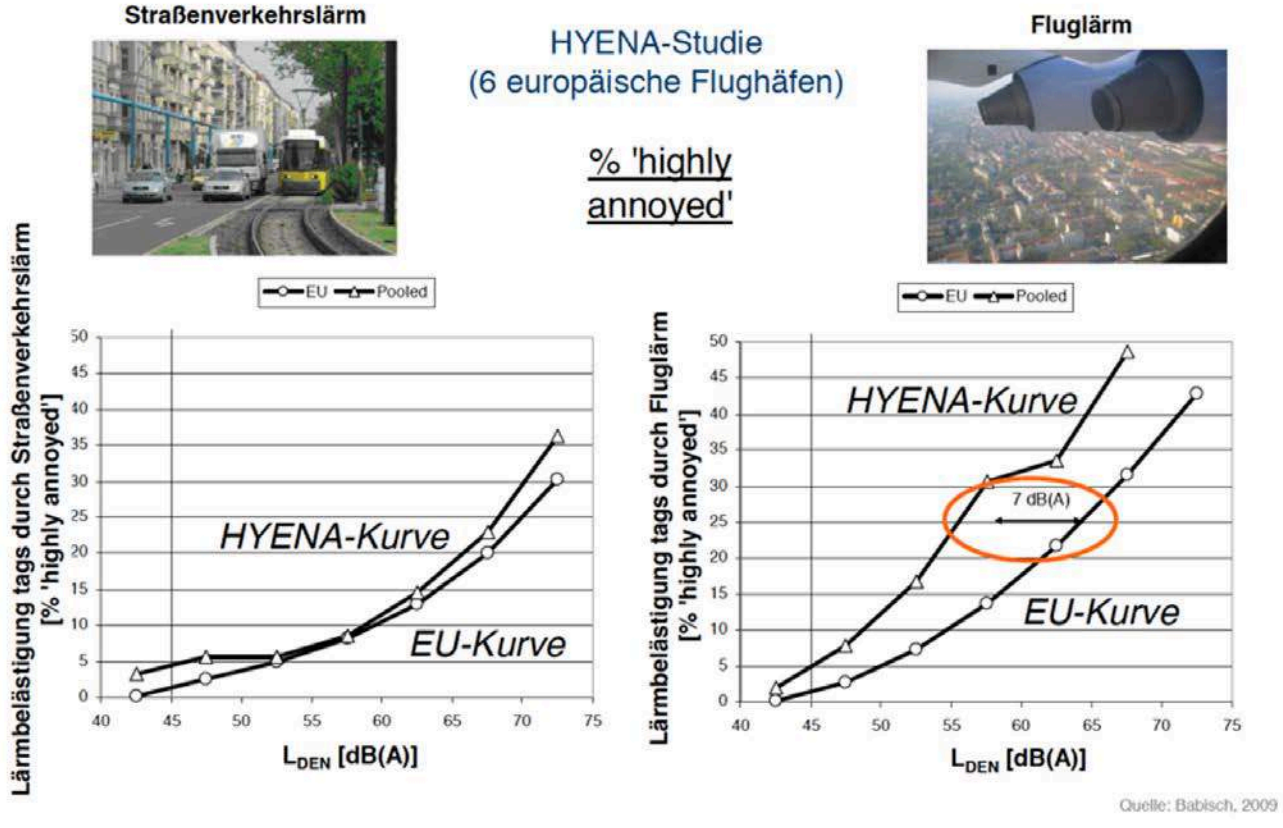


?



Transportlärm:

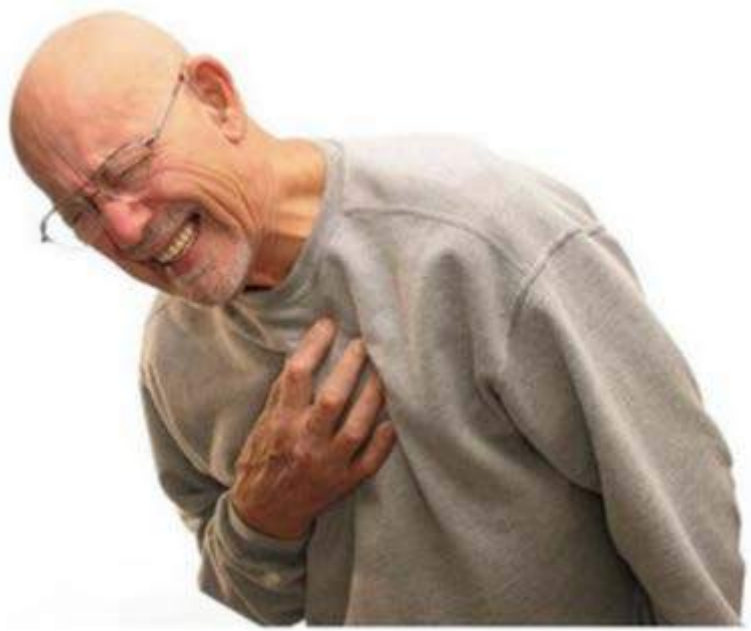
Fluglärm nervt am meisten



Quelle: Babisch, 2009

Fluglärm für Herzkreislauferkrankungen verantwortlich

- **Bluthochdruck**
- **Koronare Herzerkrankung**
- **Schlaganfall**
- **Herzschwäche**



European Heart Journal Advance Access published February 12, 2008

European Heart Journal
doi:10.1093/eurheartj/ehn013

CLINICAL RESEARCH

Acute effects of night-time noise exposure on blood pressure in populations living near airports

Alexandros S. Haralabidis[1], Konstantina Dimakopoulou[1], Federica Vigna-Taglianti[2], Matteo Giampaolo[3], Alessandro Borgini[4], Marie-Louise Dudley[5], Göran Pershagen[6], Gösta Bluhm[6], Danny Houthuijs[7], Wolfgang Babisch[8], Manolis Velonakis[9], Klea Katsouyanni[1]*, and Lars Jarup[5] for the HYENA Consortium

during night-time sleep in 140 subjects living near four major European airports.

Methods and results Non-invasive ambulatory BP measurements at 15 min intervals were performed. Noise was measured during the night sleeping period and recorded digitally for the identification of the source of a noise event. Exposure variables included equivalent noise level over 1 and 15 min and presence/absence of event (with LAmax $>$ 35 dB) before each BP measurement. Random effects models for repeated measurements were applied. An increase in BP (6.2 mmHg (0.63–12) for systolic and 7.4 mmHg (3.1, 12) for diastolic) was observed over 15 min intervals in which an aircraft event occurred. A non-significant increase in HR was also observed (by 5.4 b.p.m.). Less consistent effects were observed on HR. When the actual maximum noise level of an event was assessed there were no systematic differences in the effects according to the noise source.

