Is It Traffic-Related Air Pollution or Traffic Noise, or Both?

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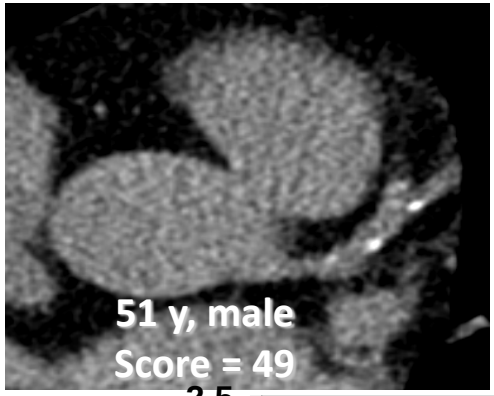
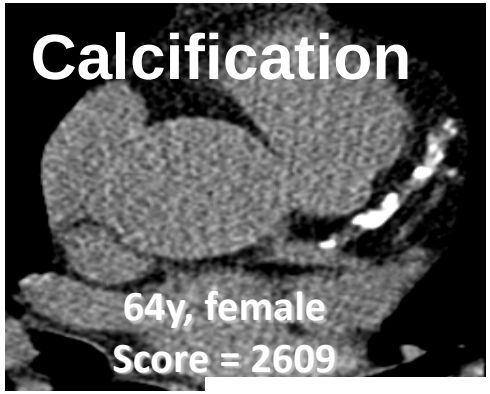
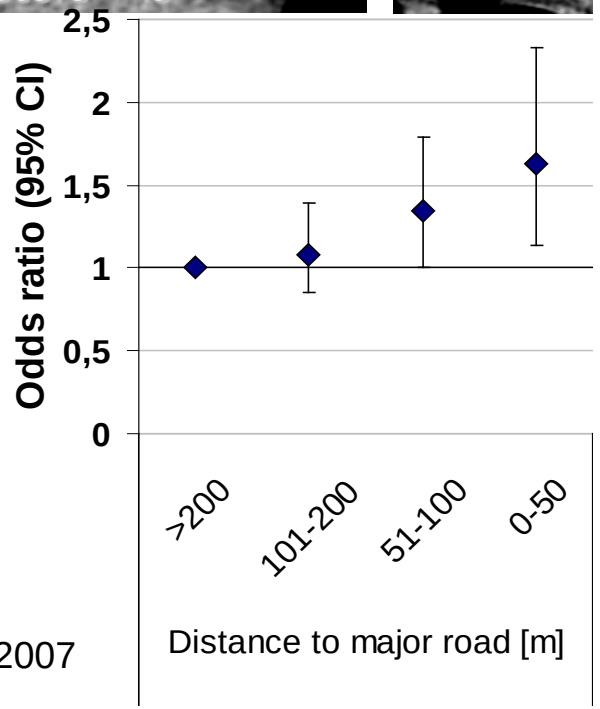
Traffic exposure and cardiovascular disease







Hoffmann et al. 2007

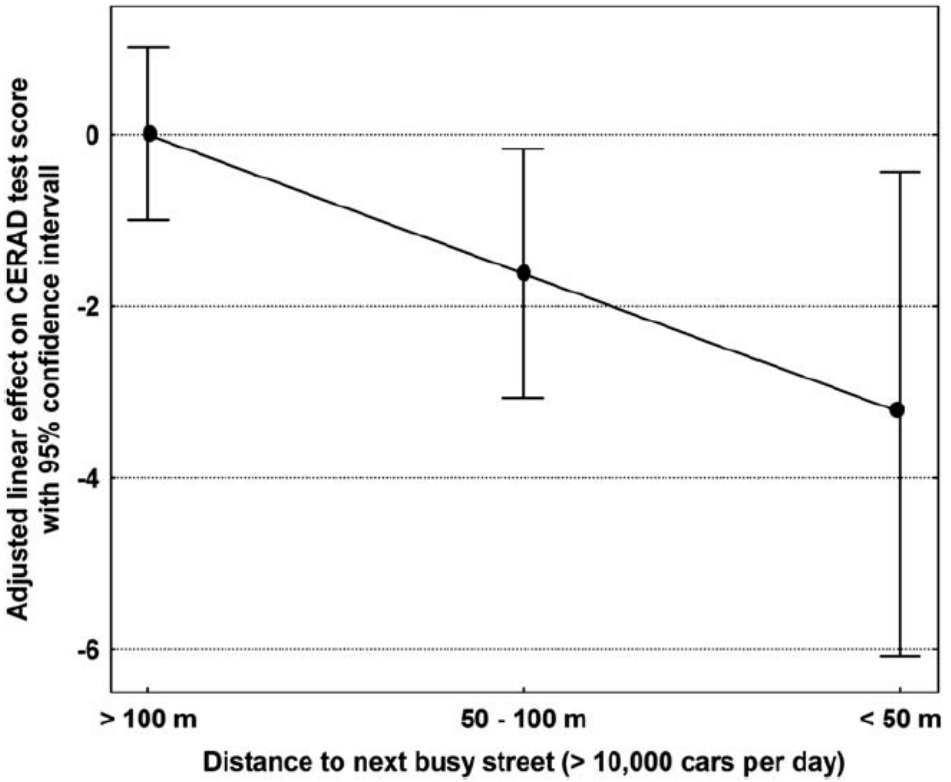
Traffic and blood pressure in children

Exposure	Estimated change in systolic pressure	95% confidence interval
Model 2		
Public transport near schools[a]	1.328[b]	0.073-2.582
Public transport near homes[a]	0.719	−0.474-1.912

