

# Health Impacts of Aircraft Noise Exposure

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Horizon 2020

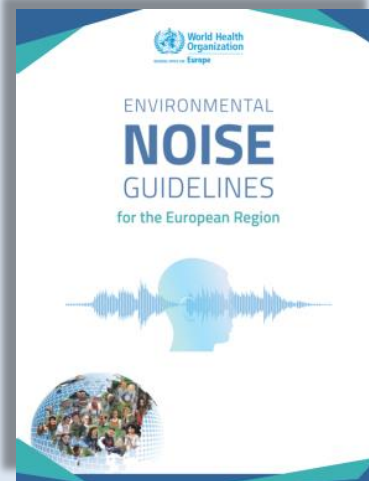
# WHO Environmental Noise Guidelines For The European Region (2018)



## 'Critical' health outcomes

- Annoyance
- Sleep disturbance
- Cardiovascular diseases
- Cognitive impairment
- Hearing impairment

& tinnitus



## 'Important' health outcomes

- Diabetes and metabolic diseases
- Adverse birth outcomes
- Quality of life, well-being

Relevance criteria:

(1) Seriousness (2) Prevalence (3) Availability of evidence



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Horizon 2020

# Aim of task

- Update the WHO evidence for the impact of aviation noise on health outcomes supplement it with findings since the cut off for the WHO reviews (around 2014)

# Noise and health

## Auditory effects

- hearing impairment



## Non-auditory effects

- stress-related effects  
outside the hearing system



M. Basner, W. Babisch, A. Davis, M. Brink,  
C. Clark, S. Janssen, S. Stansfeld: Auditory and non-auditory effects of noise on health.  
The Lancet 383 (2014) 1325–1332.

# Noise and health

## Stress

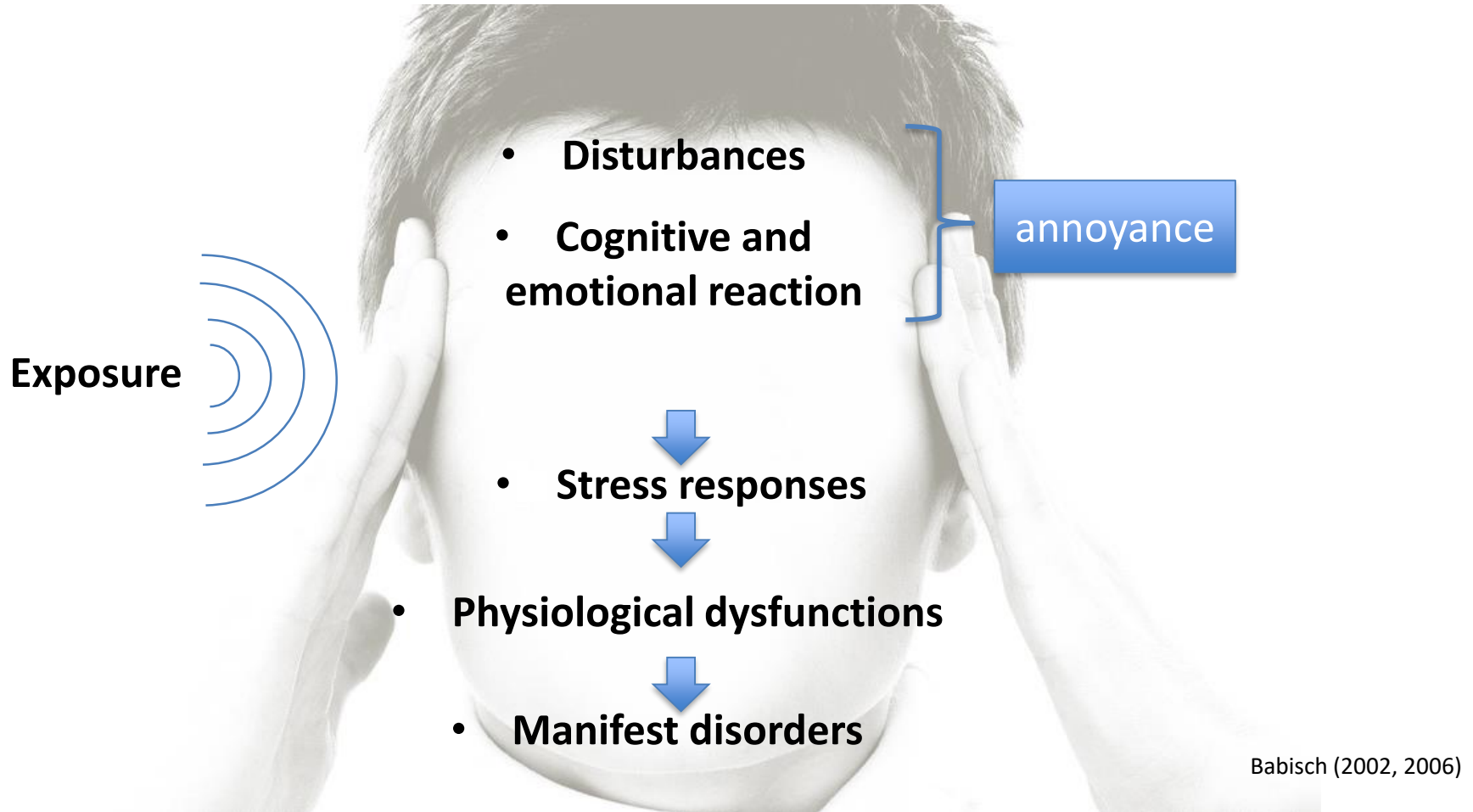
Conditions (like long-term exposure to sound) where an