Conclusion Effects of noise exposure on elevated subsequent BP measurements were clearly shown. The effect size of the noise level appears to be independent of the noise source.

Keywords Environmental noise • Blood pressure • Night-time sleep • Acute effects • Epidemiological study

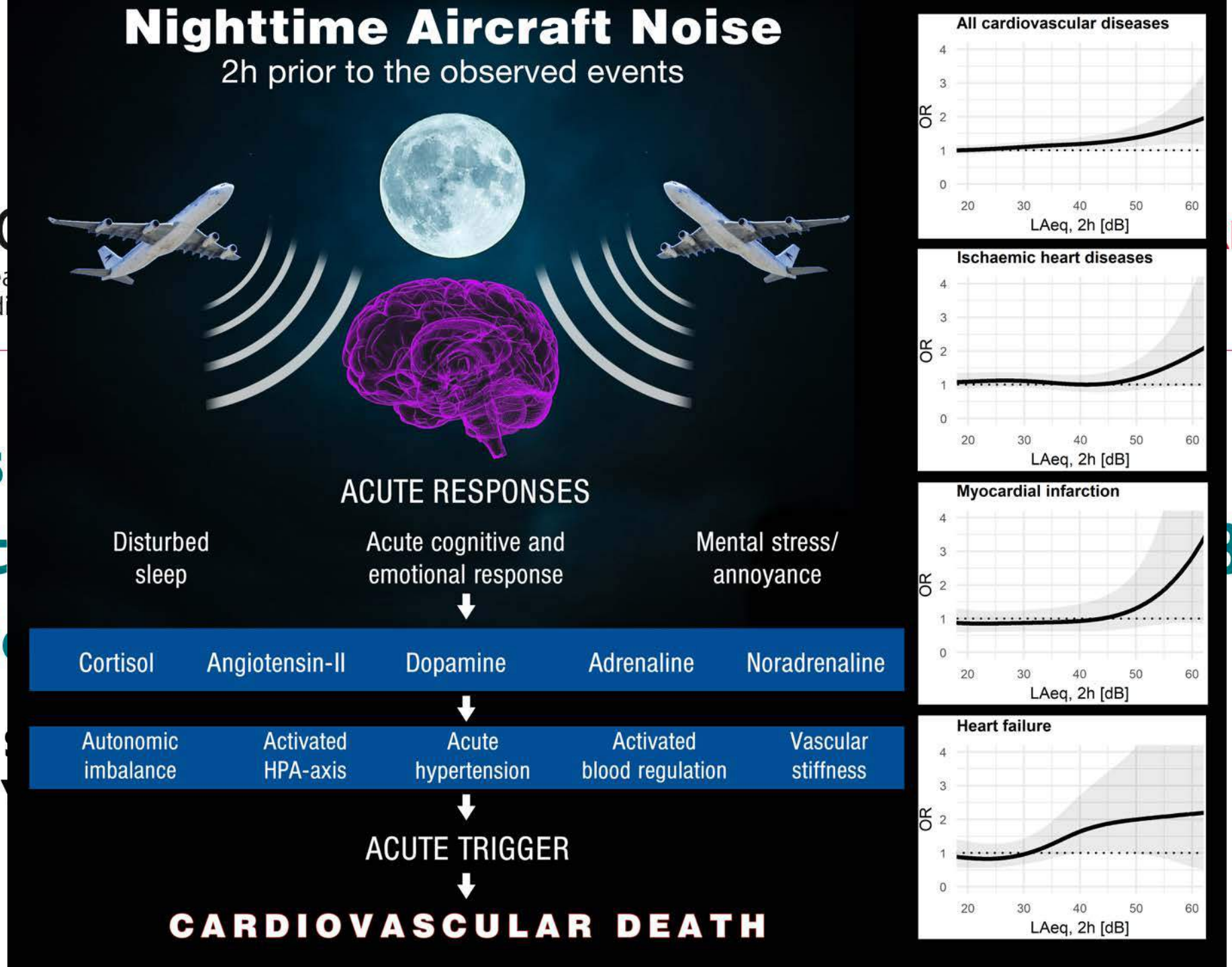
ESC
European
of Cardi

ESEARCH
Epidemiology

Does
mort
cardi

86

Apolline
Danielle



Entwicklungs-störungen bei Kindern

Aircraft and road traffic noise and children's cognition and health: a cross-national study

S A Stansfeld, B Berglund, C Clark, I Lopez-Barrio, P Fischer, E Öhrström, M M Haines, J Head, S Hygge, I van Kamp, B F Berry, on behalf of the RANCH study team*

Lancet 2005; 365: 1942–49

See Comment page 1908

*Study team listed at end of article

Barts and the London, Queen Mary's School of Medicine and Dentistry, University of London, London E1 4NS, UK (Prof S A Stansfeld PhD, C Clark PhD, M M Haines PhD, J Head MSc); Karolinska Institute, Stockholm, Sweden (Prof B Berglund PhD); Consejo Superior De Investigaciones Científicas (CSIC), Madrid, Spain (I Lopez-Barrio PhD); National Institute for Public Health and Environment (RIVM), Bilthoven, Netherlands (P Fischer MSc, I van Kamp PhD); Göteborg University, Göteborg, Sweden (Prof E Öhrström PhD); University of Gavle, Gavle, Sweden (Prof S Hygge PhD); and Berry Environmental, London, UK (B F Berry MSc)

Correspondence to:
Prof Stephen Stansfeld
S.A.Stansfeld@qmul.ac.uk

Summary

Background Exposure to environmental stressors can impair children's health and their cognitive development. The effects of air pollution, lead, and chemicals have been studied, but there has been less emphasis on the effects of noise. Our aim, therefore, was to assess the effect of exposure to aircraft and road traffic noise on cognitive performance and health in children.

Methods We did a cross-national, cross-sectional study in which we assessed 2844 of 3207 children aged 9–10 years who were attending 89 schools of 77 approached in the Netherlands, 27 in Spain, and 30 in the UK located in local authority areas around three major airports. We selected children by extent of exposure to external aircraft and road traffic noise at school as predicted from noise contour maps, modelling, and on-site measurements, and matched schools within countries for socioeconomic status. We measured cognitive and health outcomes with standardised tests and questionnaires administered in the classroom. We also used a questionnaire to obtain information from parents about socioeconomic status, their education, and ethnic origin.

