

TRAP AND HEALTH AND THE COMPLEX INTERPLAY WITH ROAD TRAFFIC NOISE AND OTHER CONFOUNDERS

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Results from the HEI-funded HERMES study



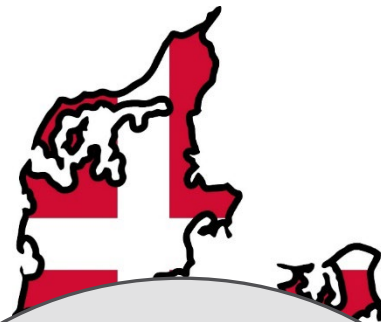
HERMES: God of transportation

STUDY POPULATION

Health registries

Hospital, mortality and prescription

- Type-2 diabetes 128,358
- MI 71,285
- Stroke 94,256



Population

All living in Denmark
> 50 years
2005 – 2017
N = 2 million



Statistics Denmark

Socioeconomic status

Income, education, marital status, occupation, ethnicity

Århus University

Yearly air pollution and green space at all addresses

CPR registry

Complete precise address history

Noise consultant

Traffic noise at all addresses

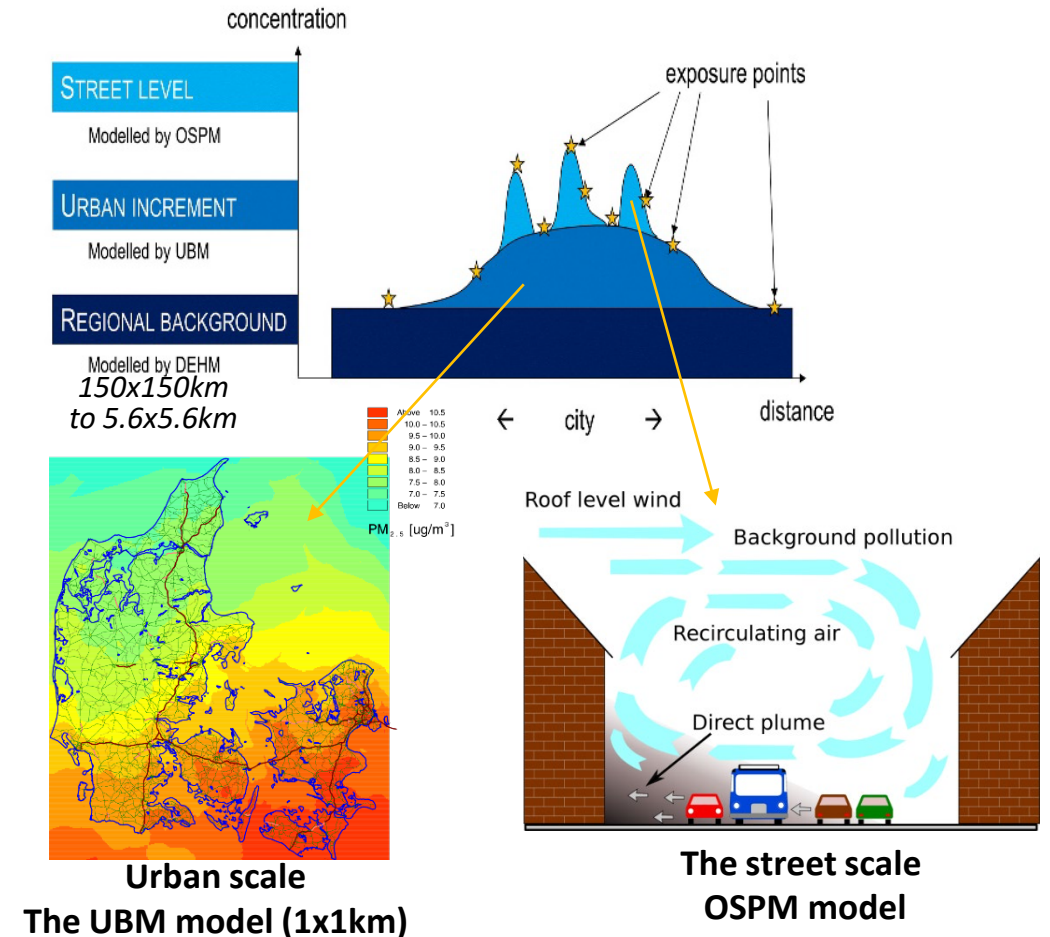
AIR POLLUTION

DEHM/UBM/AirGIS modelling system

- Multi-scale modelling (deterministic model)
 - Regional level: Danish Eulerian Hemispheric Model (DEHM)
 - Urban level: Urban Background Model (UBM)
 - Street level: Operational Street Pollution Model (OSPM)
- Input variables
 - Geocoded addresses from 2000-2017
 - Emission inventories, meteorology
 - Transportation, dispersion and chemistry

