Noise, health and effects in children

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#EUGREENWEEK

Environmental Noise – a public health issue

Environmental noise is prevalent and ubiquitous

The most prevalent noise sources are road > rail > aircraft

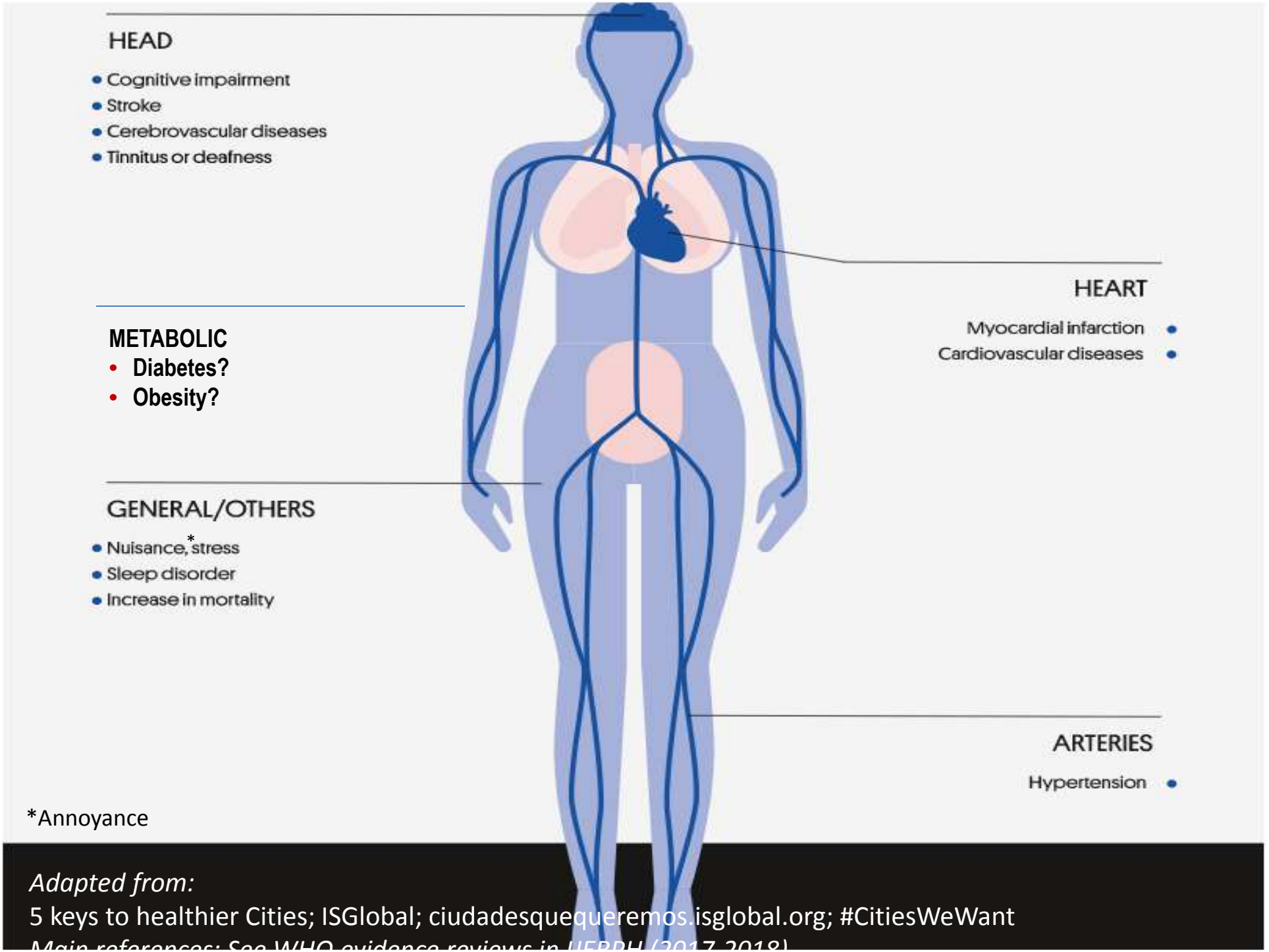
Road traffic noise is the 2nd most harmful environmental stressor in EU just after air pollution *(Hänninen et al 2014)*

- Substantial burden of disease in the EU and as important as air pollution in Barcelona *(see next presentations)*