Findings We identified linear exposure-effect associations between exposure to chronic aircraft noise and impairment of reading comprehension ($p=0\cdot0097$) and recognition memory ($p=0\cdot0141$), and a non-linear association with annoyance ($p<0\cdot0001$) maintained after adjustment for mother's education, socioeconomic status, longstanding illness, and extent of classroom insulation against noise. Exposure to road traffic noise was linearly associated with increases in episodic memory (conceptual recall: $p=0\cdot0066$; information recall: $p=0\cdot0489$), but also with annoyance ($p=0\cdot0047$). Neither aircraft noise nor traffic noise affected sustained attention, self-reported health, or overall mental health.

Interpretation Our findings indicate that a chronic environmental stressor—aircraft noise—could impair cognitive development in children, specifically reading comprehension. Schools exposed to high levels of aircraft noise are not healthy educational environments.

Lärmwirkungsforschung am Menschen

Effekte von Lärm auf die Gefäßfunktion

European Heart Journal (2013) 34, 3508–3514
doi:10.1093/eurheartj/eht269

CLINICAL RESEARCH

Effect of nighttime aircraft noise exposure on endothelial function and stress hormone release in healthy adults

Frank P. Schmidt[1], Mathias Basner[2], Gunnar Kröger[1], Stefanie Weck[1], Boris Schnorbus[1], Axel Muttray[3], Murat Sariyar[4], Harald Binder[4], Tommaso Gori[1], Ascan Warnholtz[1], and Thomas Münzel[1]*

Clin Res Cardiol
DOI 10.1007/s00392-014-0751-x

ORIGINAL PAPER

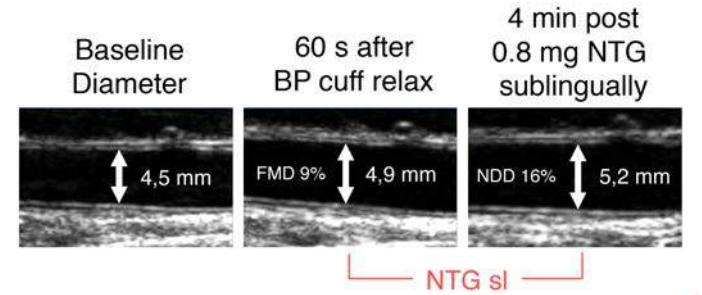
Nighttime aircraft noise impairs endothelial function and increases blood pressure in patients with or at high risk for coronary artery disease

Frank Schmidt · Kristoffer Kolle · Katharina Kreuder · Boris Schnorbus · Philip Wild · Marlene Hechtner · Harald Binder · Tommaso Gori · Thomas Münzel

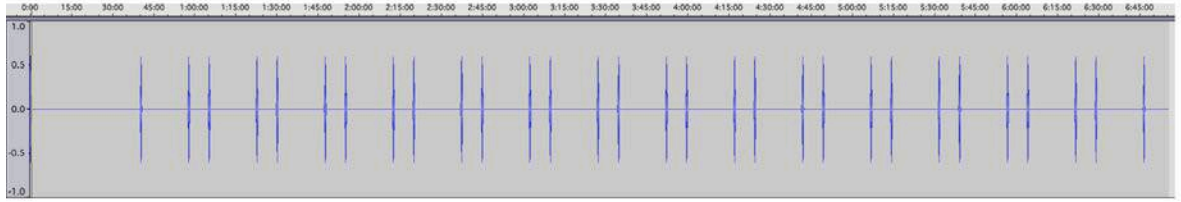
Methodik:

- Feldversuch, MP 3 Player, 60 dBA
- 30 bzw. 60 Überflüge
- Mittlere Schallpegel: 43 u. 46 dBA

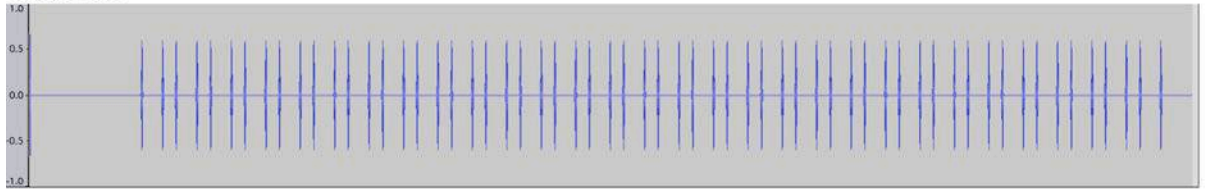
Gefäßschaden



Noise 30

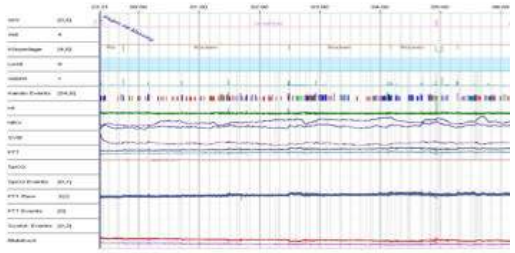


Noise 60



Polygraphie

Somnowatch



MP3 Player

Results:

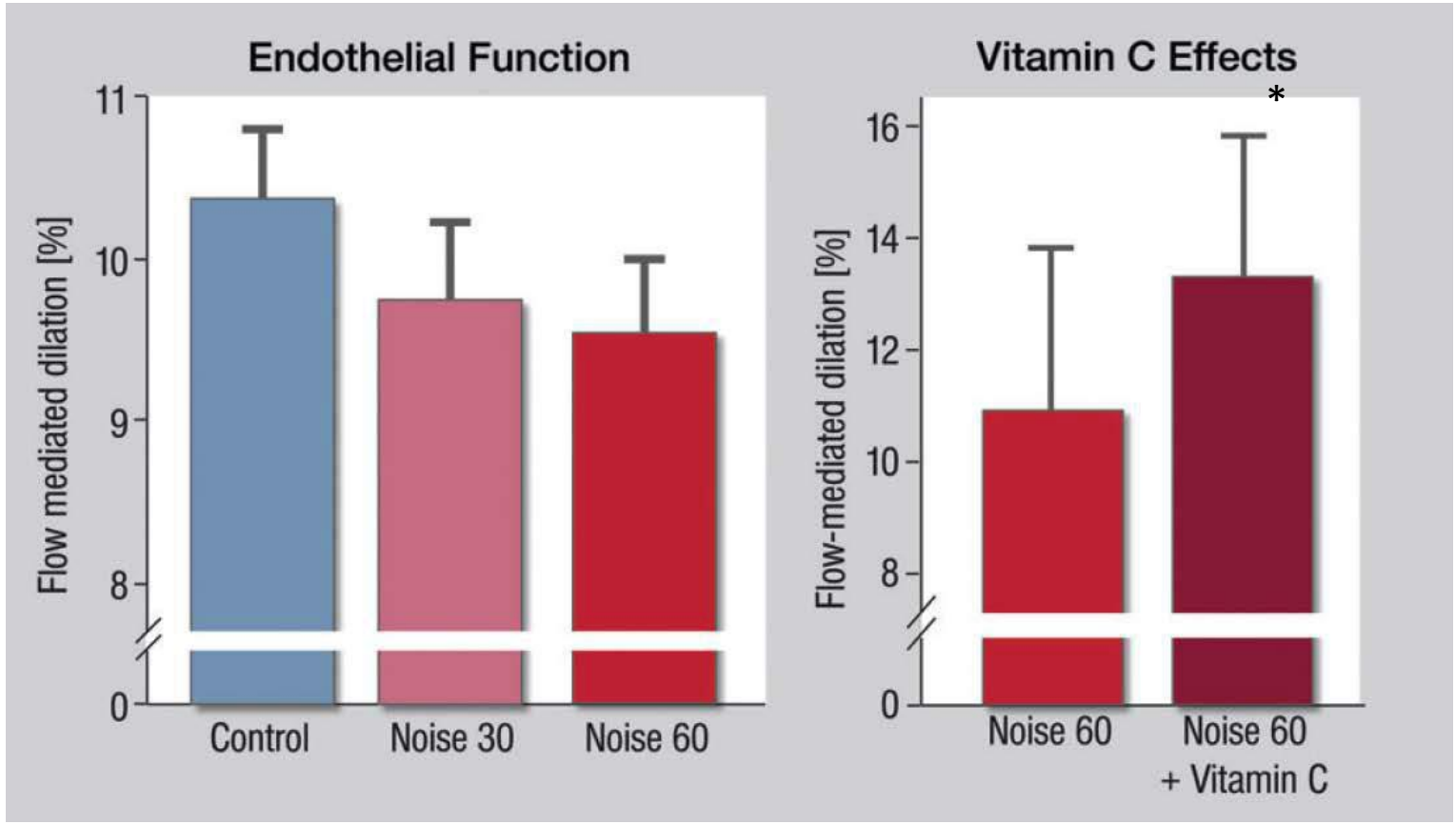
European Heart Journal (2013) 34, 3508–3514
doi:10.1093/eurheartj/eht269

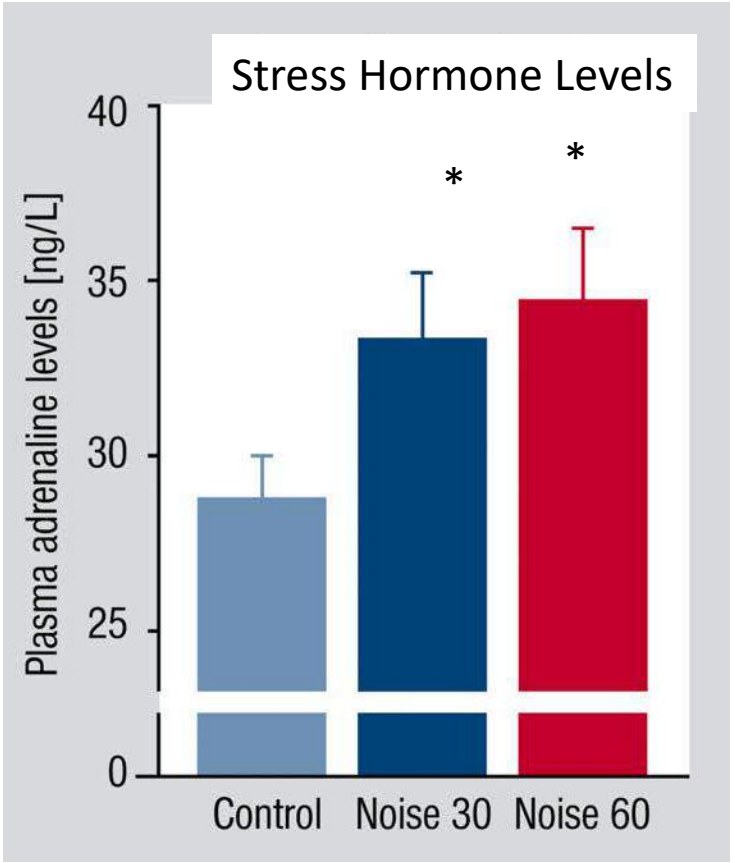
CLINICAL RESEARCH

Effect of nighttime aircraft noise exposure on endothelial function and stress hormone release in healthy adults

Frank P. Schmidt[1], Mathias Basner[2], Gunnar Kröger[1], Stefanie Weck[1], Boris Schnorbus[1], Axel Muttray[3], Murat Sariyar[4], Harald Binder[4], Tommaso Gori[1], Ascan Warnholtz[1], and Thomas Münzel[1]*

Healthy subjects: Medical Students





Zusammenfassung:

- Nachtfluglärm induziert bei Gesunden Gefäßschaden
- Bei Patienten die bereits herzkrank sind noch stärker ausgeprägt
- Vermehrte Freisetzung von Stresshormonen
- Vitamin C verbessert die Gefäßfunktion
- Bei Herzkranken wird der Blutdruck gesteigert
- Keine Korrelation zwischen Ärgerreaktion bzw. Lärmempfindlichkeit und dem Gefäßschaden
- Zunahme der Empfindlichkeit von Gefäßschäden bei mehrfacher Exposition, keine Gewöhnung

Lärmwirkungsforschung

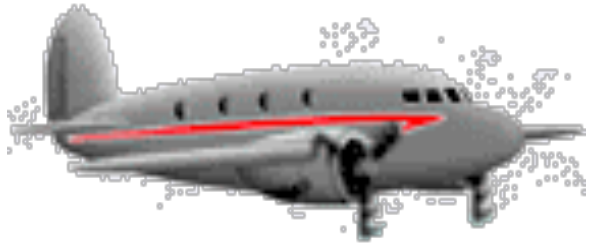
am Tier

European Heart Journal (2017) **00**, 1–12
doi:10.1093/eurheartj/ehx081

BASIC SCIENCE

Effects of noise on vascular function, oxidative stress, and inflammation: mechanistic insight from studies in mice

