Swiss TPH

Accounting for mobility in long-term exposure estimates of air pollution – does it matter?

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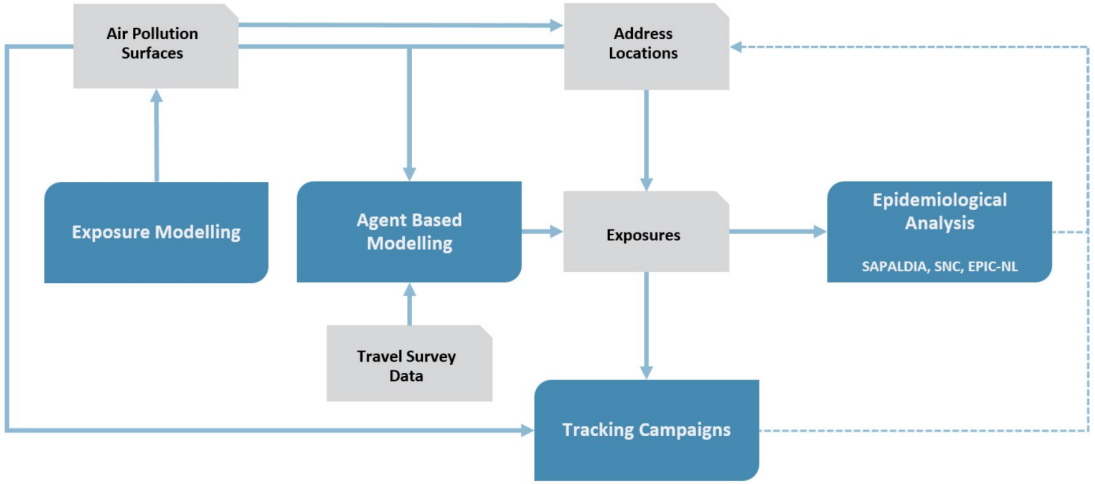
Why?

- Large scale epidemiological studies investigating **long-term** health effects of air pollution can typically only consider the residential locations of the participants, thereby ignoring the space-time activity patterns that likely influence total exposure.
- People are mobile and can be exposed to considerably different levels of air pollution or air pollution mixtures when inside vs. outside, commuting, recreating, or working.
- Neglecting these aspects in exposure assessment may lead to incorrect distributions of exposure over the population, which may lead to biased exposure health relations in epidemiological studies.

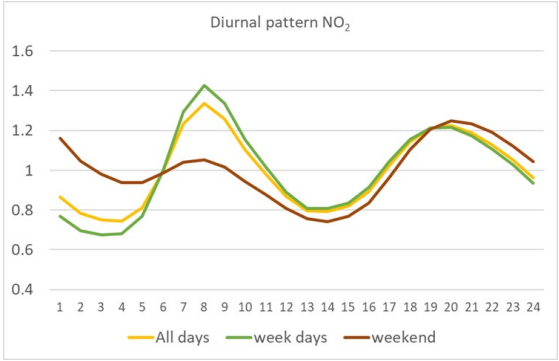
How?

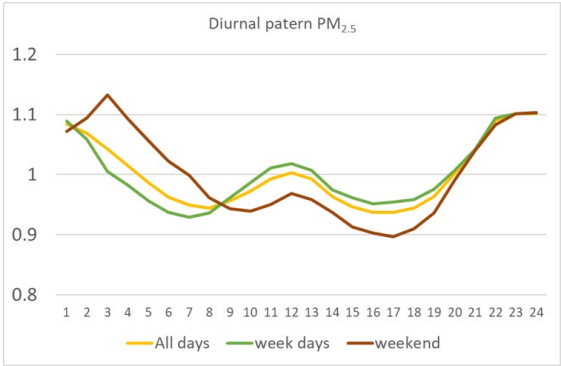
- Development of novel traffic related air pollution exposure models incorporating population dynamics
- Conduct tracking campaigns to evaluate exposure models
- Apply exposure models to Swiss and Dutch populations to study long-term exposure to air pollution and health effects