Health effects of noise

- **Auditory: hearing impairment, tinnitus**
  - → At high noise levels

- **Non-auditory**
  - → At regular environmental noise levels



*Annoyance

Adapted from:
5 keys to healthier Cities; ISGlobal; ciudadesquequeremos.isglobal.org; #CitiesWeWant
Main references: See WHO evidence reviews in UERRH (2017-2018)

Health effects of noise

- **Auditory: hearing impairment, tinnitus**
- **Non-auditory**

Hypothesized biological mechanisms

Repeated noise exposure (chronic effect)

Perceived stress - Annoyance (PSYCHOLOGICAL)

Behaviour/ lifestyle change

Non-perceived stress (PHYSIOLOGICAL)

SLEEP ALTERATION

Hormonal alteration

Autonomous nervous system (↑BP, heart rate)

Potentially also (under research): oxidative stress, inflammation, immune response

Ischeamic heart disease
Hypertension, stroke

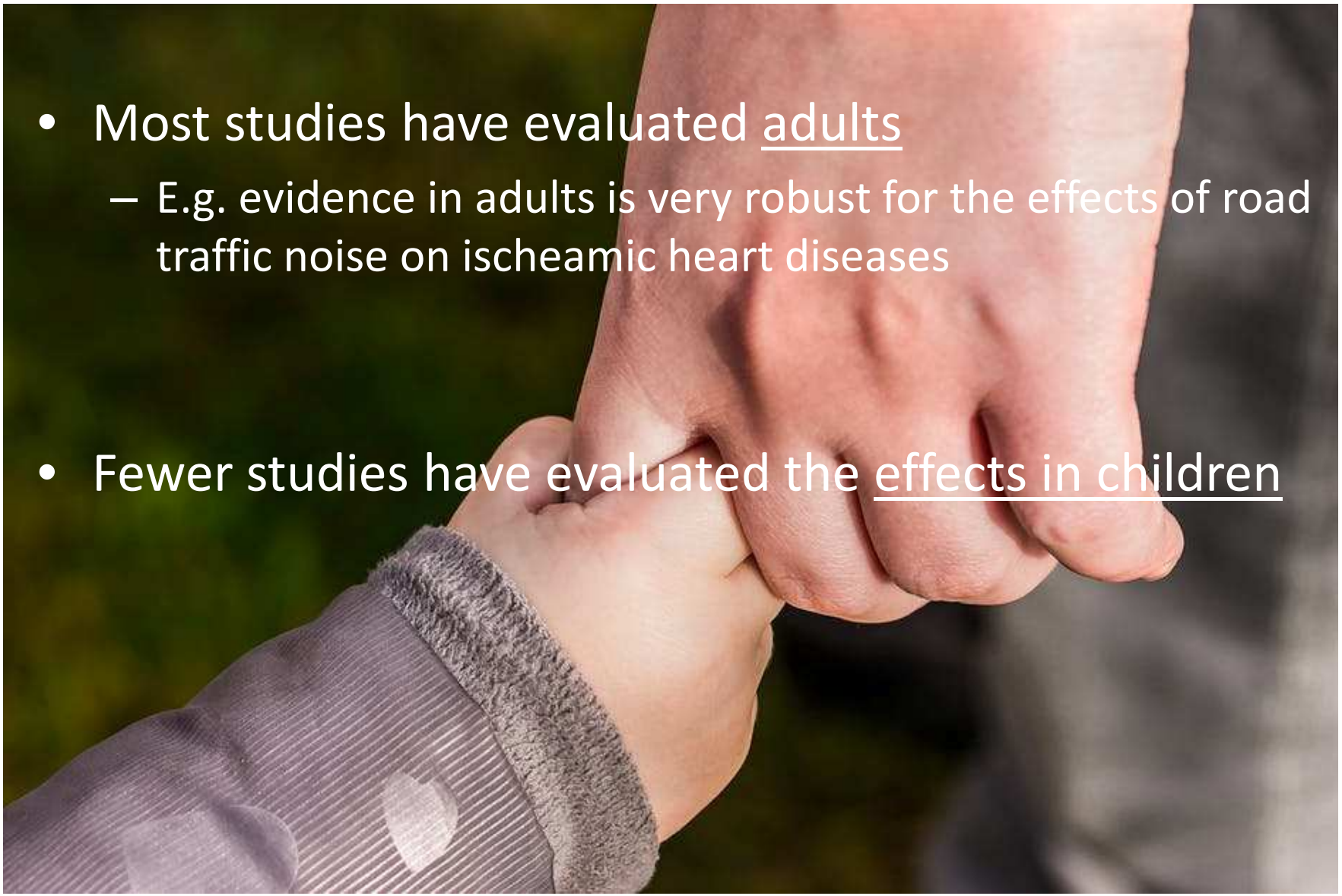
Diabetes (?)
Obesity (?)