- Environmental demand exceeds
- the natural regulatory capacity of an organism,
- in particular situations that include unpredictability and uncontrollability.



Koolhaas et al., 2011

# Model of the impact of environmental noise



# Procedure for update of reviews in ANIMA

## Literature Search for Studies

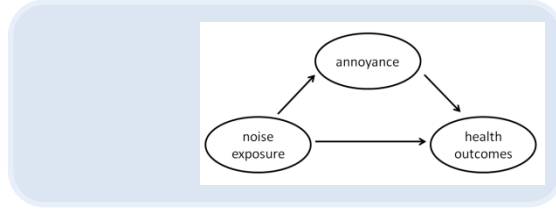
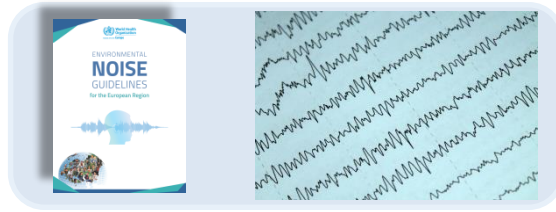
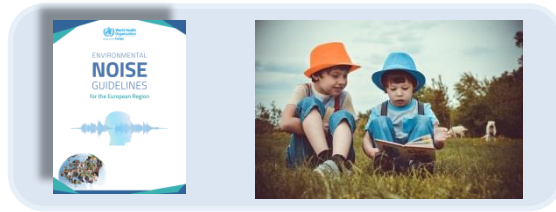
- Scientific data base: ScienceDirect, PsychIndex/PsychInfo, Ebsco, Web of Science, etc.
- Search terms: „environmental noise“/“transportation noise“/“aviation noise“ AND „health outcomes“
- Inclusion/exclusion criteria for selection of studies

# Procedure for update of reviews in ANIMA

- Inclusion/exclusion criteria:
  1. **Noise exposure measures**, calculated or noise mapping
  2. Noise source: **aviation**, or noise from airports, no combined traffic noise exposure
  3. **Health outcomes**: cardiovascular diseases, adverse effects of the metabolic system, sleep architecture/sleep quality/sleep disturbance, cognitive impairment or mental health/quality of life/wellbeing
  4. **Analysis of the relationship** between health outcomes and aircraft noise exposure
  5. **Published after deadline** of previous systematic reviews for WHO, after 2014/2015