Air pollutants

- Ultrafine particles, $PM_{2.5}$, NO_2



EMISSION INVENTORIES

TRAFFIC AND NON-TRAFFIC CONTRIBUTIONS

- SNAP 1 Combustion in energy and transformation industries
- SNAP 2 Non-industrial combustion plants
- SNAP 3 Combustion in manufacturing industry
- SNAP 4 Production processes
- SNAP 5 Extraction/distribution of fossil fuels and geothermal energy
- SNAP 6 Solvents and other product use
- SNAP 7 Road transport
- SNAP 8 Other mobile sources and machinery
- SNAP 9 Waste treatment and disposal
- SNAP 10 Agriculture
- SNAP 11 Other sources and sinks

TRAP

SNAP 7 (Road transport)

- Passenger cars
- Light duty vehicles < 3.5 t
- Heavy duty vehicles > 3.5 t
- Mopeds, motorcycles < 50 cm³
- Motorcycles > 50 cm³
- Gasoline evaporation from vehicles
- Automobile tyre and break wear
- Re-suspension of road dust

Baseline Characteristics	< Median UFP Percent	≥ Median UFP Percent
Men	49.5	47.7
Civil status		
Married/cohabiting	78.9	70.0
Widow/divorced/single	21.1	30.0
Individual income		
Low (quintile 1)	22.0	19.4
Medium (quintile 2–4)	62.2	56.4
High (quintile 5)	15.8	24.2
Highest attained education		
Mandatory	34.5	27.8
Secondary/vocational	48.2	47.1
Medium/long	17.4	25.1
Country of origin		
Danish	90.0	97.7
Occupational status		
Blue collar	38.9	31.8
White collar	27.0	31.5
Retired/unemployed	34.1	36.7

DESCRIPTIVE RESULTS



Exposure during follow-up	Median (5–95 percentile)
Air pollution (5-year mean)	
PM _{2.5} (µg/m ³)	9.95 (7.96–12.1)
Non-traffic	9.66 (7.86–11.5)
Traffic	0.18 (0.04–1.01)
UFP (particles/cm ³)	10,192 (6,454–16,061)
Non-traffic	9,080 (6,151–12,630)
Traffic	962 (210–3,781)
NO ₂ (µg/m ³)	13.8 (8.36–25.0)
Non-traffic	10.24 (7.04–13.3)
Traffic	3.36 (0.83–12.8)