Public transport near schools and near homes: 2 mmHg

Paunovic et al. Noise and Health 2013

Traffic and cognitive function



Ranft et al. Environmental Research 2009

Traffic exposure
– two important pollutants

NOISE

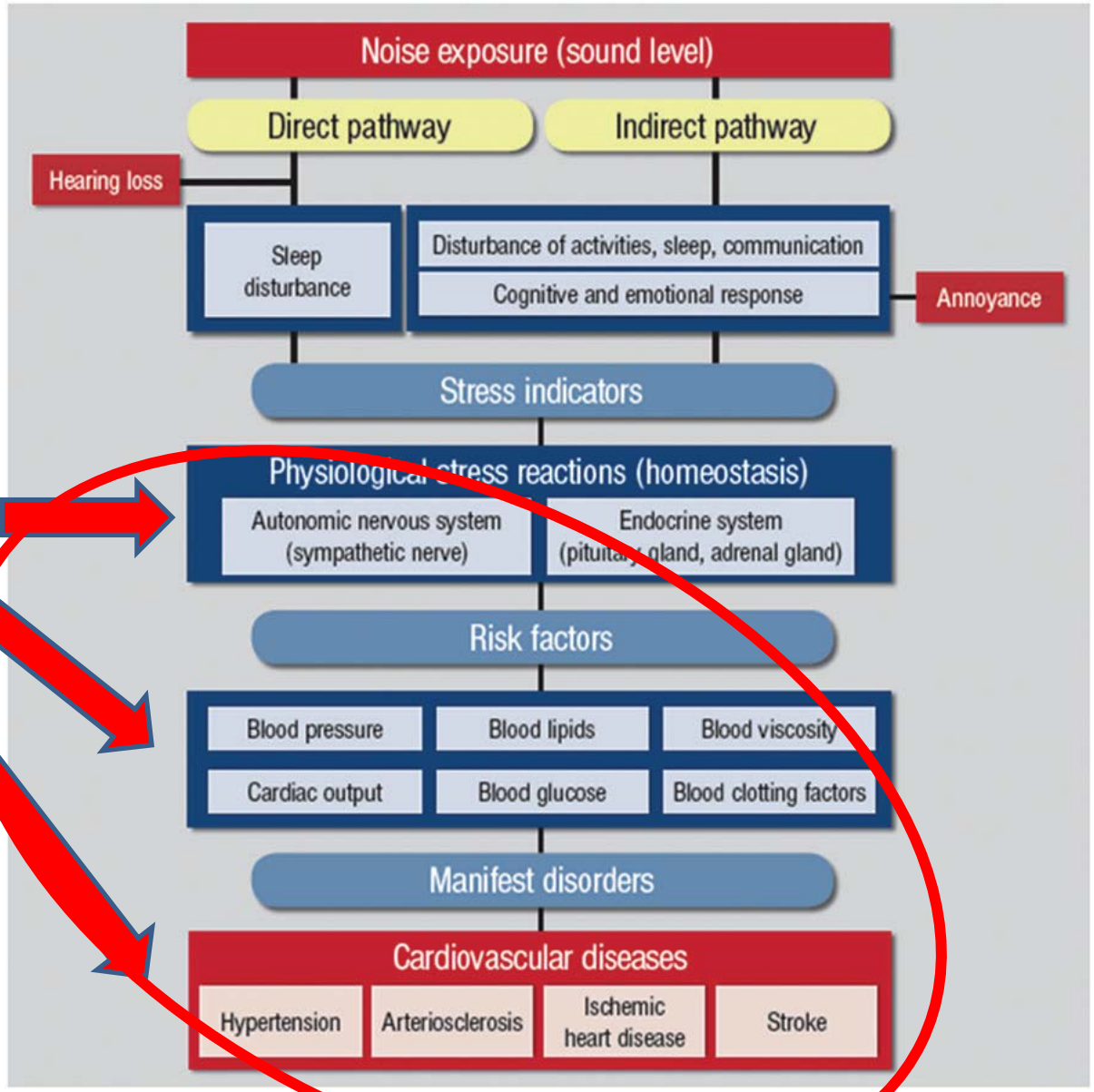
?