Exposure modelling

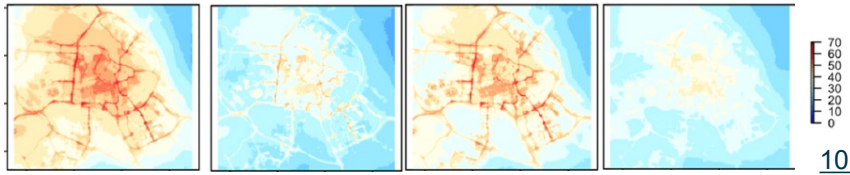
- Developed long-term hourly NO_2 and $PM_{2.5}$ surfaces for week days and weekend days
- In Switzerland by rescaling annual average $PM_{2.5}$ and NO_2 surfaces based on background monitoring stations
- In the Netherlands by developing long-term hourly NO_2 and $PM_{2.5}$ LUR models based on hourly routine monitoring data





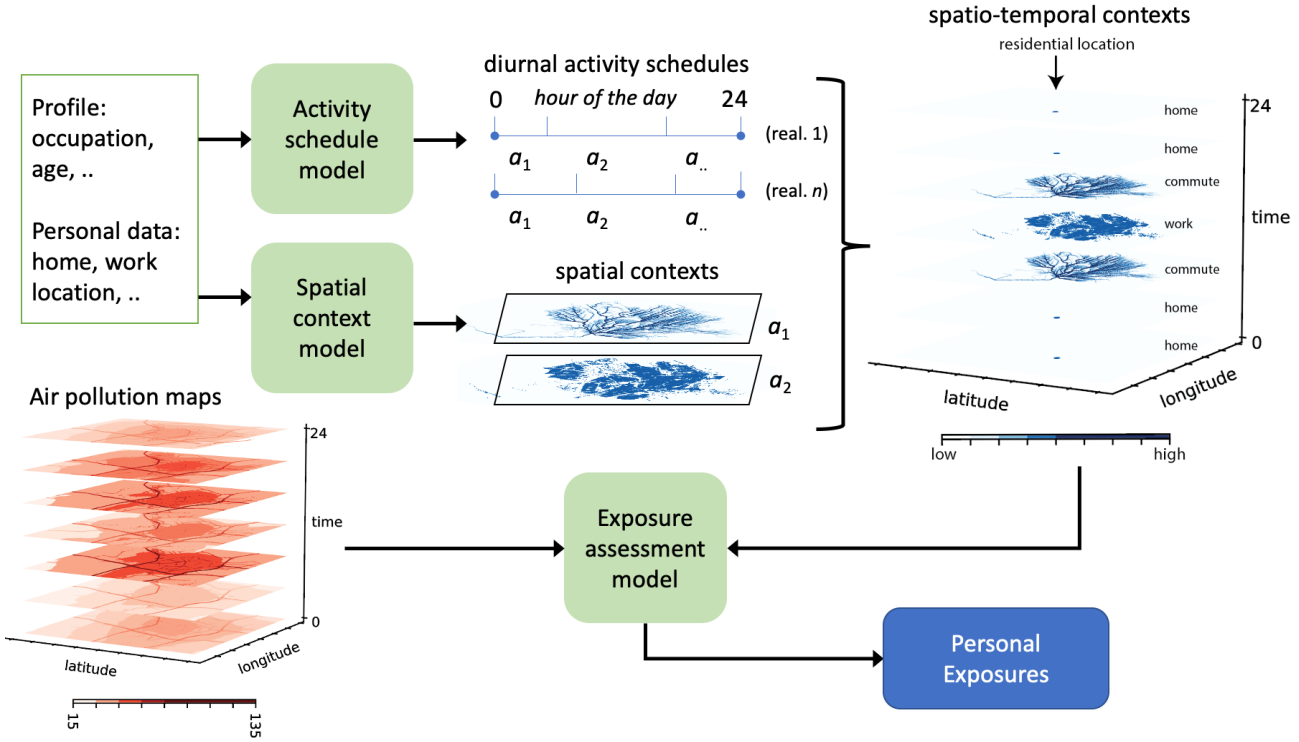
Diurnal patterns using Swiss background site locations (2016) (factors)

NO_2 (µg/m³) for Amsterdam
Hours 8, 12, 17 and 23 (Ndiaye, 2024)