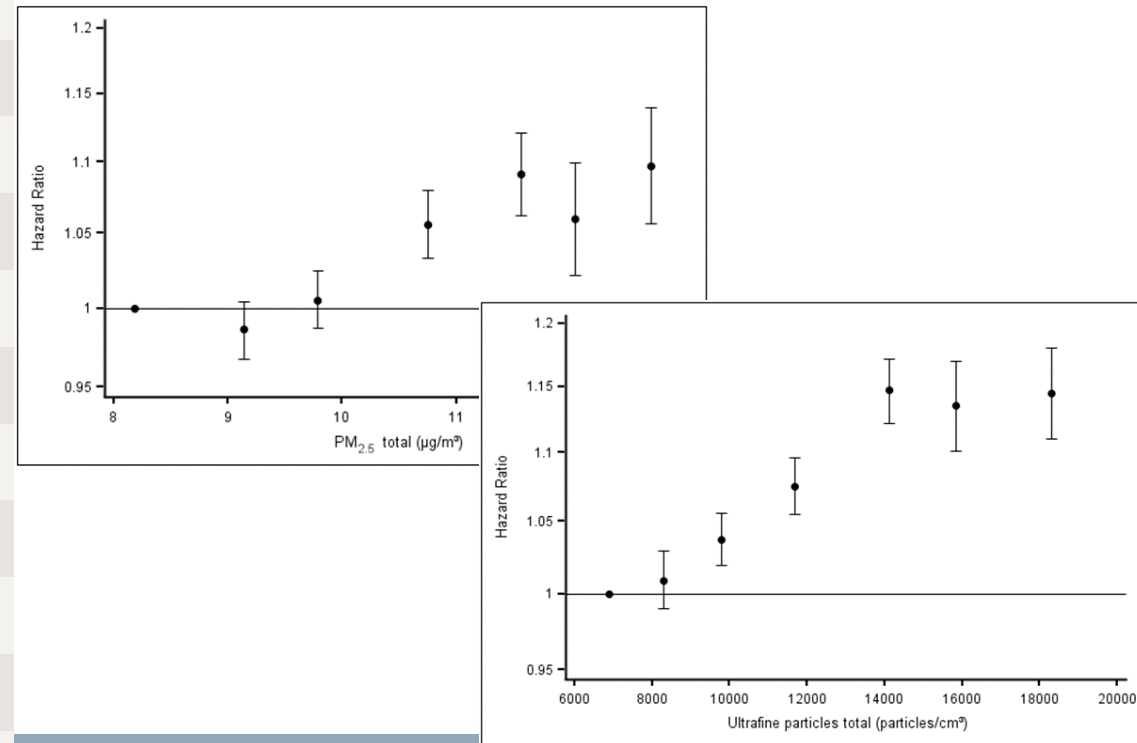
TRAFFIC VERSUS NON-TRAFFIC AP, DIABETES

	IQR	Model 1 HR (95% CI) per IQR	Model 2 HR (95% CI) per IQR
PM_{2.5} (µg/m³)			
Total	1.85	1.013 (1.003-1.024)	1.043 (1.031-1.056)
Non-traffic	1.63	0.988 (0.976-0.999)	1.020 (1.007-1.032)
Traffic	0.37	1.020 (1.016-1.025)	1.026 (1.020-1.031)
UFP (#/cm³)			
Total	4,248	1.006 (0.998-1.014)	1.052 (1.042-1.063)
Non-traffic	2,769	0.993 (0.985-1.000)	1.027 (1.019-1.036)
Traffic	1,698	1.021 (1.014-1.028)	1.049 (1.040-1.058)
NO₂ (µg/m³)			
Total	7.15	1.023 (1.016-1.030)	1.056 (1.046-1.065)
Non-traffic	2.68	1.006 (0.998-1.014)	1.043 (1.034-1.053)
Traffic	5.17	1.023 (1.016-1.029)	1.039 (1.031-1.047)

Adjusted for

Age, sex, year

Individual-level civil status, individual and family income, country of origin, occupational status, education and *area-level SES*



TRAFFIC VERSUS NON-TRAFFIC AP, DIABETES

	IQR	Model 1 HR (95% CI) per IQR	Model 2 HR (95% CI) per IQR	<u>Two-pollutant</u> Traffic and non-traffic HR (95% CI) per IQR
PM_{2.5} (µg/m³)				
Total	1.85	1.013 (1.003-1.024)	1.043 (1.031-1.056)	---
Non-traffic	1.63	0.988 (0.976-0.999)	1.020 (1.007-1.032)	1.013 (1.000, 1.026)
Traffic	0.37	1.020 (1.016-1.025)	1.026 (1.020-1.031)	1.025 (1.020, 1.030)
UFP (#/cm³)				
Total	4,248	1.006 (0.998-1.014)	1.052 (1.042-1.063)	---
Non-traffic	2,769	0.993 (0.985-1.000)	1.027 (1.019-1.036)	1.018 (1.009, 1.026)
Traffic	1,698	1.021 (1.014-1.028)	1.049 (1.040-1.058)	1.045 (1.036, 1.054)
NO₂ (µg/m³)				
Total	7.15	1.023 (1.016-1.030)	1.056 (1.046-1.065)	---
Non-traffic	2.68	1.006 (0.998-1.014)	1.043 (1.034-1.053)	1.035 (1.025, 1.045)
Traffic	5.17	1.023 (1.016-1.029)	1.039 (1.031-1.047)	1.033 (1.025, 1.041)