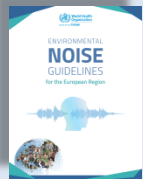
# Results



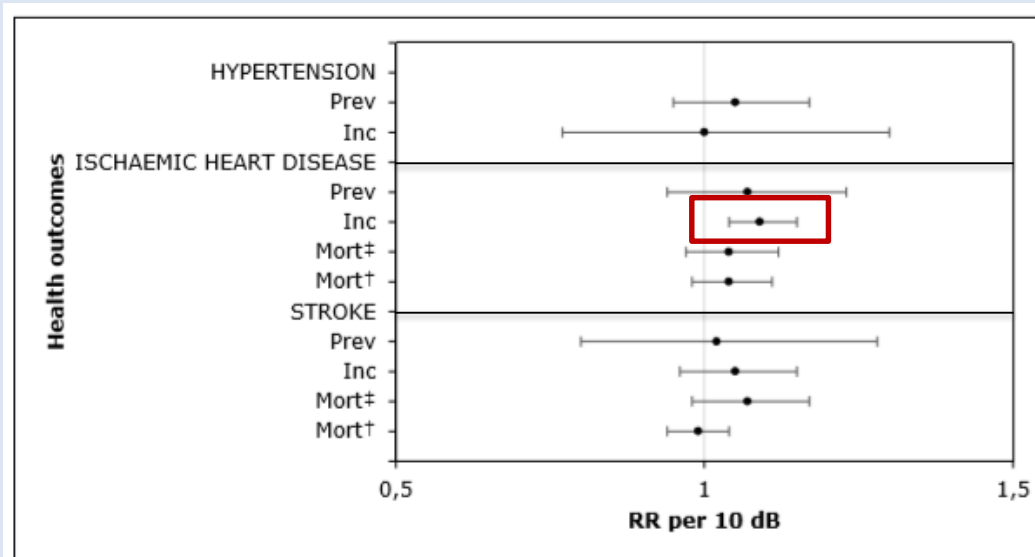
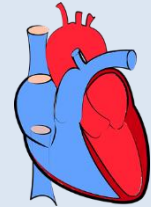
Focus on ,critical‘ outcomes  
(according to WHO)

For more information on the results of  
other impacts see the ANIMA report  
(Hudson et al., 2019)

# Results: Cardiovascular diseases



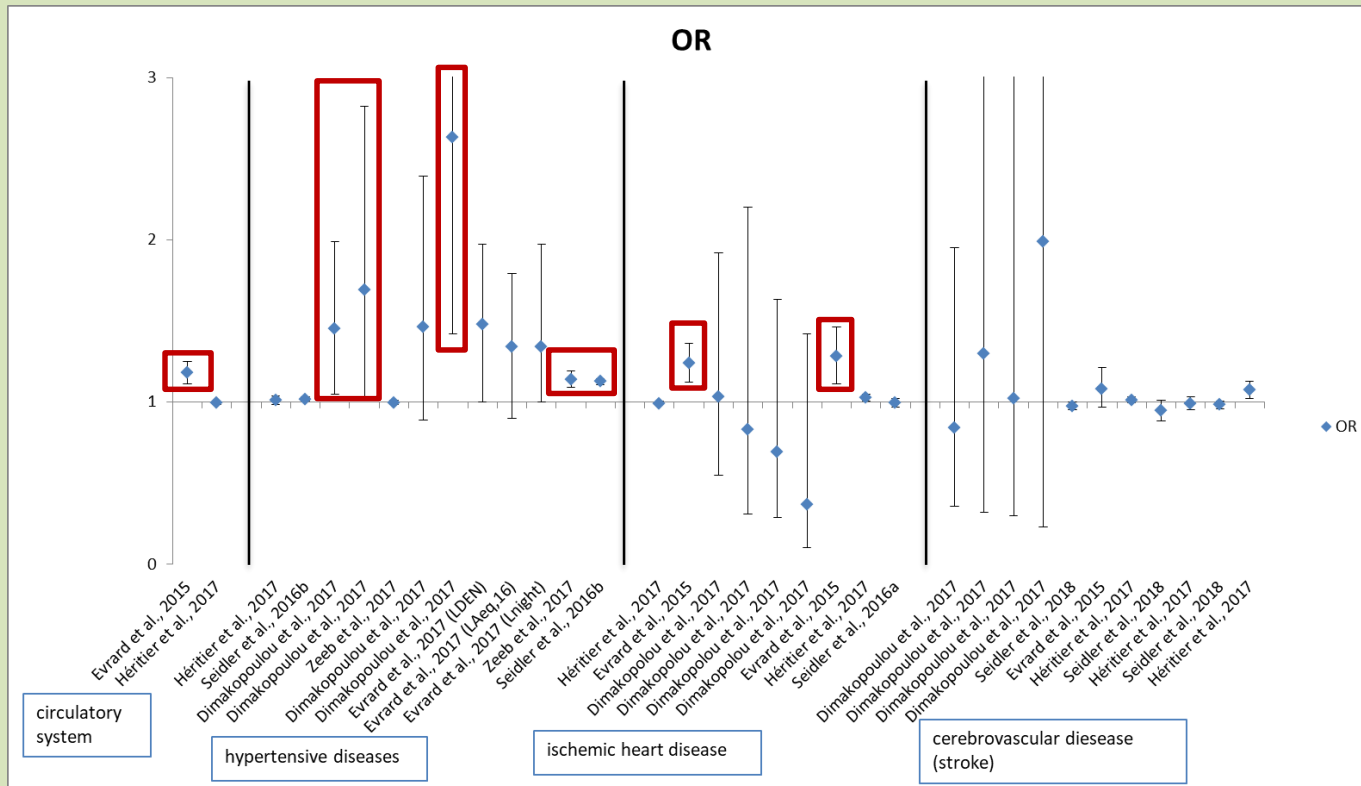
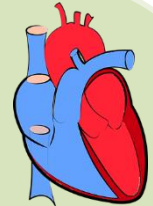
WHO: only significant associations between aircraft noise exposure and ischemic heart diseases (IHD)