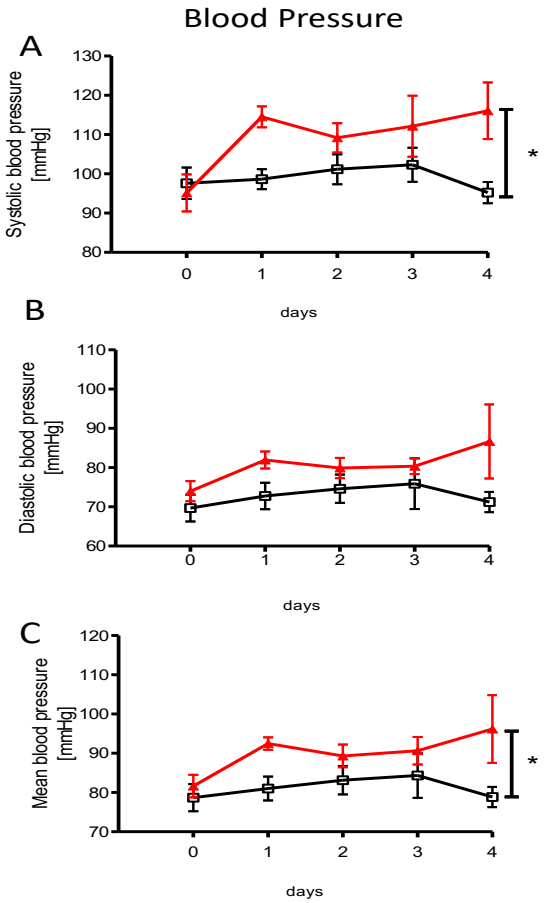
Thomas Münzel[1,2]*, Andreas Daiber[1,2], Sebastian Steven[1], Lan P. Tran[1], Elisabeth Ullmann[1], Sabine Kossmann[1], Frank P. Schmidt[1], Matthias Oelze[1], Ning Xia[3], Huige Li[3], Antonio Pinto[4], Philipp Wild[2,4], Kai Pies[5], Erwin R. Schmidt[6], Steffen Rapp[6], and Swenja Kröller-Schön[1]



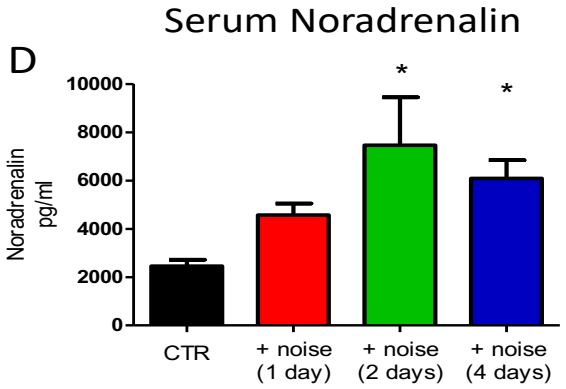
- Fluglärm: 85 dBA, mittlere Schallpegel 72dBA
- 1,2,4 Tage
- Vergleich: identische mittlere Schallpegel, weisser Lärm (White Noise)

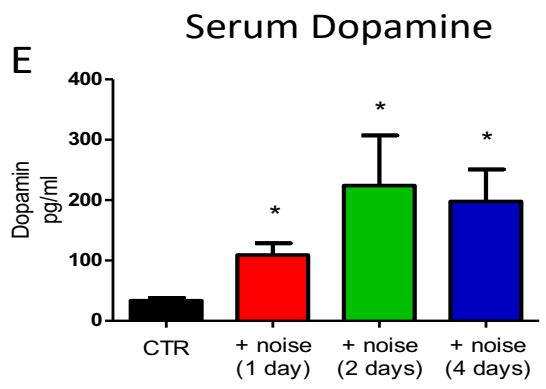
Mehr Stresshormone, hoher Blutdruck vor allem bei Nachtfluglärm