TRAFFIC VERSUS NON-TRAFFIC AP, CVD

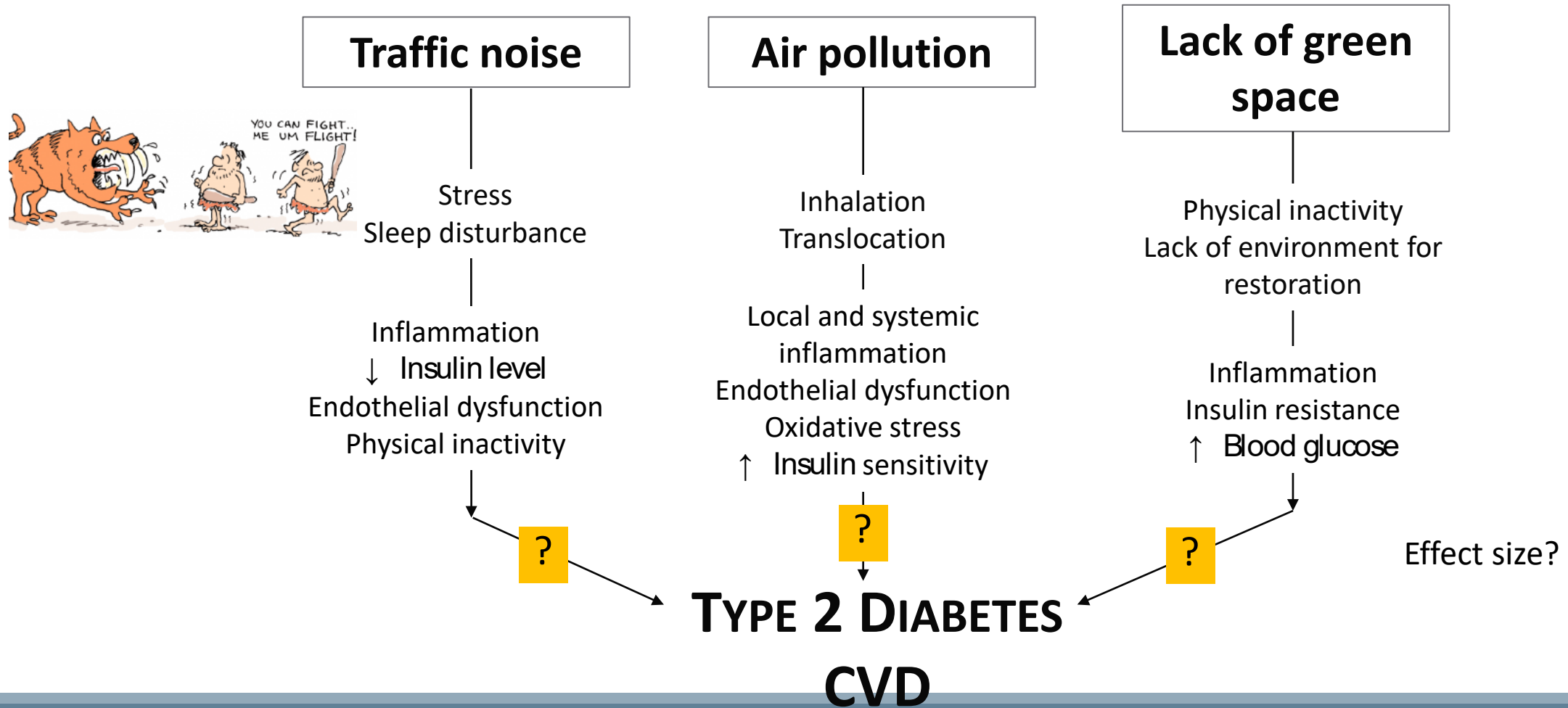
	IQR	<u>Myocardial infarction</u> HR (95% CI) per IQR	<u>Stroke</u> HR (95% CI) per IQR
PM_{2.5} (µg/m³)			
Total	1.85	1.053 (1.035-1.071)	1.077 (1.061-1.094)
Non-traffic	1.63	1.051 (1.032-1.069)	1.091 (1.074-1.108)
Traffic	0.37	1.011 (1.003-1.018)	1.004 (0.998-1.011)
UFP (#/cm³)			
Total	4,248	1.040 (1.025-1.055)	1.039 (1.026-1.052)
Non-traffic	2,769	1.034 (1.022-1.046)	1.038 (1.028-1.049)
Traffic	1,698	1.011 (0.999-1.024)	1.003 (0.992-1.014)
NO₂ (µg/m³)			
Total	7.15	1.027 (1.013-1.040)	1.028 (1.017-1.040)
Non-traffic	2.68	1.048 (1.034-1.062)	1.077 (1.065-1.089)
Traffic	5.17	1.009 (0.998-1.020)	1.001 (0.991-1.010)

LIFESTYLE RESIDUAL CONFOUNDING?