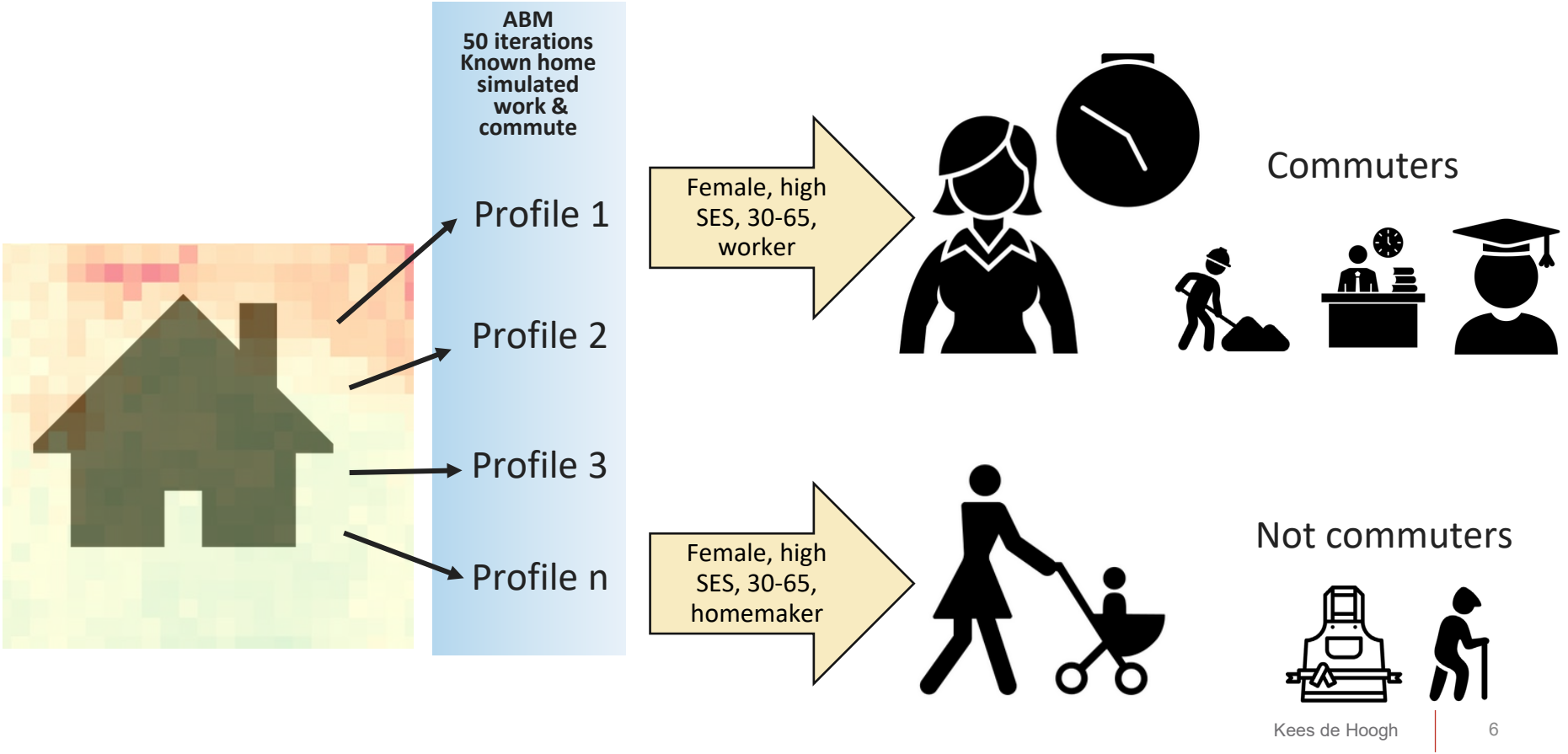


10.1016/j.envres.2024.119233

Agent based modelling

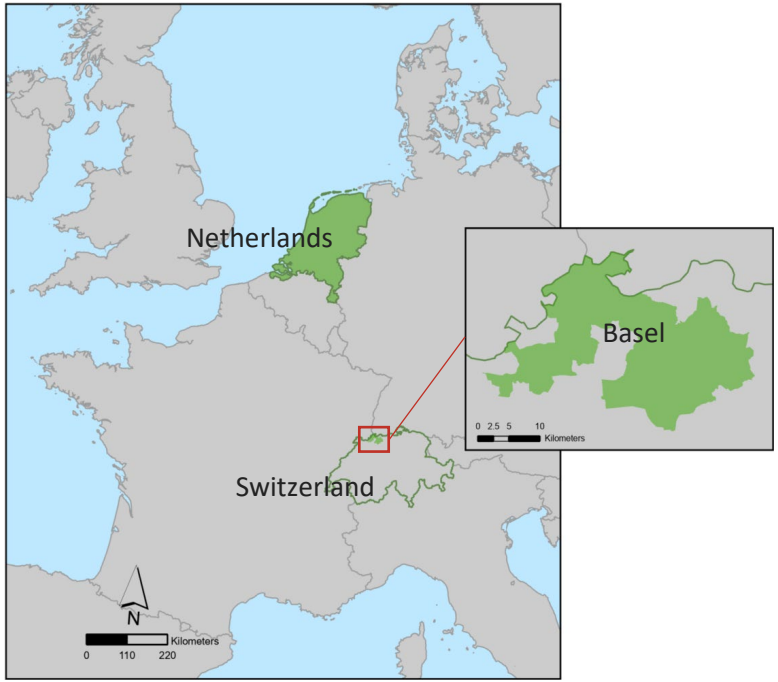


ABM to Mobility Enhanced Exposure



Tracking Campaign
Demographics Switzerland & Netherlands

		CH *	NL
N		489	189
Sex	Male	195	84
	Female	293	103
	Other	1	2
Age	18-40	90	55
	40-60	268	71
	>60	131	63
Annual Income	Low (<36'000 CHF / <25'000€)	22	18
	Middle (36'-72'000/ 25'-50'000€)	86	44
	High (> 72'000 CHF / >50'000€)	348	100
	No answer	33	27