Air pollution

Shared health effects

Health Outcome	Transportation noise	Traffic-related air pollution
Mortality	X	X
Cardiovascular disease	X	X
Cerebrovascular disease	X	X
Respiratory disease	-	X
Neurodevelopment in children	X	X
Neurocognition in adults	X	X
Sleep Disturbance	X	(-)
CVD risk factors	X	X
Depression	X	-

Shared biological pathways (CVD)



Air Pollution

Adapted from Münzel et al. EHJ 2014

Fundamental differences

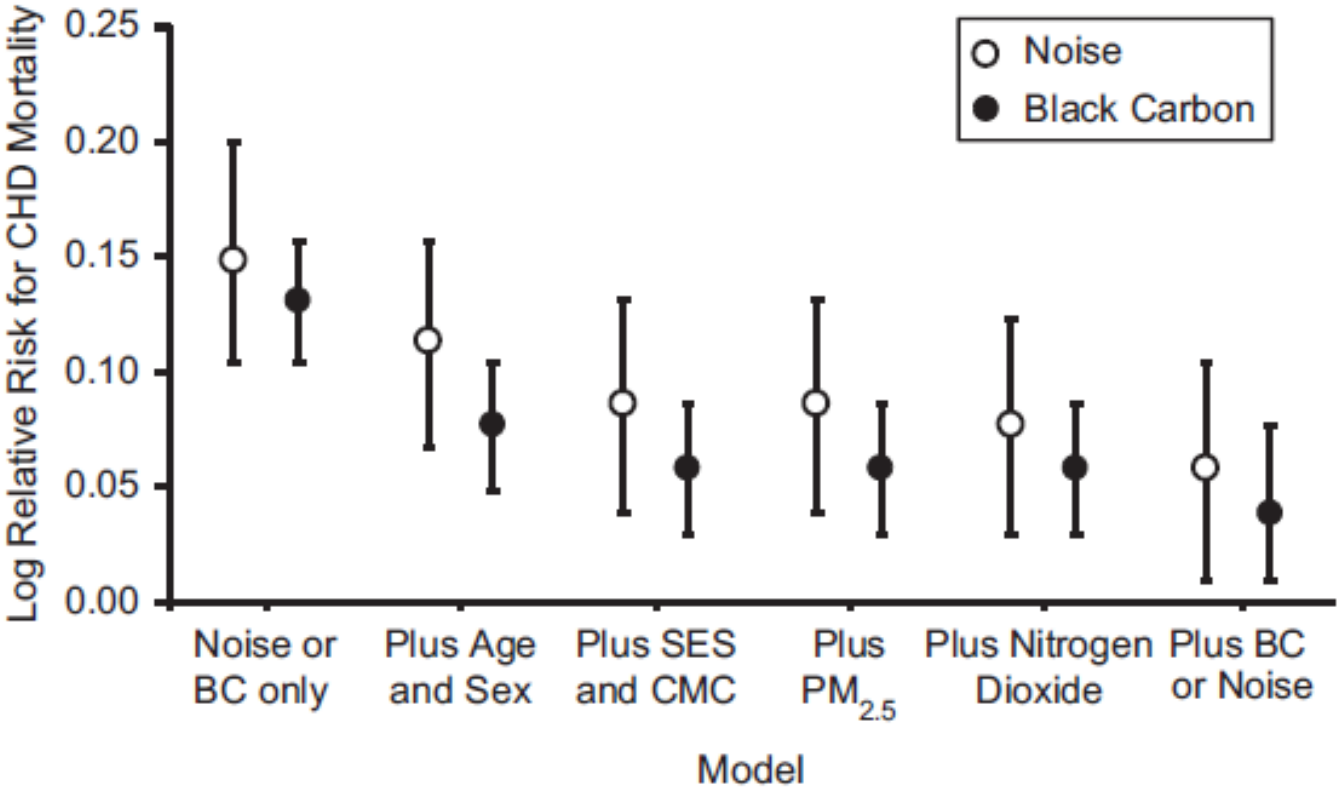
1) Subjective perception
   - Noise vs. air pollution
   - Context, noise sensitivity -> annoyance -> behaviour
2) Determinants of spatial patterns
3) Determinants of personal exposure
4) Threshold
5) Different exposure sources

Basic Questions

1. Are the effects independent?
2. What is the degree of confounding between the two exposures?
3. Do noise and air pollution interact?