COHORT, N=246,766

	N cases	<u>HR (95% CI)</u>		
		<u>Model 1</u> Age, sex, year	<u>Model 2</u> Model 1 + all registry-based socio-demographic variables	<u>Model 3</u> Model 2 + <u>lifestyle</u> variables (smoking, diet, PA, BMI)
MI	3,247			
PM _{2.5} (5 µg/m ³)		1.02 (0.82-1.27)	1.16 (0.90-1.49)	1.18 (0.91-1.52)
NO ₂ (10 µg/m ³)		0.98 (0.91-1.06)	1.05 (0.94-1.16)	1.03 (0.92-1.14)
Stroke	4,166			
PM _{2.5} (5 µg/m ³)		1.08 (0.89-1.31)	1.09 (0.87-1.37)	1.11 (0.88-1.40)
NO ₂ (10 µg/m ³)		1.05 (0.98-1.13)	1.11 (1.01-1.22)	1.10 (1.00-1.20)
Diabetes	6,366			
PM _{2.5} (5 µg/m ³)		1.00 (0.85-1.16)	1.27 (1.06-1.52)	1.24 (1.03-1.50)
NO ₂ (10 µg/m ³)		1.02 (0.96-1.07)	1.16 (1.07-1.24)	1.14 (1.06-1.23)

RESULTS FROM MULTIPOLLUTANT STUDY

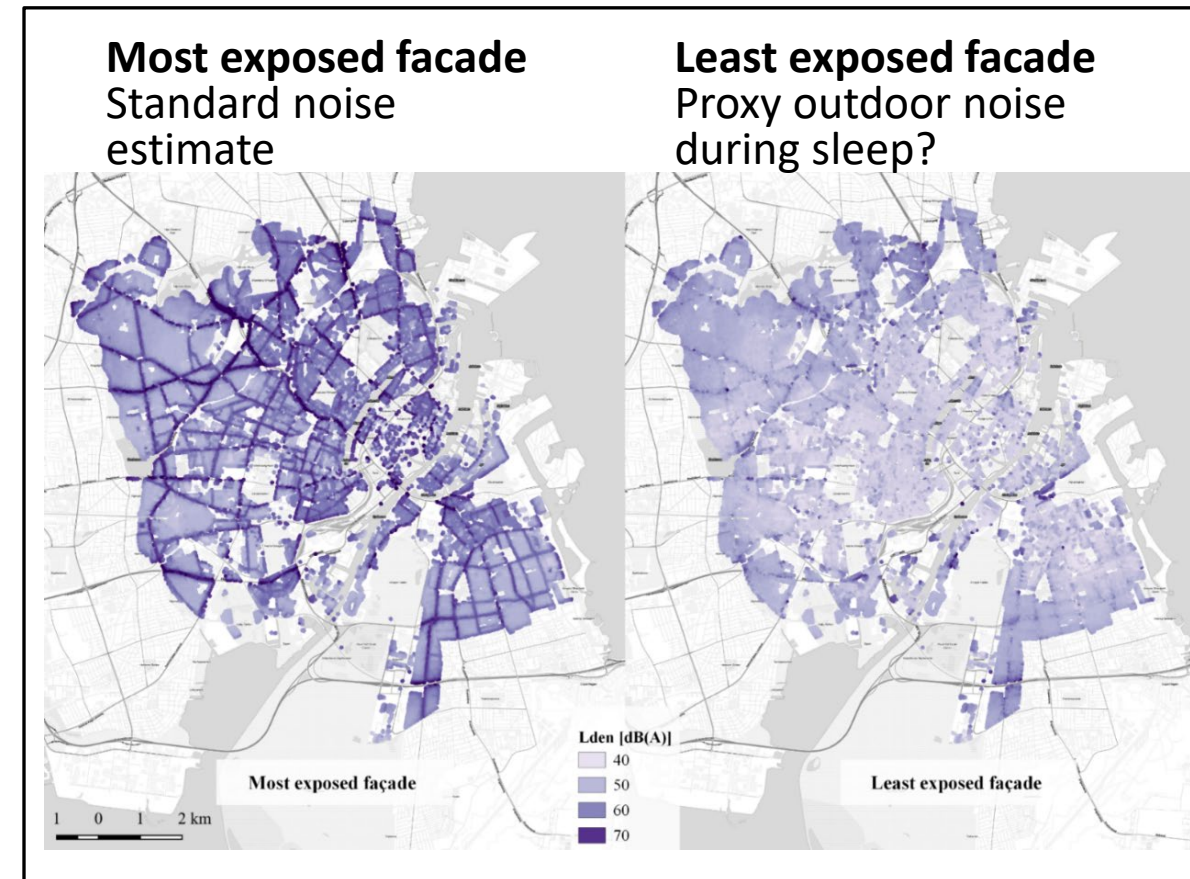


ROAD TRAFFIC NOISE

The Nordic Prediction Method

- Geocode and height (floor) for all addresses (2000-2017)
- Screening buildings, noise barriers, terrain
- Reflections
- All road lines
 - Traffic composition (heavy/light)
 - Yearly average daily traffic
 - Traffic speed
 - Road type