Education Level	Primary education	5	1
	Vocational education	120	17
	Secondary education	34	14
	Tertiary education	336	157
Employment	Fulltime	291	97
	Part time / Irregular	116	37
	Homemaker / Not Working	27	16
	Retired	44	36
	Other / No Answer	11	4



*Recruited from the COVCO-Basel cohort

Tracking Devices

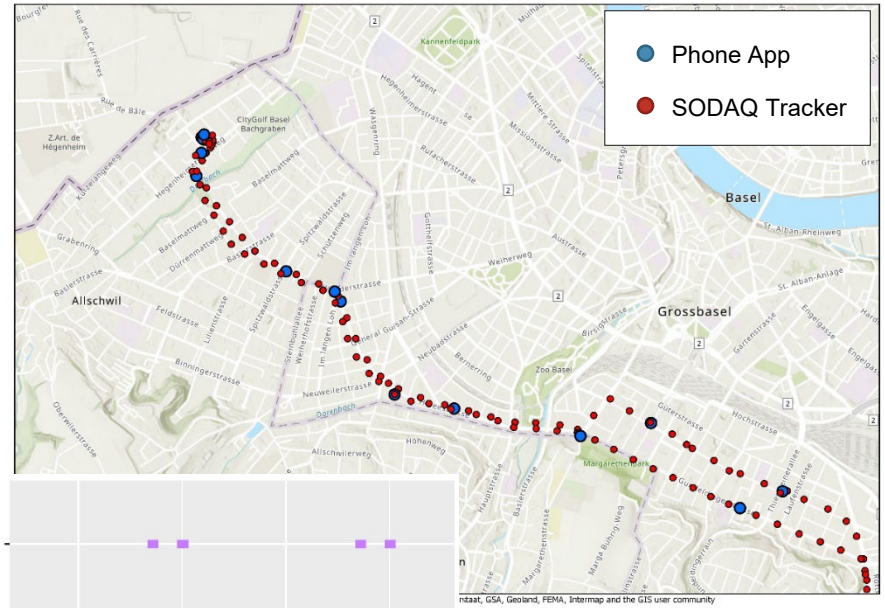
SODAQ Tracker

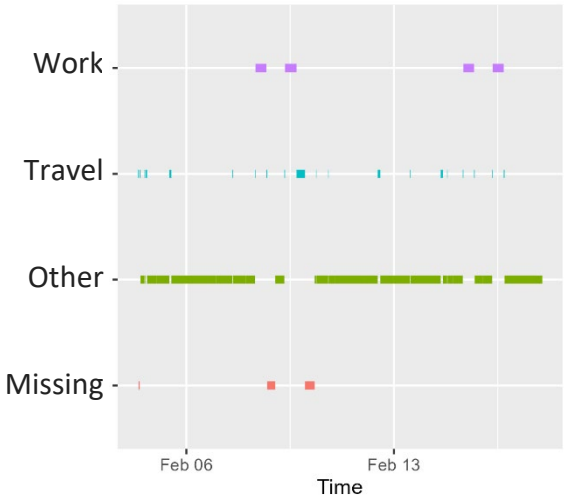
Sampling Rate:
In motion every 20 seconds, stationary every 5 Minutes