Prev – prevalence; Inc – incidence; Mort – mortality; ± – from ecological study; † – from cohort study

Figure 2: Pooled exposure-effect estimates of aircraft noise exposure on cardiovascular diseases from van Kempen et al., (2017, 2018)

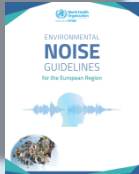
# Results: Cardiovascular diseases



Exposure to aircraft noise and the assessed risk for cardiovascular diseases from epidemiological studies (in Hudson et al., 2018)



# Results: Cognition



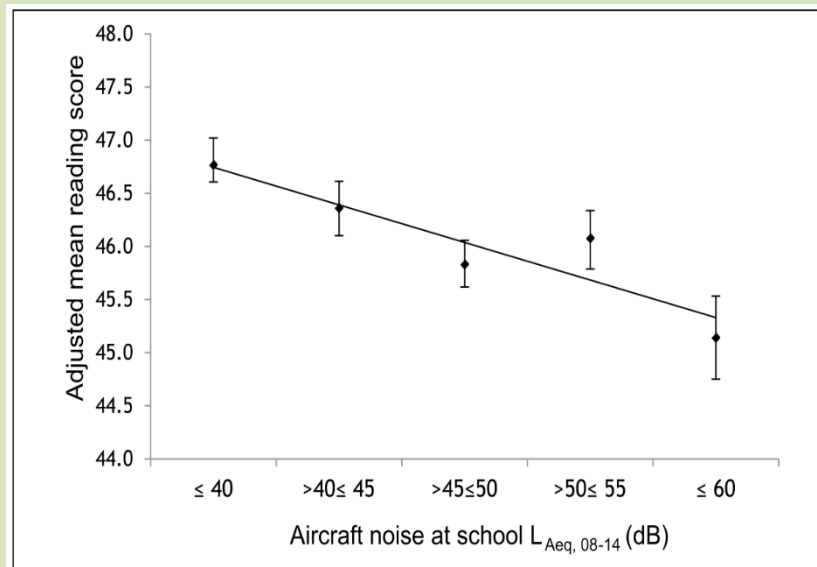
WHO: negative implications on memory functions, attention reading and oral comprehension (Clark & Paunovic, 2018)



# Results: Cognition

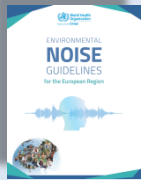


- A delay in reading and oral comprehension was associated with aircraft noise (Klatte et al., 2016)