Baseline Exposure	Median (5–95 percentile)
Road traffic noise (dB)	
Most exposed façade	54.9 (40.4–67.5)
Least exposed façade	44.1 (35.0–56.1)

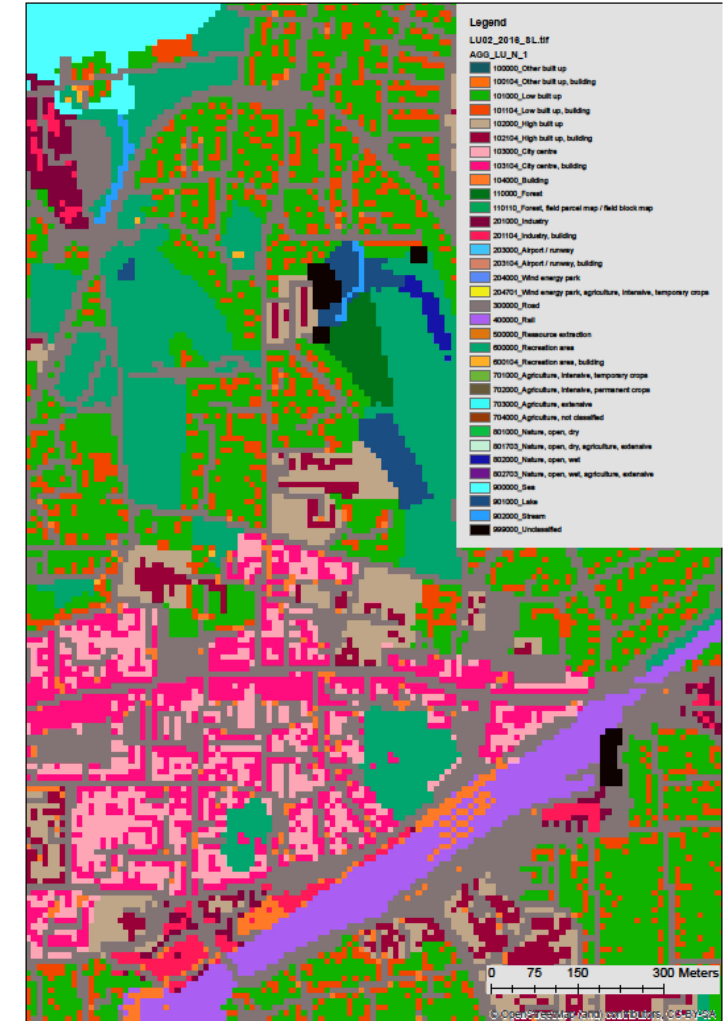


GREEN SPACE

Danish Land Use Map with 36 land use classes

1. Publicly accessible green space -> encourage physical activity?
Within 1000 m of address: Proportion of recreational areas, forests and open nature
2. Greenness visible from the residence -> anti-stressful?
Within 150 m of address: Proportion of recreational areas, forests, open nature PLUS household gardens and agricultural areas