Independence of effects

CHD Mortality in Vancouver, N=445,868

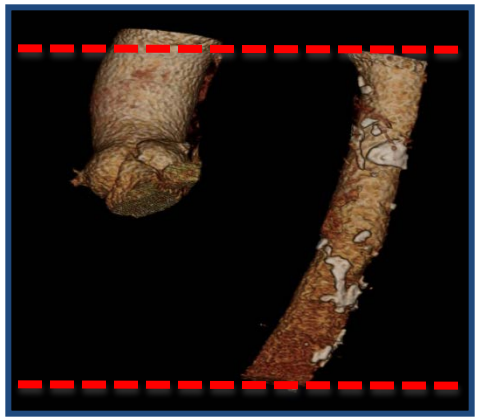


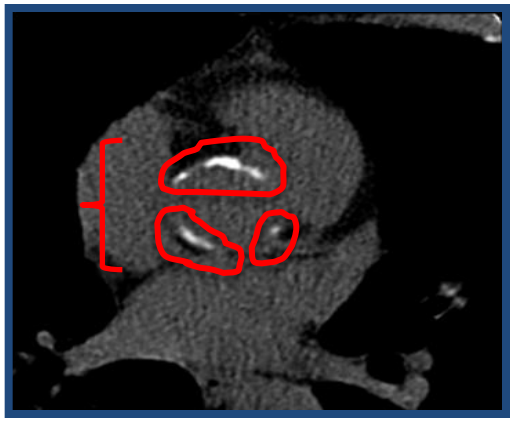
Gan et al. AJE 2012

Subclinical atherosclerosis

Thoracic aortic calcification **(TAC)**

non-contrast Cardio-CT





Takasu et al. Am Heart J 2008
Kälsch et al. Int J Cardiovasc Imaging 2013

Air pollution, noise and TAC

% Change in TAC

	Pollutant (IQR) Crude Model	Main Model Adjusted	Two Exposure Model
$PM_{2.5}$ (2.4 µg/m³)	26.5 (12.8-41.8)	**19.5 (7.9-32.4)**	**18.1 (6.6-30.9)**
PM_{10} (4.0 µg/m³)	19.6 (6.2-34.7)	**11.6 (0.4–24.1)**	9.4 (-1.8–21.9)
L_{den} (per 5 dB(A))	2.5 (-3.9-9.4)	2.5 (-3.3-8.6)	1.9 (-3.8-8.0)
L_{night} (per 5 dB(A))	5.5 (1.0-10.1)	**4.6 (0.7-8.7)**	**3.9 (0.0-8.0)**

Kälsch et al. EHJ 2013

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Degree of confounding …

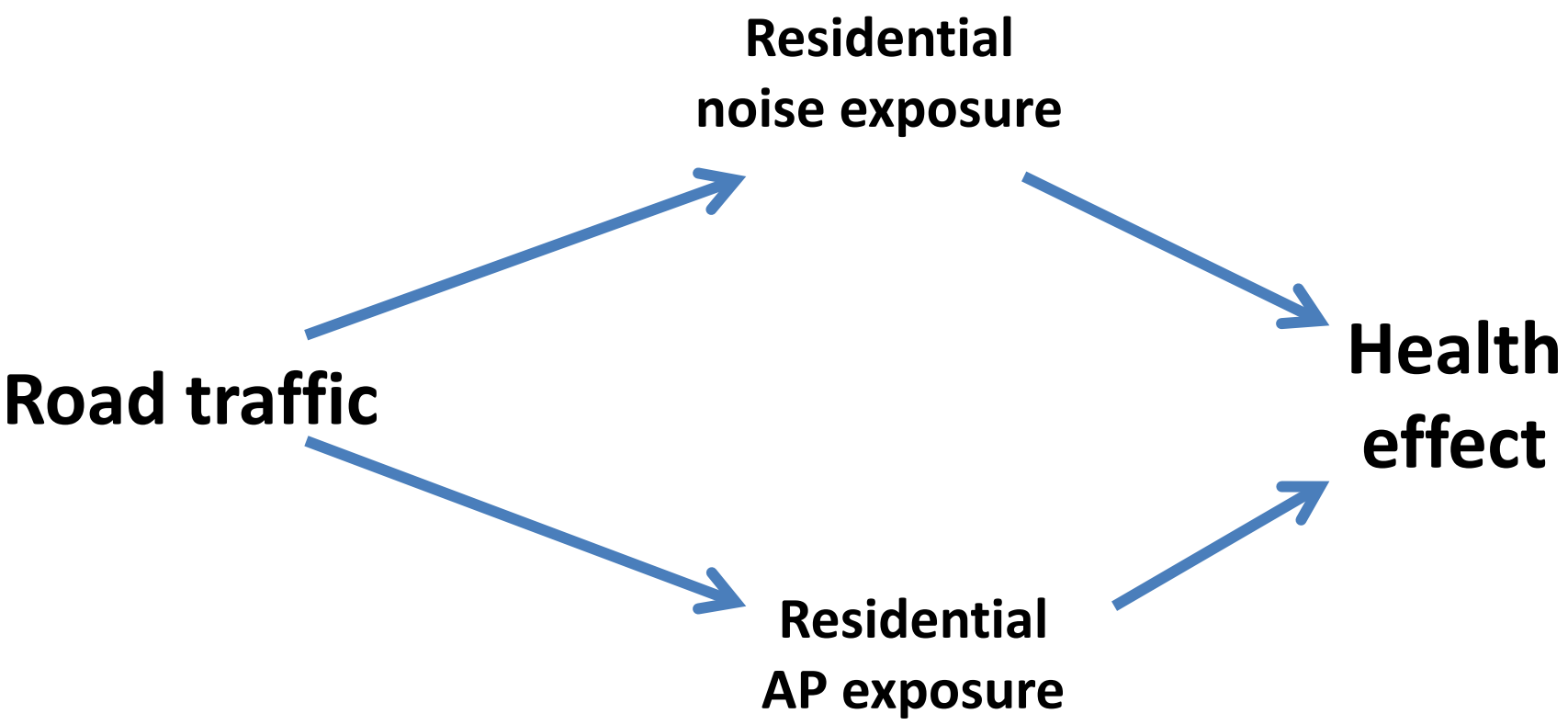
- Differs between study i.e. for hypertension:
  Kluizenaar 2007 positive confounding up to 10%
  Babisch 2014 negative confounding of appr. 30%

- Differs between outcomes in same study
  i.e. Beelen 2009:
  Cardiac dysrhythmia mortality 0%
  Ischemic heart disease mortality 13%