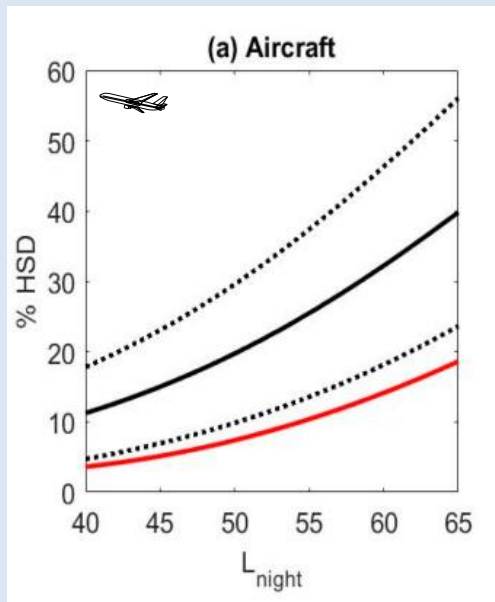


n = 1,209 children (7-9 yrs) from 29 primary schools in Rhine-Main region around Frankfurt airport

# Results: Sleep



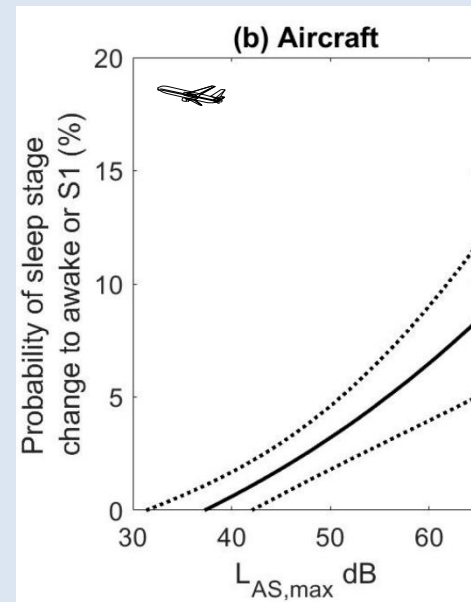
## Exposure-response functions for noise impact on sleep



%HSD – reported sleep disturbances

Black curve: Basner & McGuire (2017), WHO review

Red curve: Miedema & Vos (2007), EU re-analysis



p (additional awakenings)

Basner & McGuire (2017)

# Results: Sleep



Sleep measures	Study	Effect	
<b>(self) reported sleep measures</b>	Basner et al., 2017	+	Poorer sleep quality
	Douglas et al., 2016	+	Highest sleep disturbance compared to other noise sources
	Hiroe et al., 2017	+	$L_{Aeq, night}$ and associated with insomnia
	Holt et al., 2015	-	
	Janssen et al., 2014	-	
	Kim et al., 2014	+	Prevalence in sleep disturbance higher with higher noise levels
	Kwak et al., 2016	+	Higher insomnia severity and sleepiness in exposure group
	Müller et al., 2016	+	Poorer sleep quality
	Nassur et al., 2017	+	Shorter sleep time with increasing $L_{DEN}$
	Nguyen et al., 2017	-	
	Rösli et al., 2017	+	Higher intermittency ratio associated with sleep disturbances
	Schreckenberg et al., 2016	+	Sleep disturbances reduced after night curfew
<b>Physiological measures of sleep</b> (polysomnography and actimetry)	Basner et al., 2017	-	No significant difference for sleep fragmentation index.
	Janssen et al., 2014	+	Higher sound pressure levels with more body movements
	Müller et al., 2016, Müller et al., 2017	+	Night flight ban an decreased number of awakenings (Müller et al., 2016), less sleep (Müller et al., 2017)

## Interim results

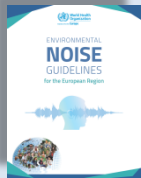
- Guideline exposure levels = Noise exposure levels above which the GDG is confident that there is an increased risk of adverse health effects