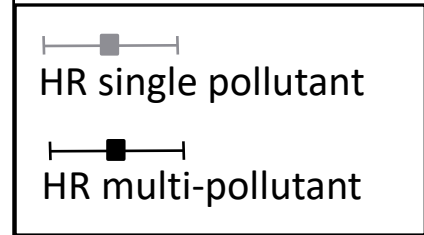
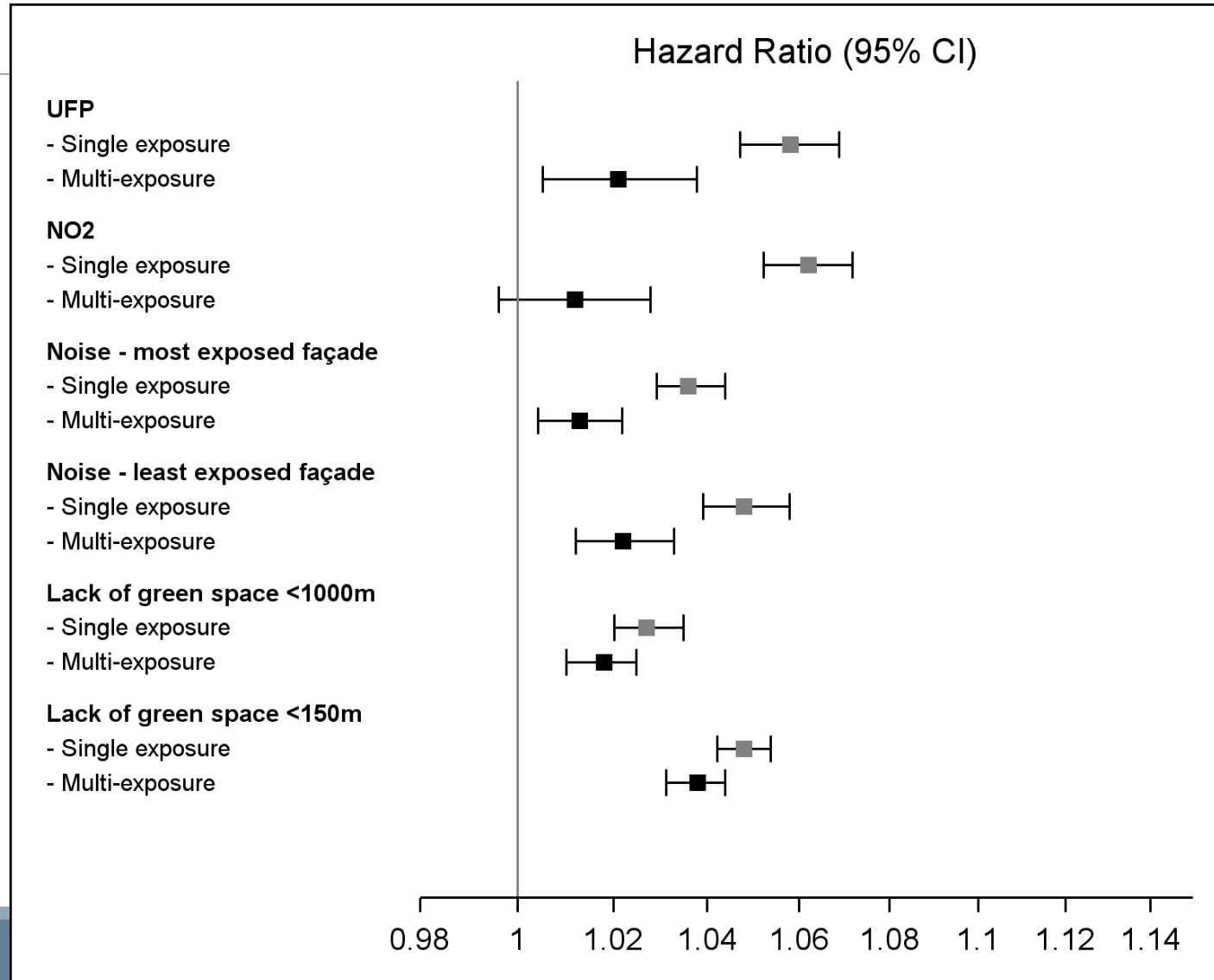
Baseline exposure	Median (5–95 percentile)
Non-green space (%) within	
150 m	41.2 (12.5–82.0)
1000 m	86.9 (63.7–91.9)