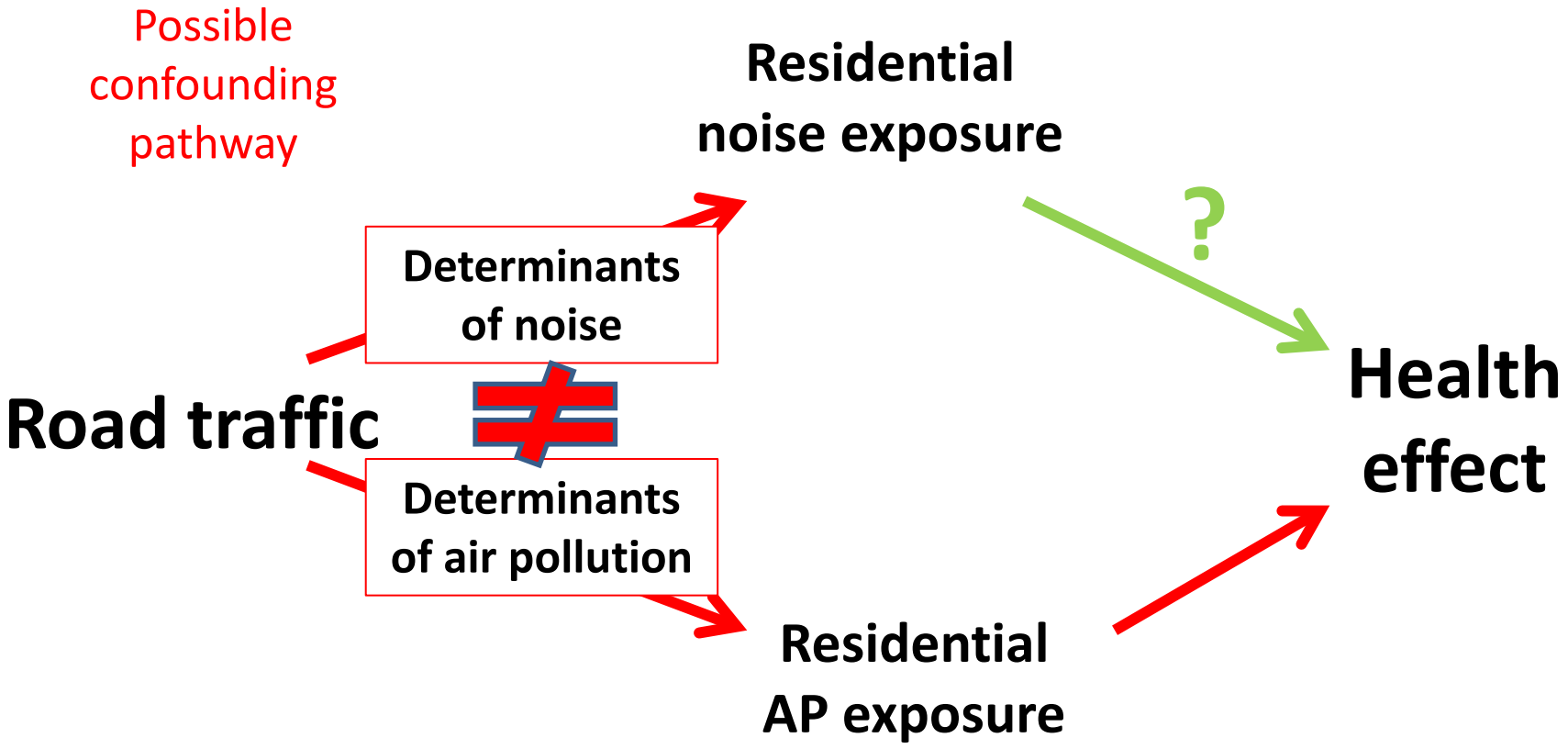
- Might differ according to area and spatial unit
  i.e. Fecht 2015:
  Within neighorhoods of appr. 1600 inhabitants (London) Spearman´s rho 0.01-0.87

- No clear patterns so far (correlation, type of study, quality of exposure assessment)
  i.e. Tétreault 2013, Foraster 2013