Health outcome	Relevant risk increase	Aircraft	
		Lden	Lnight
IHD (incidence)	5% rel. risk increase	52.6	--
hypertension (incid.)	10% rel. risk increase	--	--
% HSD	3 % absolute risk		40
% HA	10% absolute risk	45.4	--
Perm. hearing impairment	No risk increase	--	--
Reading/oral comprehension	1 months delay	55	--
<b>Guideline exposure level (rounded)</b>		<b>45</b>	<b>40</b>
Recommendation		strong	

- Regulation: Noise – impact relation
- Managing: process of genesis/development of diseases in order to derive potentially influencing factors to design reasonable interventions
- Annoyance and sleep disturbances discussed as potential mediators for the effect of noise exposure on health outcomes

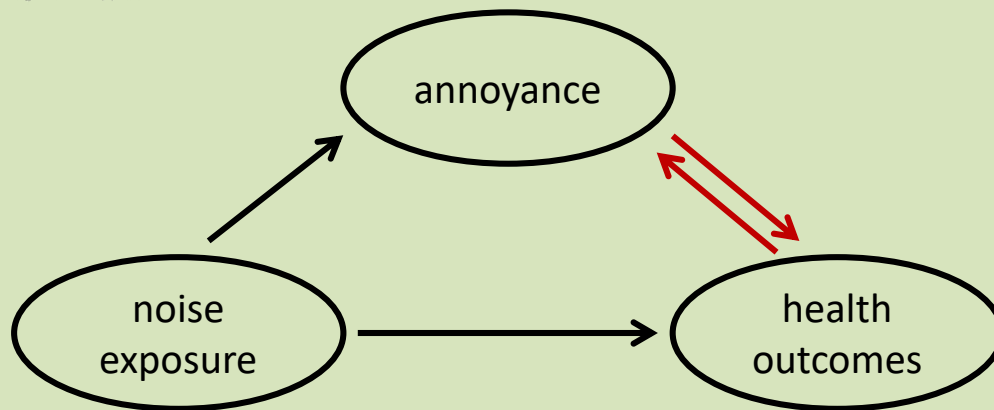
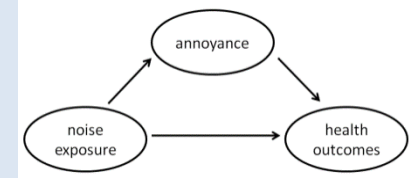


# Results: link annoyance and health outcomes



WHO: no review, but:

Highlight it as potential mediator of other long-term health impacts



- Cardiovascular diseases (Eriksson et al., 2010; Babisch et al., 2013)
- Sleep (Bartels, 2014; van den Berg et al., 2014)
- Mental health (Schreckenberget al., 2017; Baudin et al., 2018)
- Physical activity (Foraster et al., 2016)

# Conclusion of the ANIMA health review

- More evidence for the effect of aviation noise exposure on cardiovascular disease, reading and oral comprehension and sleep measures
- Indications of this reviews are not exhaustive
- But: More evidence for hypothesis that annoyance has a mediating function for the relationship between aviation noise exposure and health outcomes

# Implications

- In order to optimise efforts to mitigate health risks, airports and other stakeholders should focus on annoyance and sleep outcomes in addition to conventional attempts to reduce noise exposure.
- Addressing annoyance and sleep disturbances is expected to lead to a **reduction** in other health outcomes.
- Management measures and interventions should be **evaluated** regarding the impact of noise rather than just focusing on a dB reduction.

## Thanks for your attention!

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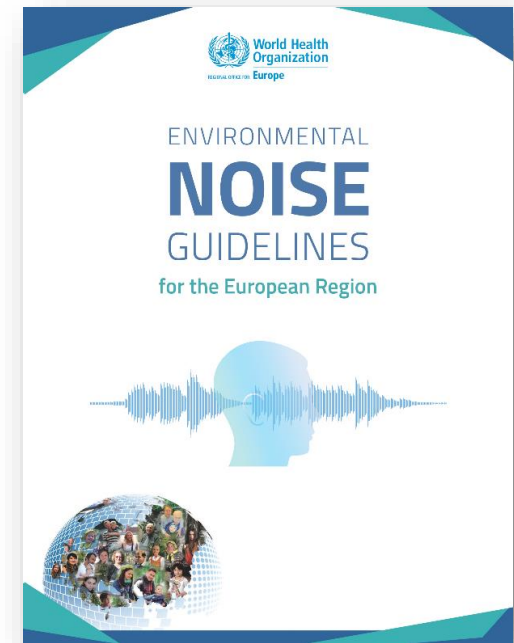
Phone: +49 2331 - 47 84 960