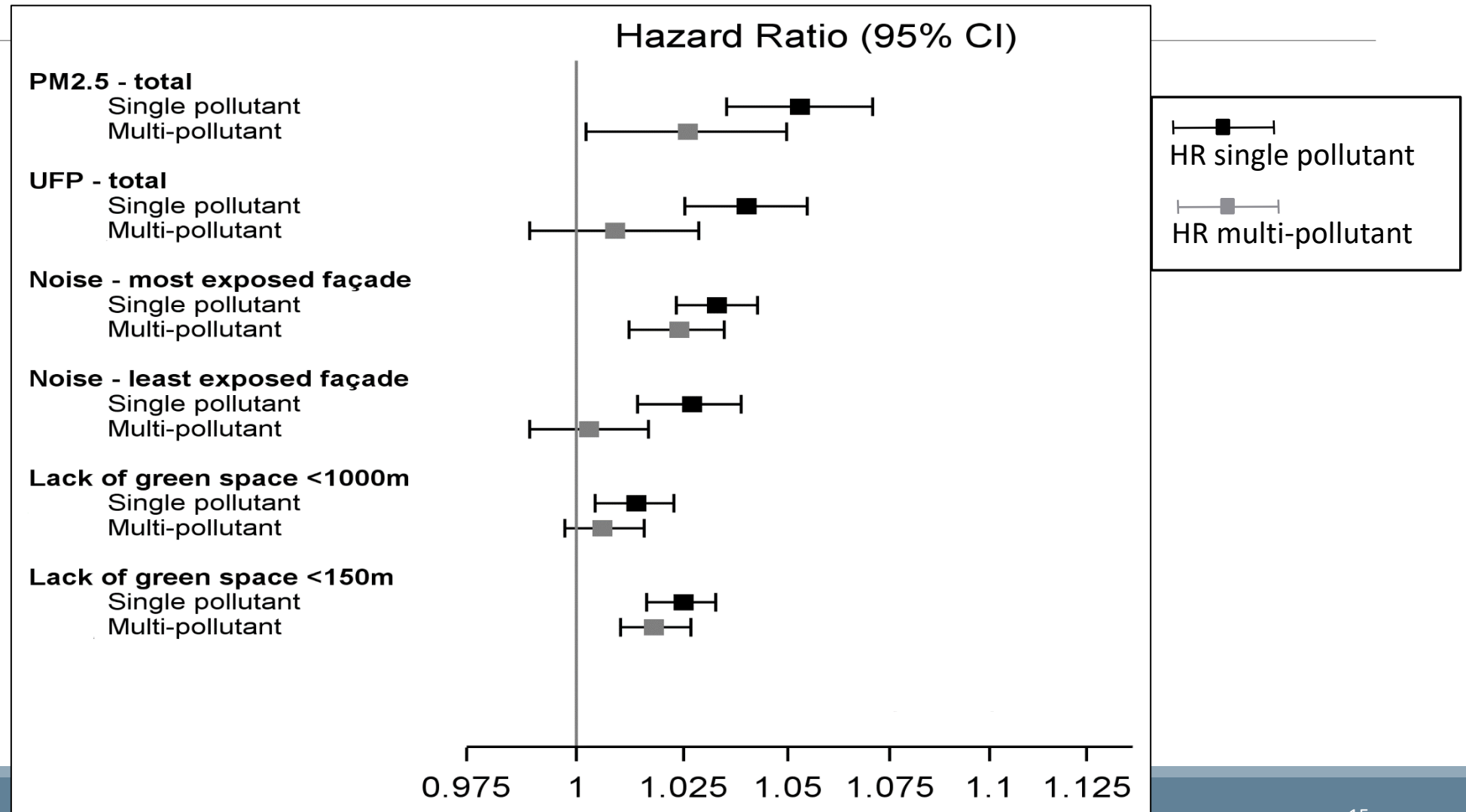
SPEARMAN CORRELATIONS

	Total PM _{2.5}	Total UFP	Total NO ₂	Total EC	LdenMax	LdenMin	NonGreen150m	NonGreen1000m
Total PM_{2.5}, 5-y	1	0.77	0.76	0.71	0.20	0.26	0.23	0.02
Total UFP, 5-y		1	0.92	0.91	0.24	0.44	0.37	-0.06
Total NO₂, 5-y			1	0.93	0.39	0.53	0.40	-0.04
Total EC, 5-y				1	0.34	0.52	0.40	-0.07
LdenMax, 5-y					1	0.48	0.19	0.05
LdenMin, 5-y						1	0.34	-0.08
NonGreen150m							1	0.01
NonGreen1000m								1
	High correlations				Low-Moderate correlations			No correlations

RESULTS FOR DIABETES, PER IQR



RESULTS FOR MI, PER IQR



CONCLUSIONS

- Adjustment for SES important
- After comprehensive SES adjustment, we found little residual confounding from lifestyle
- *Diabetes*: Strongest association with particulate matter from **traffic sources**
- *CVD*: Strongest association with air pollution from **non-traffic sources**
- Particulate air pollution, road traffic noise and green space independently associated with diabetes and CVD
- HRs higher in single-pollutant model compared to multi-pollutant model
 - Indicates that estimating the effect of only one of these exposures will result in **overestimating** the effect of that exposure

THE HERMES STUDY

Funded by
Health Effects Institute
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THANK YOU
QUESTIONS?



HERMES: God of transportation