Confounding



Confounding

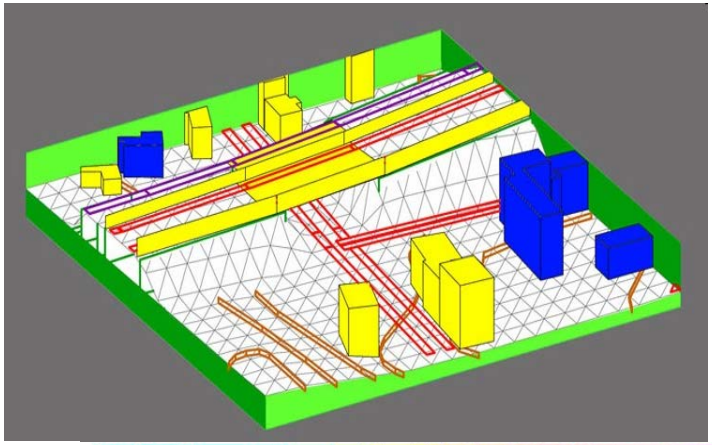


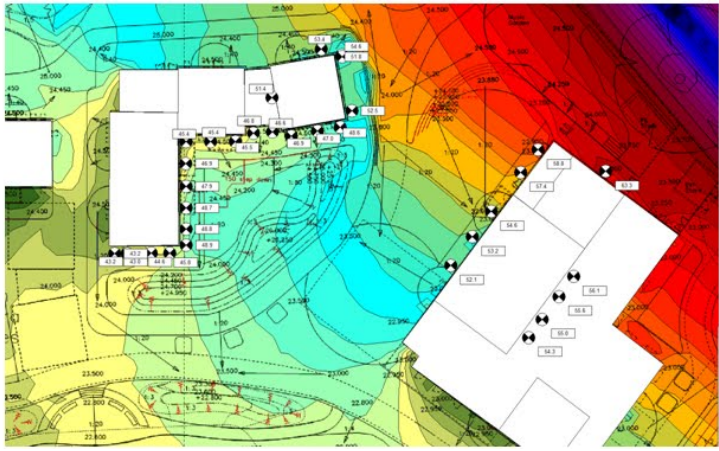
Long-term traffic noise

EU Directive; 2002/49/EC, input variables

- Topography, **Buildings, Noise barriers**
- **Street axis,** Vehicle-type specific traffic density
- Speed limit, **Street surface**

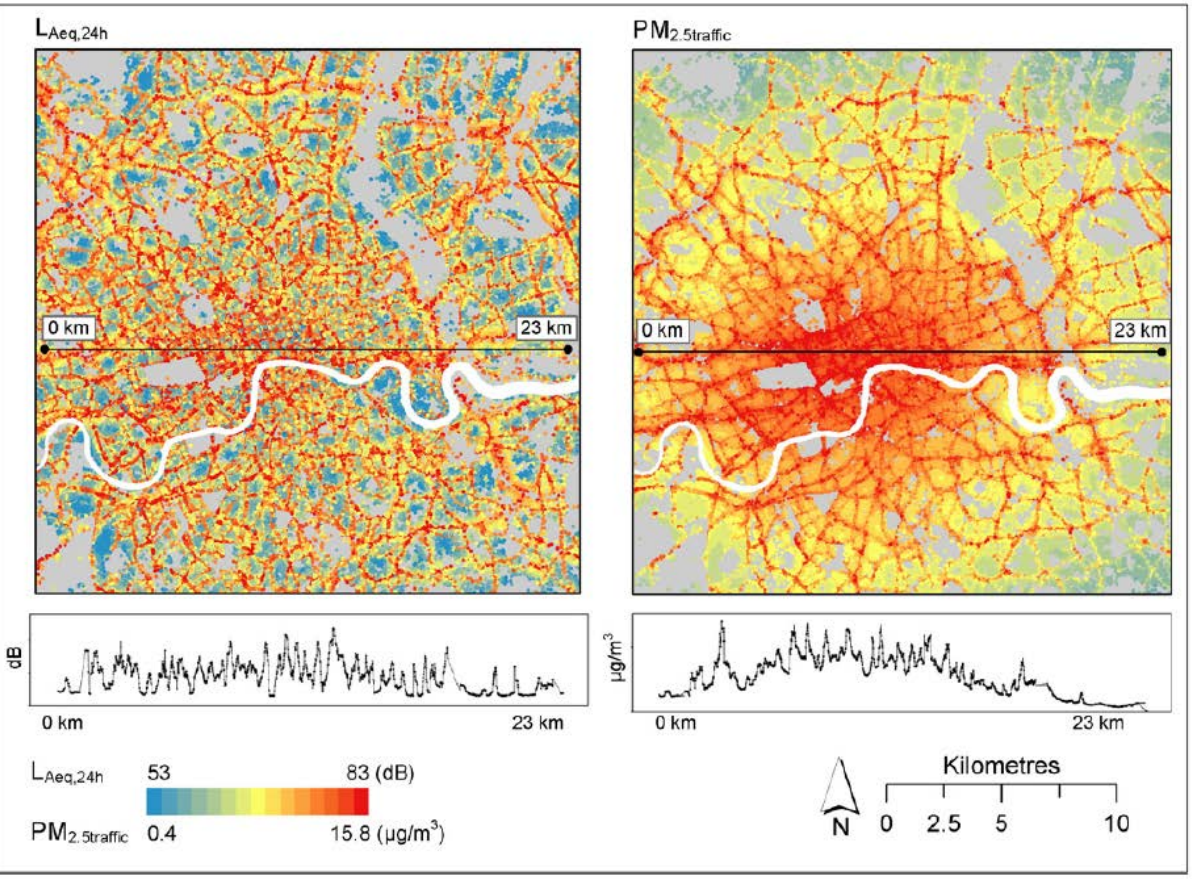
→ **most exposed facade**





Spatial distribution, London

Fecht et al. Env Int. 2016



Average and range of median correlations increase with decreasing size of spatial unit:

Spatial scale	**rho**
Greater London	0.51
London Boroughs	0.61
Neighborhood	0.69

Correlation of noise x air pollution

Girona, Spain N=1,926

Further determinants

Characteristics of housing (type of window, room orientation, etc.)
Subjective perception, noise sensitivity
Personal behaviour