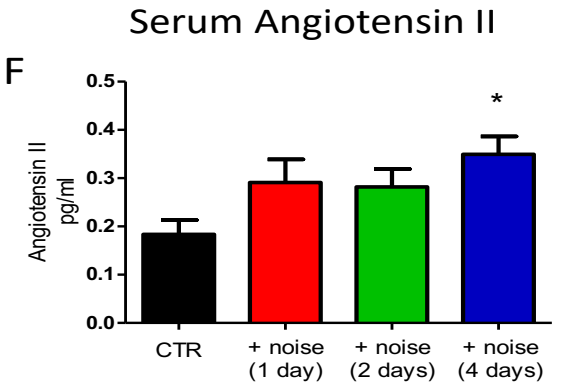
Blutdruck

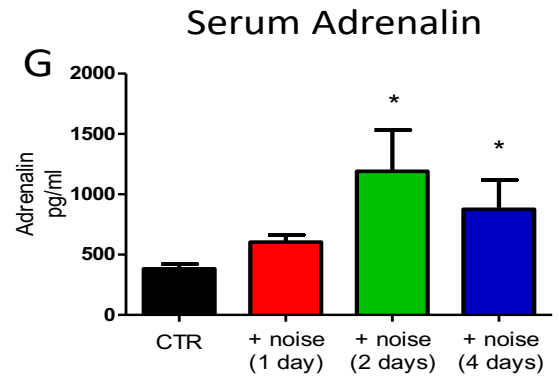


Stresshormone





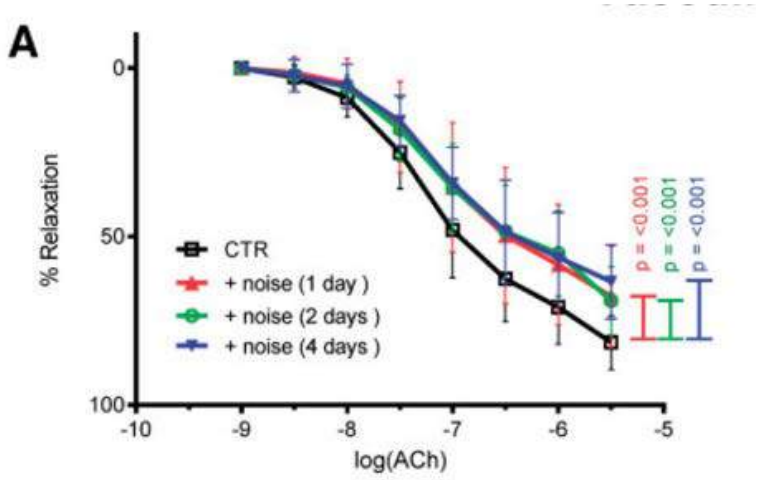


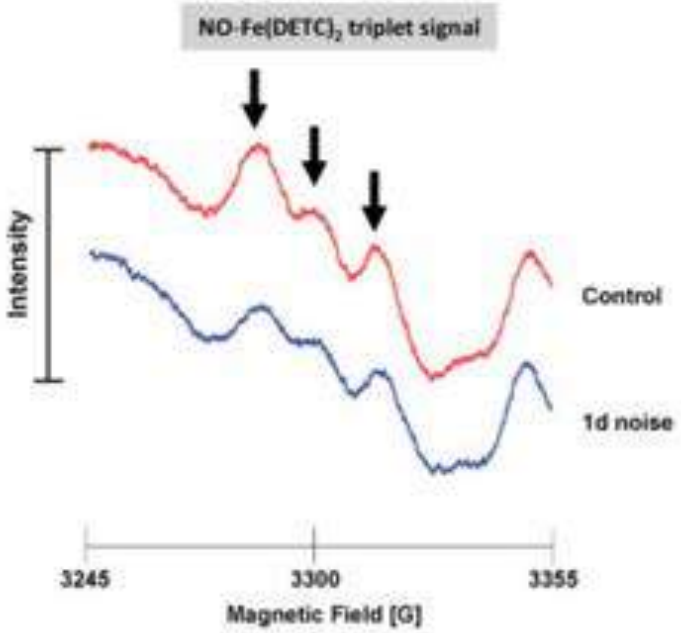


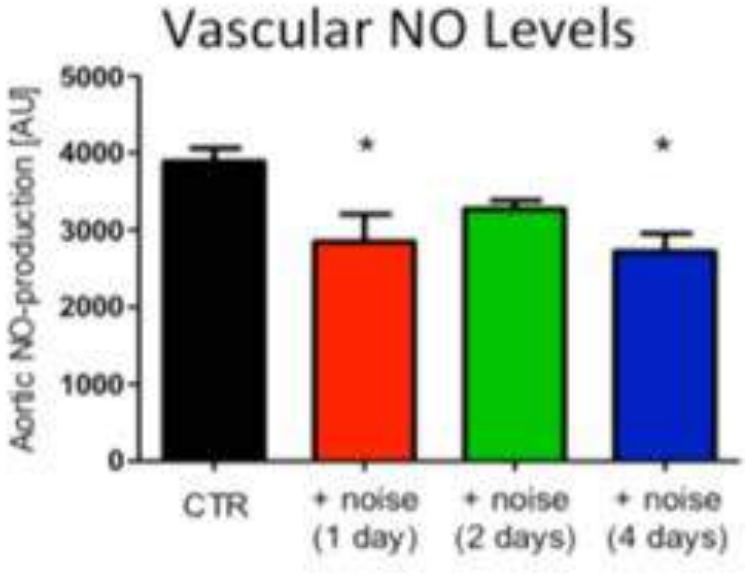
Kurzfristiger Nachtfluglärmlärm induziert Gefäßschaden (Endotheldysfunktion)