Cognitive impairment
Depression (?)

Quality of life

Adapted from McEwen, 2006 & Münzel et al 2016 & Recio et al 2016

Studied groups



- Most studies have evaluated adults
  - E.g. evidence in adults is very robust for the effects of road traffic noise on ischeamic heart diseases
- Fewer studies have evaluated the effects in children

Noise and health in children

- Vulnerable period: early environmental stressors may impact children's correct cognitive, behavioural and overall physiological development → predict adult impaired health
- Vulnerability of children to noise is recognized in reviews *(e.g. Clark and Stansfeld, Berry, Davies, van Kamp, WHO, etc).*
- But there are few studies & small scale
- Mostly focused on aircraft noise

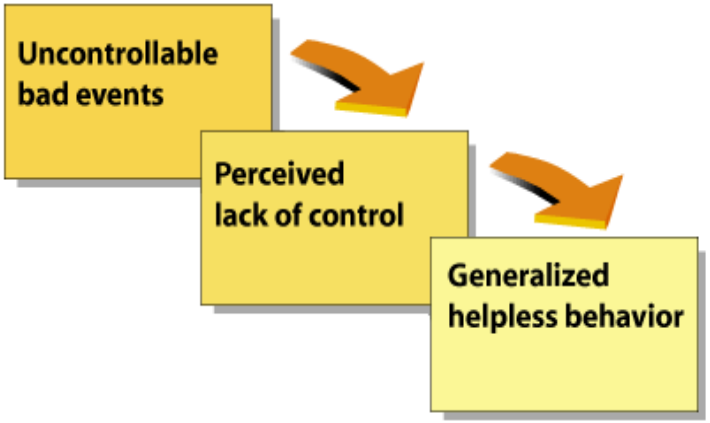
Noise and cardiovascular health in children

- Exposure to aircraft noise related to higher blood pressure and heart rate in schoolchildren (RANCH).
- However studies show inconsistencies in methods and results
- Mechanisms: stress-related, particularly during sleep
- Cardiovascular effects during sleep + pronounced in children.
- Elevated blood pressure during childhood: predictor of HYPERTENSION in later life

Cognitive effects

- Impaired cognitive development: it might represent one of the main health effects of noise in children (Stansfeld et al, 2005).

- **Suggested mechanisms**
  - Learned helplesness
    - Children → less coping skills
  - Disturbed sleep (at home)



Other mechanisms?

- Inattention
- Impaired development of basic language functions
- Impaired development of memory
- Functional and structural brain changes?

Ref.: Klatte et al. 2013, Stansfeld & Clark 2015; van Kamp I, Foraster M, seminars

Cognitive effects

Four main recent studies which meet basic methodological quality criteria and comparable measures:

- NORAH (Frankfurt Airport) study (Klatte et al. 2016) To be published soon in broad lines like RANCH.
- RANCH study (Stansfeld et al, 2005), as follow up of West London School study) Air- and Road-traffic: Impaired reading comprehension and recognition memory, after taking a range of socioeconomic and confounding factors into account) – Airtraffic.
- Munich Airport study (Evans, Hygge & Bullinger, 1995; Evans, Bullinger & Hygge, 1998; Hygge, Evans & Bullinger, 2002) Memory deficits and reading comprehension.
- Tyrol Study (Lercher, 2006) predominantly road and rail sources Effect on intentional and incidental memory (effects smaller than those found around airports).