Phone App

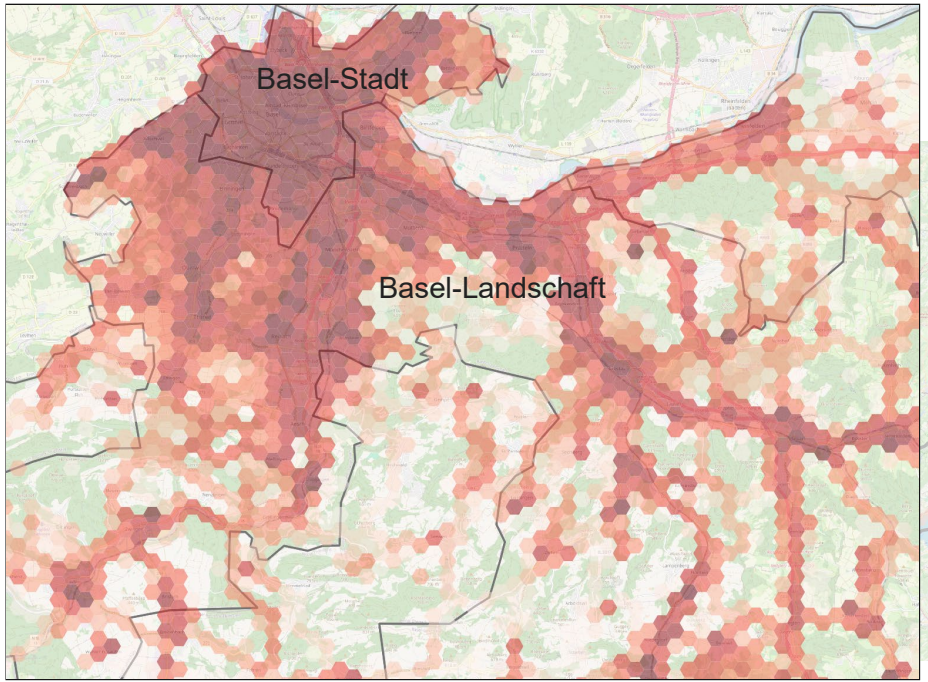
Sampling Rate:
Every 3-4 Minutes

Plus: Time-Activity Diary

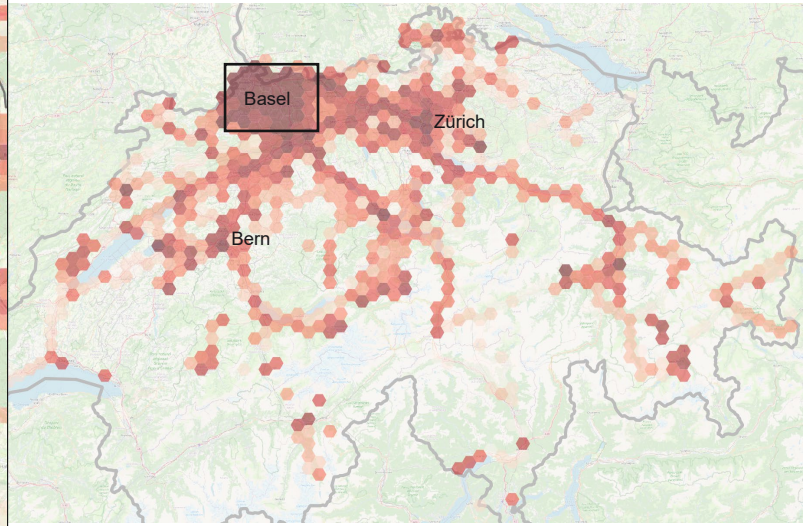




Heat map Tracking data – all GPS points



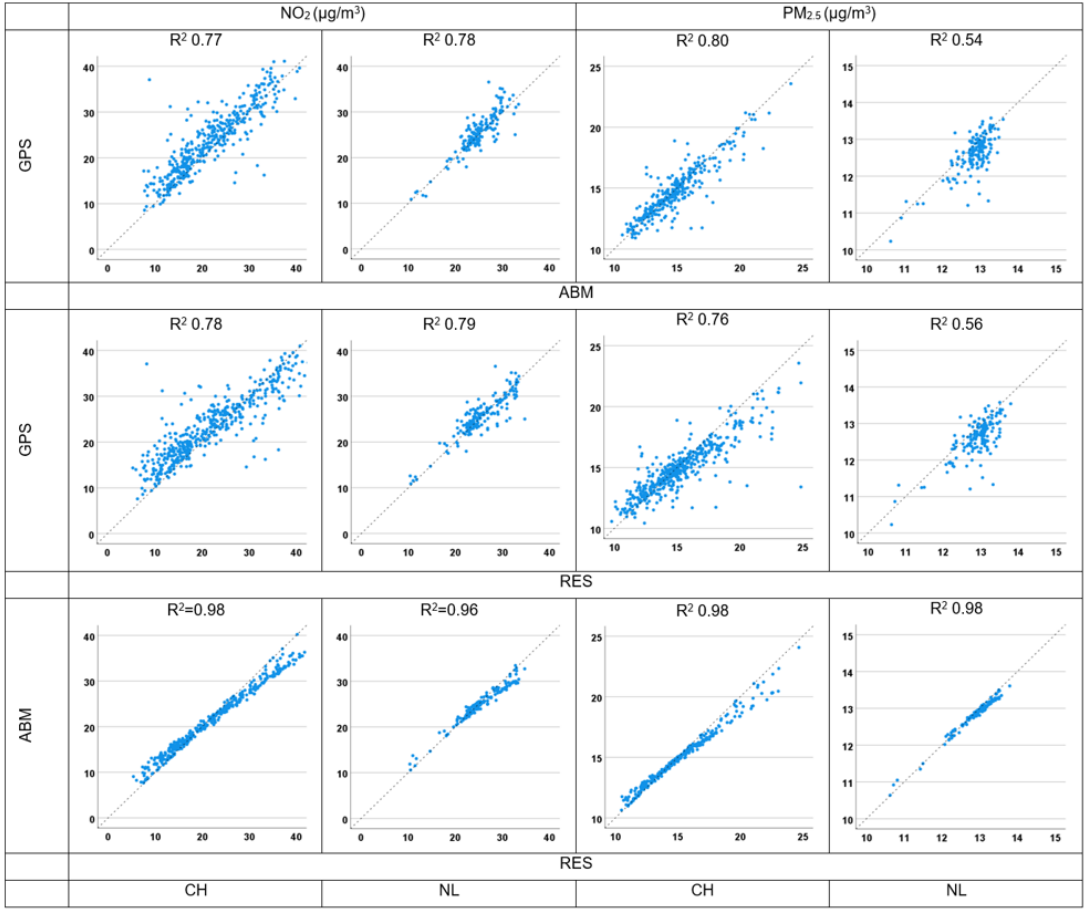
Hexagon: 500m



Hexagon: 5km

Comparison exposures

- Relationship between exposures for the Swiss and Dutch participants NO_2 and $PM_{2.5}$ exposures based on:
  - tracking data (GPS)
  - ABM mobility enhanced (ABM)
  - residential location only (RES)



Published epidemiological findings

- Very high correlation mobility-integrated and residential exposure for both pollutants and cohorts (R2 > 0.97).
- Only small differences in effect estimates between residential-only and mobility-enhanced exposure.
- Findings support that assessment of long-term air pollution exposure at the residential address only may not lead to substantial bias and loss of precision in health effects estimates


Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Full length article

Associations between long-term air pollution exposure and mortality and cardiovascular morbidity: A comparison of mobility-integrated and residential-only exposure assessment