→ **residential/personal exposure**

Variable	Outdoor NO_2	Outdoor L_{night}	Outdoor L_{night} at façade	Indoor L_{night}
Outdoor annual average NO_2 ($\mu g/m^3$)	1.00			
Outdoor L_{night} [dB(A)]	0.75	1.00		
Outdoor L_{night} at bedroom façade [dB(A)]	0.39	0.55	1.00	
Indoor L_{night} [dB(A)]	0.23	0.35	0.78	1.00

Foraster et al. EHP 2014

Hypertension: Noise and air pollution

Models[b]	Hypertension [OR (95% CI)]	
	L_{night}	NO_2
Outdoor model[c]		
Single-exposure	1.18 (1.05, 1.32)**	1.16 (0.99, 1.36)*
Multi-exposure	1.19 (1.02, 1.40)**	0.98 (0.79, 1.22)
Façade model[d]		
Single-exposure	1.08 (1.01, 1.15)**	1.16 (0.99, 1.36)*
Multi-exposure	1.07 (1.01, 1.14)**	1.14 (0.97, 1.33)
Indoor model[e]		
Single-exposure	1.06 (0.99, 1.13)*	1.16 (0.99, 1.36)*
Multi-exposure	1.06 (0.99, 1.13)*	1.16 (0.99, 1.36)*

Foraster et al. EHP 2014

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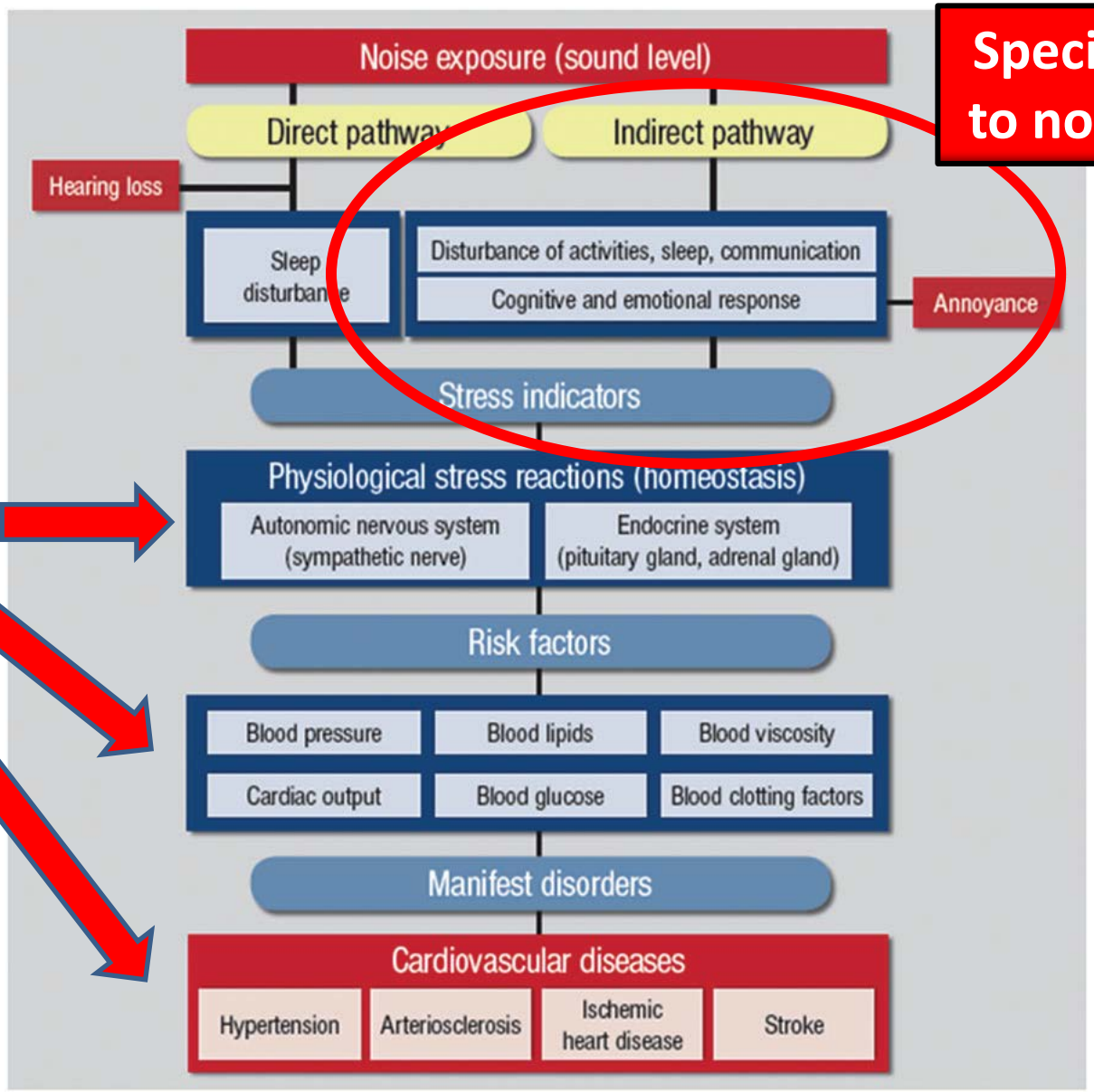
Shared biological pathways (CVD)