Exposure-Response relationships

RANCH Study

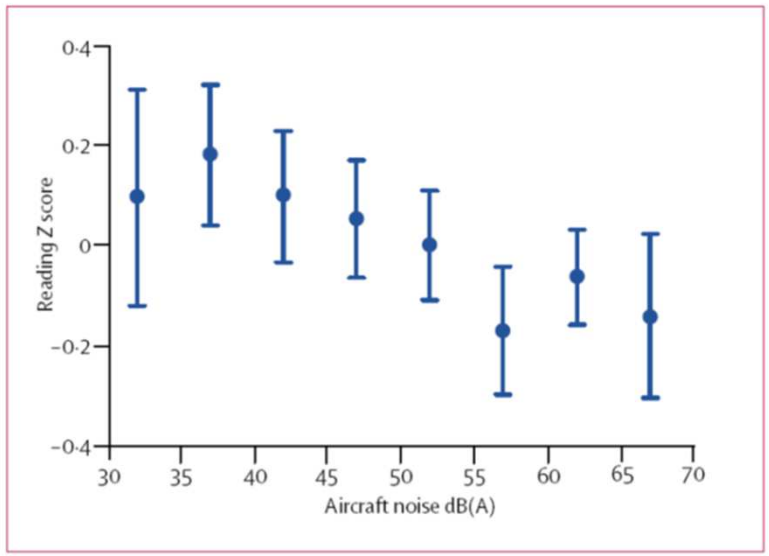
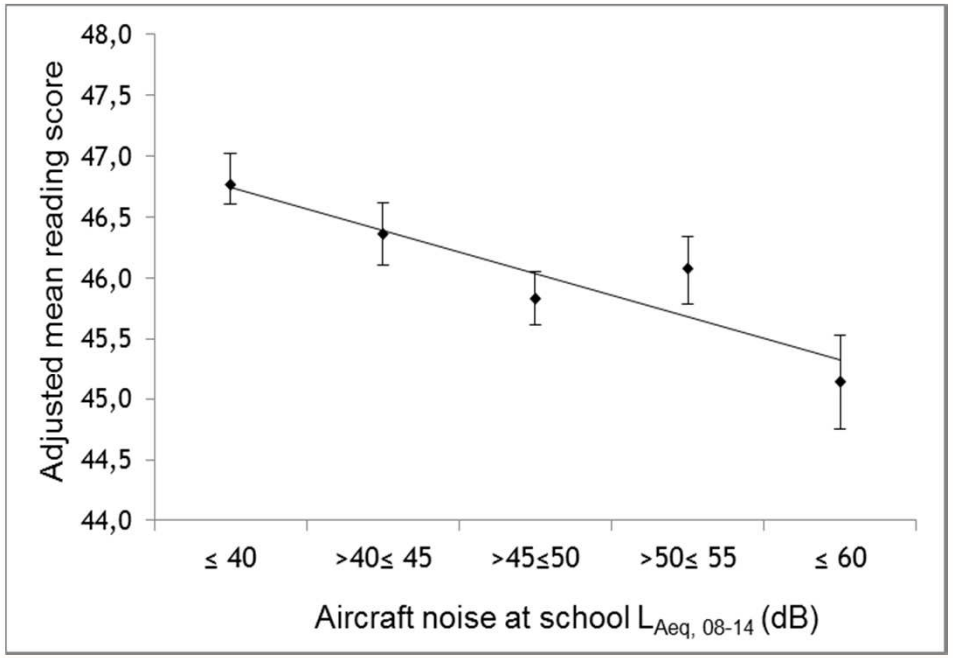


Figure 1: Adjusted mean reading Z score (95% CI) for 5 dB bands of aircraft noise (adjusted for age, sex, and country)

Stansfeld et al., 2005, The Lancet; 365: 1942-1949.

NORAH Study



Klatte et al., 2016, Environment & Behavior

- In both studies a linear association between noise and worse reding comprehension after adjustment for a whole range of confounders.
- A 20 dB increase of aircraft noise at school >>> decrease in reading skills of 1/5 of the standard deviation

Noise and health in children

- In summary, regarding cognition:

Strongest evidence:

  - Reading comprehension
  - Lower academical attainment

- More research needed
  - Involved cognitive areas: e.g. working memory
  - Behavioural reactions, e.g. hyperactivity symptoms

Noise and children's health in Barcelona

(BREATHE Project – ERC funded, PI J Sunyer)

N= 2715, 7-10 y; 39 schools, selected by NO_2 range, paired: socioeconomics

Measured outcomes:

Cognitive development: 4 times in 12 months, at schools (n=10'112)

- Working memory (2-back numbers detectability)
- Superior working memory (3-back numbers detectability)
- Inattentiveness (hit reaction time standard error)

Behaviour: ADHD symptomatology, total difficulties score (SDQ) (questions)

Other data: socioeconomics, lifestyles, age, sex, health, about classroom window types, orientation, measurement height.