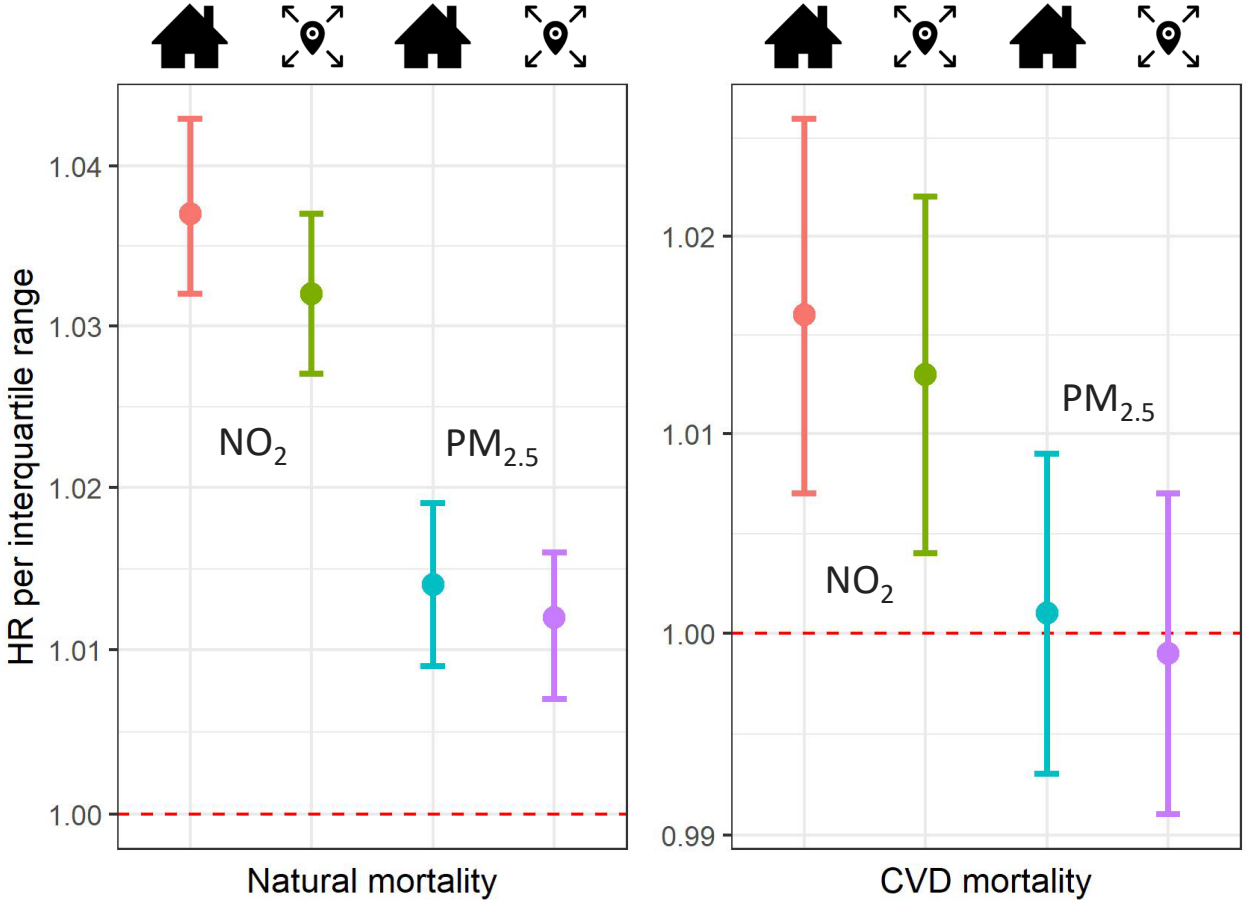
Aisha Ndiaye [a,*,1], Danielle Vienneau [b,c,1], Benjamin Flückiger [b,c], Nicole Probst-Hensch [b,c], Ayoung Jeong [b,c], Medea Imboden [b,c], Oliver Schmitz [d], Meng Lu [e], Roel Vermeulen [a], Kalliopi Kyriakou [a], Youchen Shen [a], Derek Karssenberg [d], Kees de Hoogh [b,c,1], Gerard Hoek [a,1]

https://doi.org/10.1016/j.envint.2025.109387

Swiss example

Swiss National Cohort

- HRs for natural and CVD mortality per interquartile range (IQR) increase in NO_2 and $PM_{2.5}$
- for
  - Residential
  - Mobility-enhanced exposure



Conclusions / Lessons learned

- Tracking campaign with a mobile phone only is possible
- There is a very high correlation between tracking campaign and ABM exposures
- Correlations between residential and mobility-enhanced exposures are very high
- In SAPALDIA, SNC and EPIC-NL no differences were found in health effect estimates between residential only and mobility-enhanced exposures
- Results suggest that by not including mobility + work location in exposure assessment does not lead to substantial bias in long-term air pollution health studies

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