Specific to noise

Air Pollution

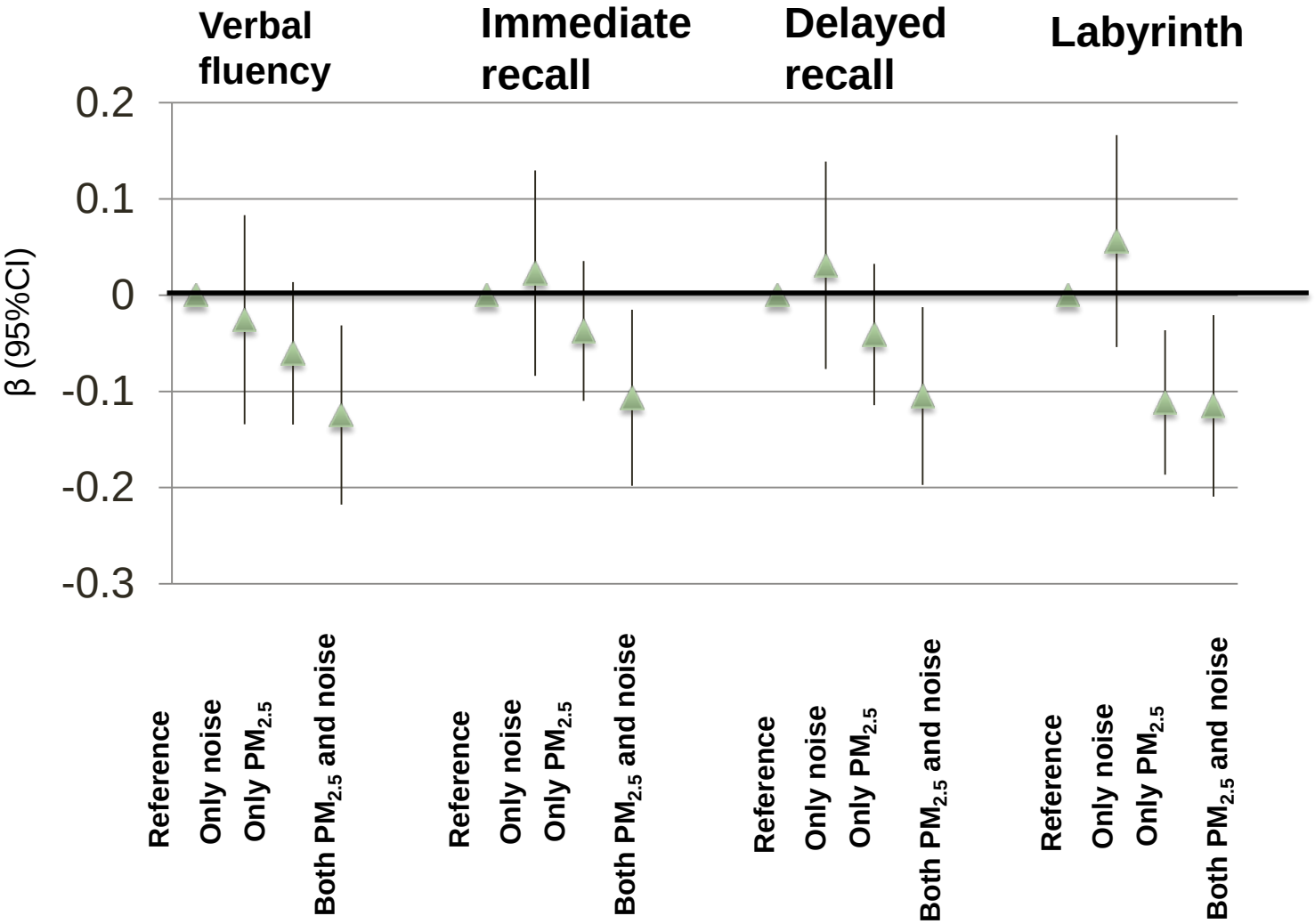
Adapted from Münzel et al. EHJ 2014

Transportation noise exposure

- Subjective perception
- Social context
- Cognitive and emotional response
- Endocrine system: Hypothalamic-pituitary-adrenal axis

Synergism? Cognitive function in adults

Heinz Nixdorf Recall Study, Germany



*Adjusted for age, sex, SES, alcohol consumption, smoking status, self-reported ETS, any regular physical activity and BMI.

Tzivian et al. submitted

Over-additive effect – Synergism

Verbal fluency

$$|D| > |B + C|$$

		Air pollution	
		Low	**High**
Noise	**Low**	Reference (A)	(C) β = -0.06
	High	(B) β = -0.02	(D) β = -0.12

|-0.12| > |-0.02 -0.06|

Tzivian et al. submitted

Some answers to basic questions…

1. In most studies, effects persist upon mutual adjustment – independence!
2. Degree of observed confounding varies strongly between studies, outcomes, areas!
3. Synergism of these two environmental exposures biologically plausible, but very little evidence so far!

Conclusions

When investigating health effects from traffic exposure….

- it is essential to include **air pollution and noise** to really understand their mutual role and their interplay in causing adverse health effects!
- And don´t forget another related exposure with strong health effects and similar spatial patterns: **SES**

Thank you very much

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