BREATHE Brain Air School investigation

erc European Research Council

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Air pollution and noise measurements

2 campaigns, 6 mo. apart

<u>Noise (LAeq; SC160 CESVA device)</u>

- 2 days (30 min), < 9 am
- 1st campaign only indoors*
- 2nd campaign: in/out simultaneously
- Street measurement: 20-30 min
  (r=0.86 with BCN noise map)

<u>Air pollution</u>

1 week, in/out simultaneouly

- 24h: UFP (DiscMini), NO2 (Gradko passive samplers)
- 8h: PM2.5 , EC (MCV CAV-A)

**Acknowledgment: Josep M. Querol*

Forns et al. 2016, EHP. Air pollution and noise and behavioural problems

Table 4. Adjusted mean ratios (95% CIs) of SDQ total difficulties score and ADHD symptomatology (from ADHD-DSM-IV) for TRAPs exposure at school (μg/m³) and noise at school (dB) as continuous variable (based on an IQR increase).

	EC and noise		NO_2 and noise	
Variable	EC indoor IQR = 1.01 μg/m³ EC outdoor IQR = 0.86 μg/m³	Noise IQR = 7.60 dB	NO_2 indoor IQR = 21.01 μg/m³ NO_2 outdoor IQR = 22.26 μg/m³	Noise IQR = 7.60 dB
Total difficulties score (SDQ)[a]				
Indoor				
Single-exposure	1.07 (1.01, 1.12)*	1.01 (0.96, 1.07)	1.02 (0.96, 1.08)	1.01 (0.96, 1.07)
Multi-exposure	1.08 (1.02, 1.14)**	0.98 (0.92, 1.04)	1.02 (0.95, 1.10)	1.01 (0.94, 1.07)
Outdoor				
Single-exposure	1.07 (1.03, 1.12)**	1.01 (0.96, 1.07)	1.07 (1.01, 1.14)*	1.01 (0.96, 1.07)
Multi-exposure	1.08 (1.03, 1.13)**	0.97 (0.92, 1.03)	1.08 (1.01, 1.16)*	0.98 (0.92, 1.04)
ADHD symptomatology (DSM-IV)[b]				
Indoor				
Single-exposure	0.96 (0.89, 1.03)	1.22 (1.11, 1.34)**	1.08 (0.99, 1.17)	1.22 (1.11, 1.34)**
Multi-exposure	0.89 (0.82, 0.96)*	1.29 (1.18, 1.43)**	0.98 (0.89, 1.08)	1.24 (1.12, 1.38)**
Outdoor				
Single-exposure	0.99 (0.93, 1.07)	1.22 (1.11, 1.34)**	1.03 (0.94, 1.13)	1.22 (1.11, 1.34)**
Multi-exposure	0.94 (0.87, 1.01)	1.27 (1.15, 1.40)**	0.94 (0.85, 1.04)	1.26 (1.14, 1.39)**

Single-exposure models including TRAPs (EC and NO_2) were adjusted for child's sex, child's age, maternal education, urban vulnerability index at home address, air pollution (BC) at home, home tobacco use, urban vulnerability index at school, and type of school. Single-exposure models including noise were adjusted for child's sex, child's age, maternal education, urban vulnerability index at home address, traffic noise annoyance at home, home tobacco use, urban vulnerability index at school, and type of school. Multi-exposure models including TRAPs and noise were adjusted for child's sex, child's age, maternal education, urban vulnerability index at home address, air pollution (BC) at home, traffic noise annoyance at home, home tobacco use, urban vulnerability index at school, and type of school.

[a]Including school as random effect. [b]Including teacher as random effect. *$p < 0.05$. **$p < 0.001$.

Conclusions

- Noise is associated with:

Annoyance, stress, ↓ quality of life	Sleep impairment	Cognitive impairment (very relevant in children)	Cardiovascular disease & deaths

- Childhood is a vulnerable period for noise effects, but less investigated

- URGENT: Better noise exposure assessment & + health research

Noise contributes substantially to the burden of disease, how much could we avoid? (next presentations)

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