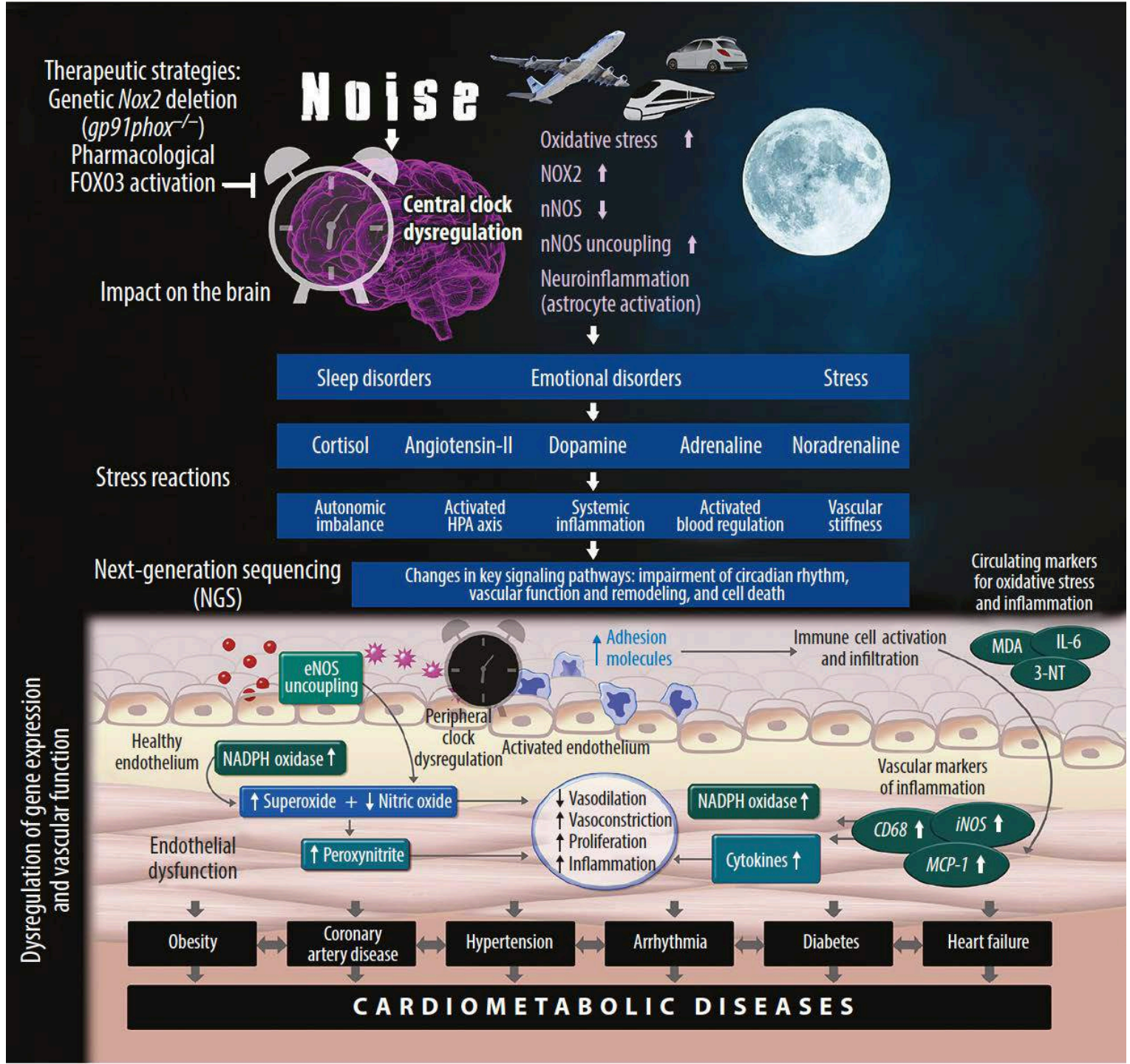
Endotheldysfunktion

Weniger NO








Therapeutic strategies:
Genetic Nox2 deletion
(gp91phox−/−)
Pharmacological
FOXO3 activation
Noise
Central clock
dysregulation
Impact on the brain
Oxidative stress ↑
NOX2 ↑
nNOS ↓
nNOS uncoupling ↑
Neuroinflammation
(astrocyte activation)
Sleep disorders
Emotional disorders
Stress
Stress reactions
Cortisol
Angiotensin-II
Dopamine
Adrenaline
Noradrenaline
Autonomic imbalance
Activated HPA axis
Systemic inflammation
Activated blood regulation
Vascular stiffness
Next-generation sequencing (NGS)
Changes in key signaling pathways: impairment of circadian rhythm, vascular function and remodeling, and cell death
Circulating markers for oxidative stress and inflammation
MDA
IL-6
3-NT
Dysregulation of gene expression and vascular function
Adhesion molecules
Immune cell activation and infiltration
eNOS uncoupling
Peripheral clock dysregulation
Healthy endothelium
NADPH oxidase ↑
Activated endothelium
↑ Superoxide + ↓ Nitric oxide
↓ Vasodilation
↑ Vasoconstriction
↑ Proliferation
↑ Inflammation
NADPH oxidase ↑
Vascular markers of inflammation
CD68 ↑
iNOS ↑
MCP-1 ↑
Endothelial dysfunction
↑ Peroxynitrite
Cytokines ↑
Obesity
Coronary artery disease
Hypertension
Arrhythmia
Diabetes
Heart failure
CARDIOMETABOLIC DISEASES

Fluglärm:

Psychisches Störungen wie **Angststörungen und Depressionen**

Herzryhthmusstörungen

(Vorhofflimmern) als Folge von Lärmbelästigung -> Schlaganfälle

Bedeutung des Schlafs: zu kurzer Schlaf häufig unterbrochener Schlaf

Hochdruck, Herzinfarkt,
Schlaganfall, Herzrhythmusstörungen
Störung der circadianen Rhythmik

World Health Organization
REGIONAL OFFICE FOR Europe

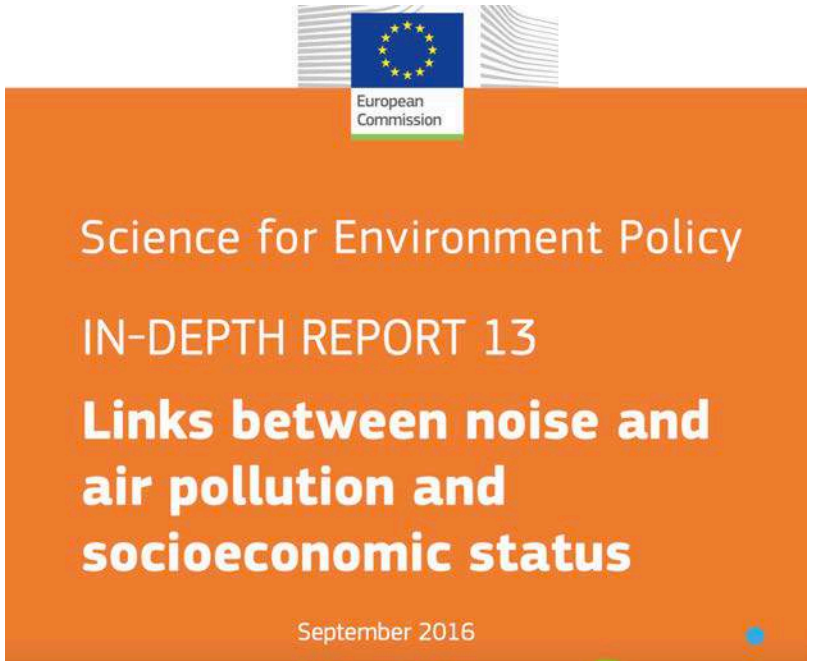
ENVIRONMENTAL NOISE GUIDELINES

for the European Region

Aircraft noise

Recommendation	Strength
For average noise exposure, the GDG strongly recommends reducing noise levels produced by aircraft below **45 dB** L_{den}, as aircraft noise above this level is associated with adverse health effects.	Strong
For night noise exposure, the GDG strongly recommends reducing noise levels produced by aircraft during night time below **40 dB** L_{night}, as night-time aircraft noise above this level is associated with adverse effects on sleep.	Strong
To reduce health effects, the GDG strongly recommends that policy-makers implement suitable measures to reduce noise exposure from aircraft in the population exposed to levels above the guideline values for average and night noise exposure. For specific interventions the GDG recommends implementing suitable changes in infrastructure.	Strong

Noise and Air Pollution have Many of the Same Sources……



Air and noise pollution have many of the same sources, such as heavy industry, aircraft, railways and road vehicles. Research suggests that the social cost of noise and air pollution in the EU — including death and disease — could be nearly €1 trillion. For comparison, the social cost of alcohol in the EU has been estimated to be €50-120 billion and smoking at €544 billion.

Air pollution and noise pollution have negative health impacts on all socioeconomic groups, rich and poor. However, the risks may not be evenly shared; it is often society's poorest who live and work in the most polluted environments. Furthermore, these same people may be more impacted by pollution's damaging effects than more advantaged groups of society.