## Backup

# Health impacts according to WHO Environmental Noise Guidelines

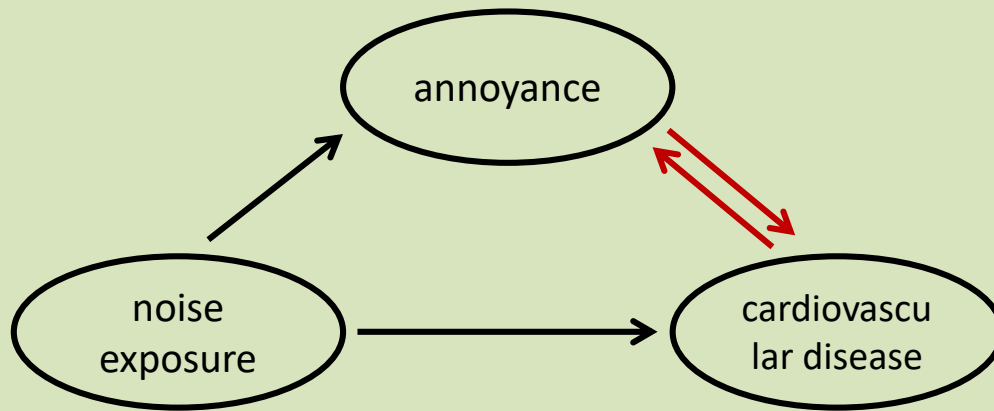
## 'Critical' health outcomes

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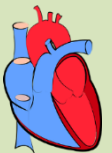


Health outcome	IHD	% HSD	% HA	Reading/oral comprehension	ENG exposure level
Relevant risk increase	5% rel. risk increase	3 % absolute risk	10% absolute risk	1 months delay	
$L_{den}$	52.6		45.4	55	45
$L_{night}$	--	40	--	--	40

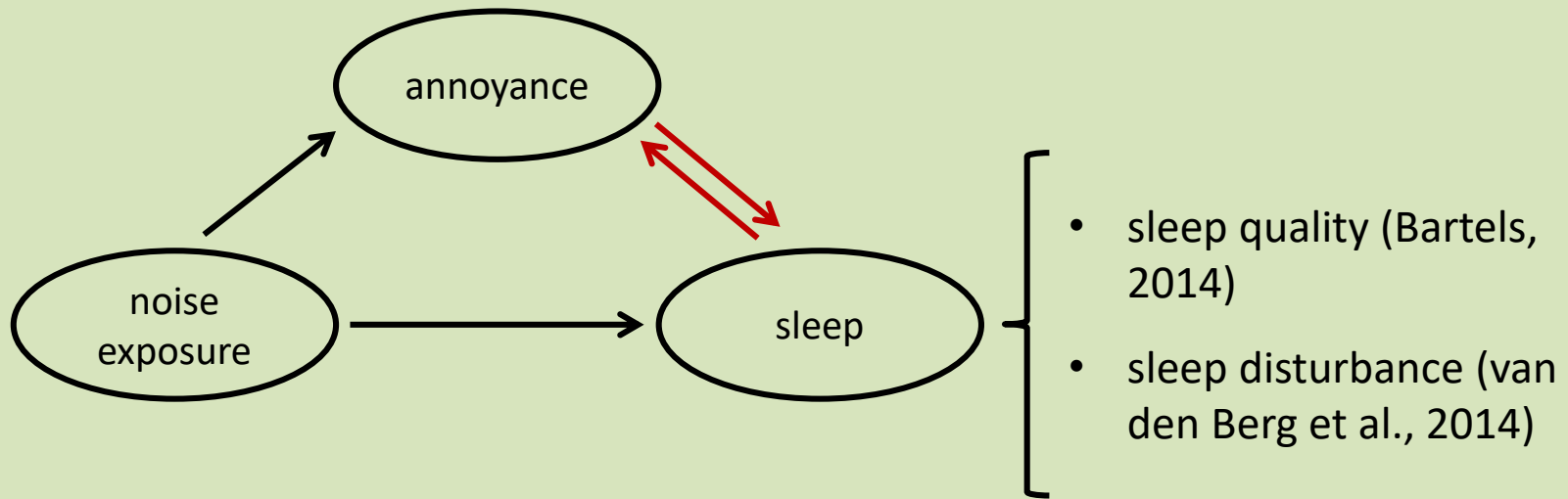
# Results: Annoyance and cardiovascular disease