Partikel aus Turbinen

Flughafenanwohner können mehr Ultrafeinstaub ausgesetzt sein

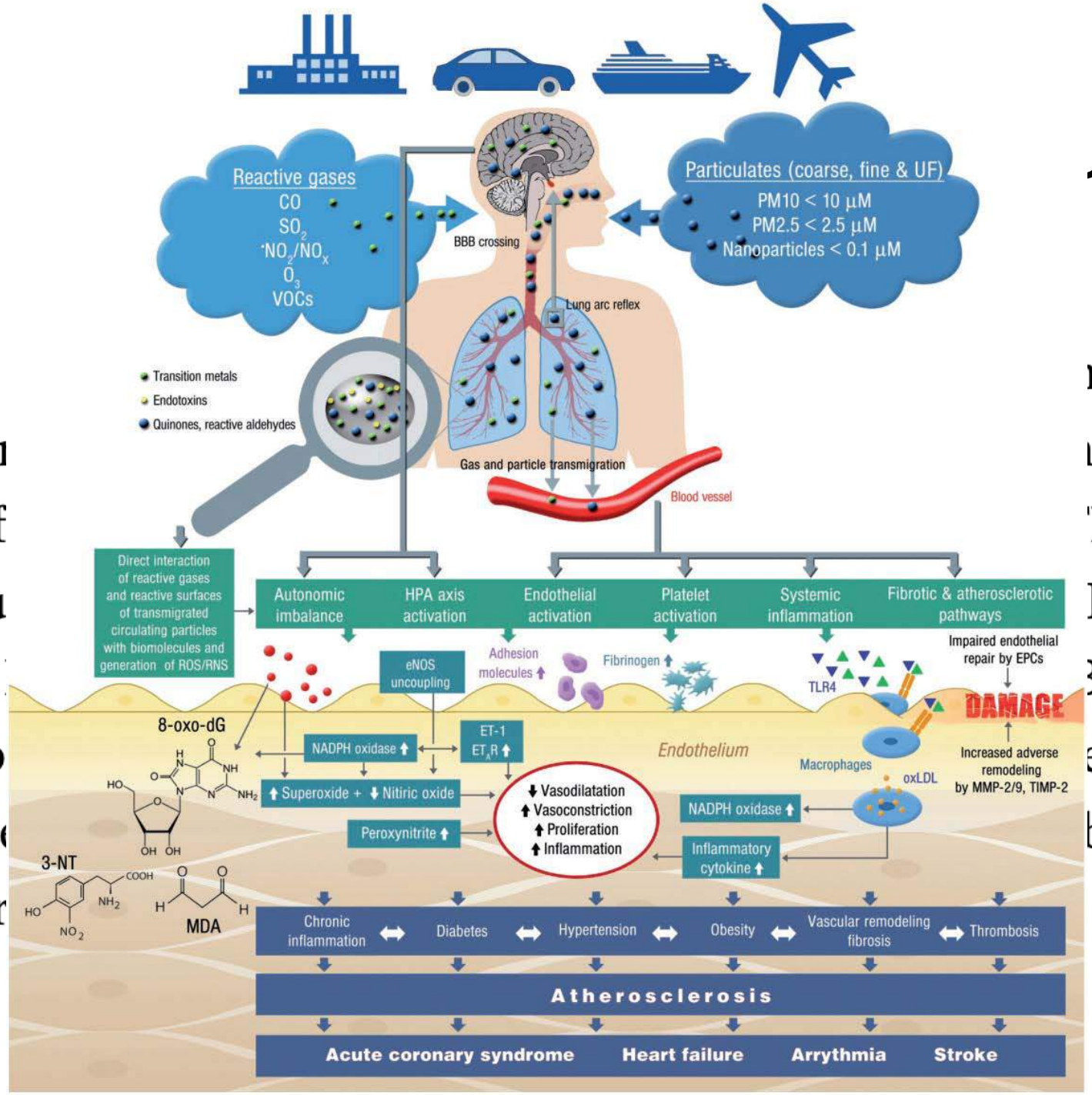
Er kann tief in die Lunge eindringen und sogar ins Blut: Ultrafeinstaub gilt als mögliche Gesundheitsgefahr. Eine Studie zeigt nun, wie sich die Partikel rund um den Flughafen Frankfurt ausbreiten.

12.03.2021, 13.57 Uhr

Frachtmaschine am Flughafen Frankfurt am Main: Fast die Hälfte des Ultrafeinstaubs entsteht am Boden

ıge

Anders ı die Quellen
des Ulti ıstaubs aus
Flughäf 'lugzeuge,
aber nu Landen. Die
andere Boden fahren.
Das Ub en Schleppern
zu zieh bstoffs könne
die Ultr



Pro Tonne Kerosin 15 Kg NOx

Stickoxide (NOx)

Stickoxide (NO_x)

Verbindungen zwischen Stickstoff- und Sauerstoffatomen. NO_x ist definiert als die Summe der NO- und NO_2–Verbindungen.

Natürliche Quellen sind Blitze und Mikroben im Erdboden. Stickoxide entstehen auch bei Verbrennungsprozessen unter hohen Drücken und Temperaturen. Durch die Entwicklung sparsamerer Triebwerke wurden diese Parameter erhöht, so dass steigende Stickoxidemissionen den geringerem Treibstoffverbrauch und den geringeren Emissionen an Kohlenmonoxid und Unverbrannten Kohlenwasserstoffen entgegen stehen. Durch neuartige Brennkammern könnten aber auch die NOx-Emissionen in Zukunft um bis zu 85 Prozent verringert werden. Lufthansa Flugzeuge verursachen je Tonne Kerosin durchschnittlich 15,0 Kilogramm NO_x.

Flughafen Glossar von A-Z

Spezialausdrücke und Fachterminologie der Flughäfen

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Abkürzungen

Abk.	Bedeutung
ABl	Amtsblatt
ACI	Airports Council International

Konsequenzen der Lärmwirkungsforschung

- **Absolutes Verbot von Flugbewegungen zwischen 22 Uhr und 6 Uhr morgens**
- **Implementierung von aktiven Schallschutzmaßnahmen (Flugzeug)**
  - **CDA**
  - **Höher fliegen Steiler landen**
  - **GPS gesteuert bevölkerungsarme Gebiete überfliegen**
- **Schutz von lärmempfindlichen Menschengruppen:**
  - **Kinder (Kitas)**
  - **Kranke (Krankenhäuser)**
  - **Senioren (heime)**
- **Keine Kurzstreckenflüge mehr in Europa**
- **Besteuerung des Kerosins und des CO2 Ausstoßes**

Anerkennung von Lärm als Herzkreislauf-risikofaktor

Vielen Dank