- higher risk for hypertension for participants reporting annoyance (Eriksson et al., 2010)
- Effect of noise levels on hypertension only in those reporting higher annoyance (Babisch et al., 2013)

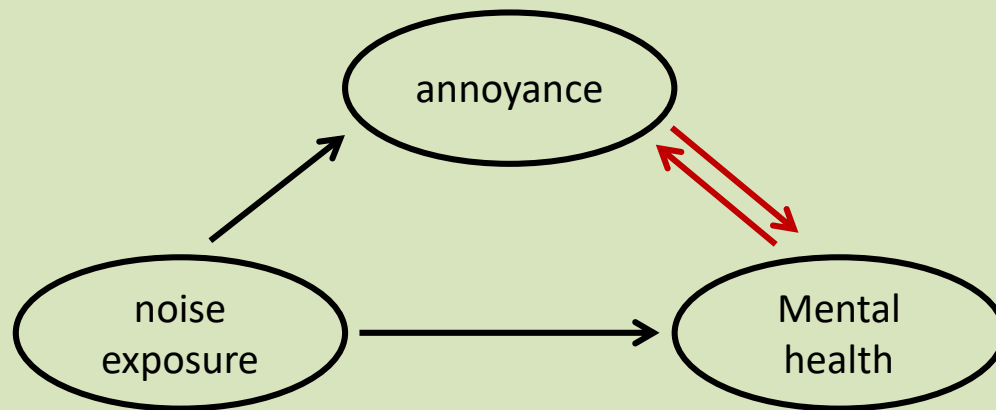


# Results: Annoyance and sleep measures

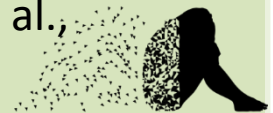




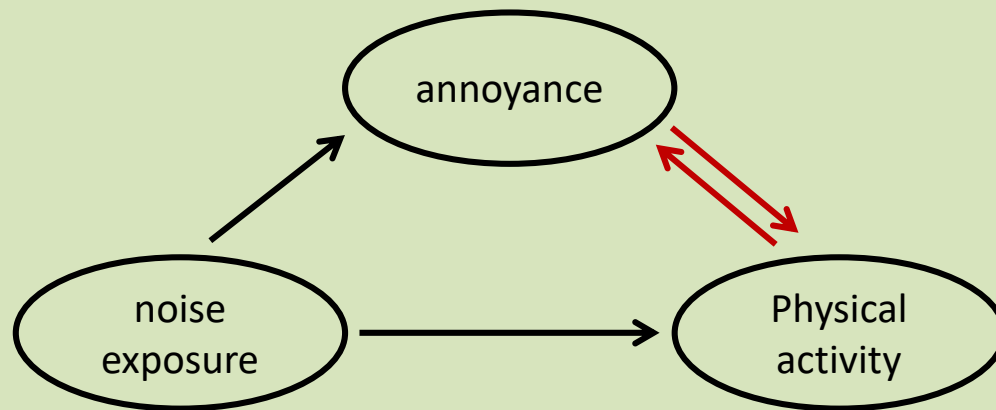
# Results: Annoyance and quality of life/mental health



- Mental-health related quality of life (Schreckenberget al., 2017)
- Psychological distress (Baudin et al., 2018)



# Results: Annoyance and physical activity



- Negative association of annoyance and physical activity (Foraster et al., 2016)

