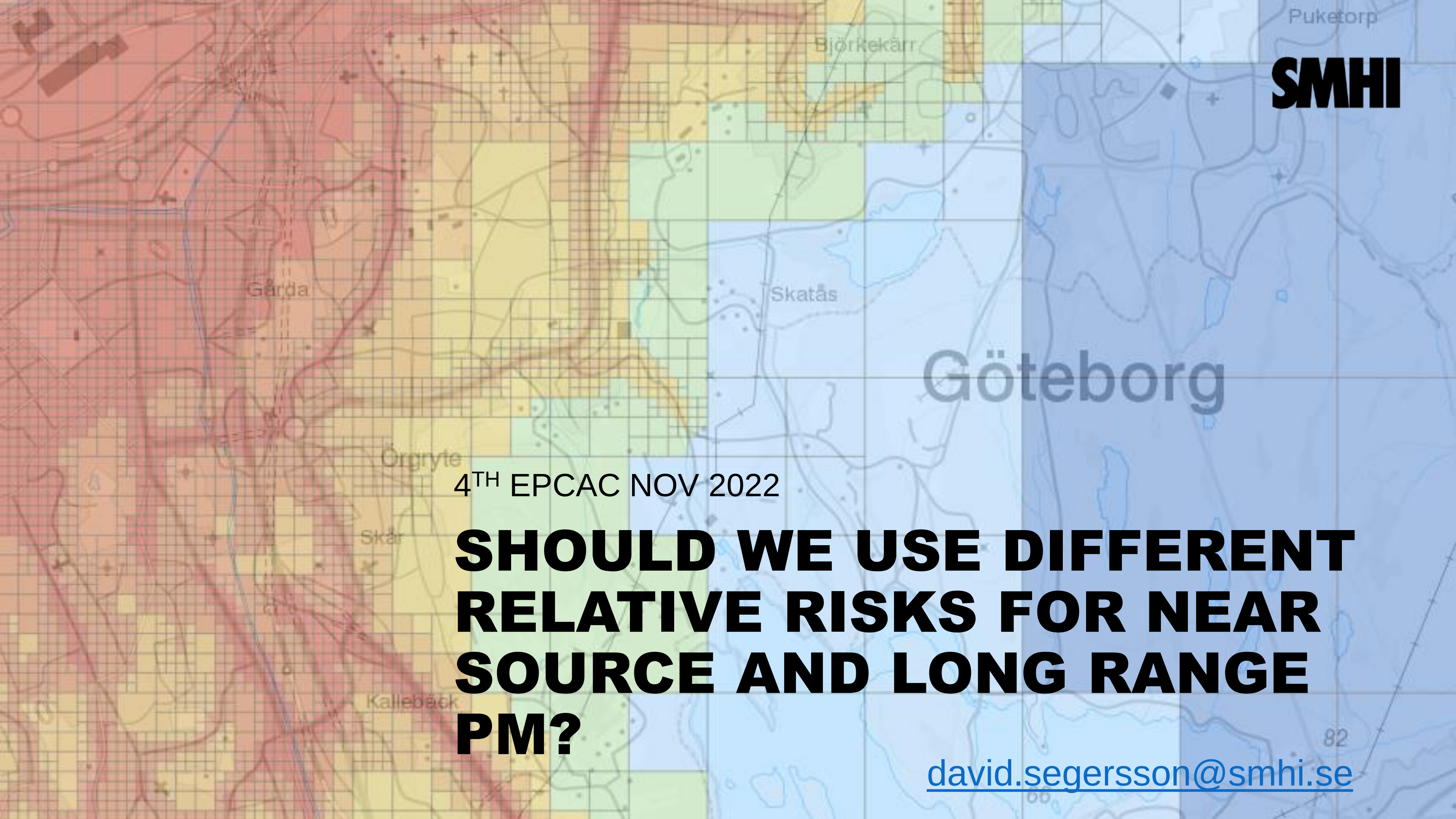

4TH EPCAC NOV 2022

SHOULD WE USE DIFFERENT RELATIVE RISKS FOR NEAR SOURCE AND LONG RANGE PM?

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Scope

- Recap of state-of-the-art related to assessment of premature mortality caused by PM (WHO and COMEAP conclusions)
- Between-city vs within-city - overview of studies comparing associations at different spatial scales
- Sensitivity analysis: how does choice of exposure-response-function affect potential of different abatement strategies in Stockholm and Gothenburg
- Conclusions

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Assessment of premature mortality due to PM exposure – state-of-the-art

- Health impact assessments mainly **focus on particles**, particularly $PM_{2.5}$
- Health effects of PM can be seen at levels **well below current standard** (1)
- **Linear exposure-response relationships reasonable** for PM and all-cause mortality(1)
- It is expected that the **relative toxicity** for PM of different sizes and of different chemical composition **differs.** However, due to insufficient evidence, they are often **treated as equally hazardous** to health in HIA (2)
- **Health effects for non-exhaust PM not considered** (…at present there was not sufficient evidence available to ascertain if non exhaust-PM had adverse effects in real-world studies(3))
- Exposure-response functions seem to be steeper at lower concentrations

(1) WHO 2013, REVIHAAP Project
(2) COMEAP (2022) Statement on the differential toxicity of particulate matter according to source or constituents
(3) COMEAP (2020) Statement on the evidence for health effects associated with exposure to non-exhaust particulate matter from road transport.’

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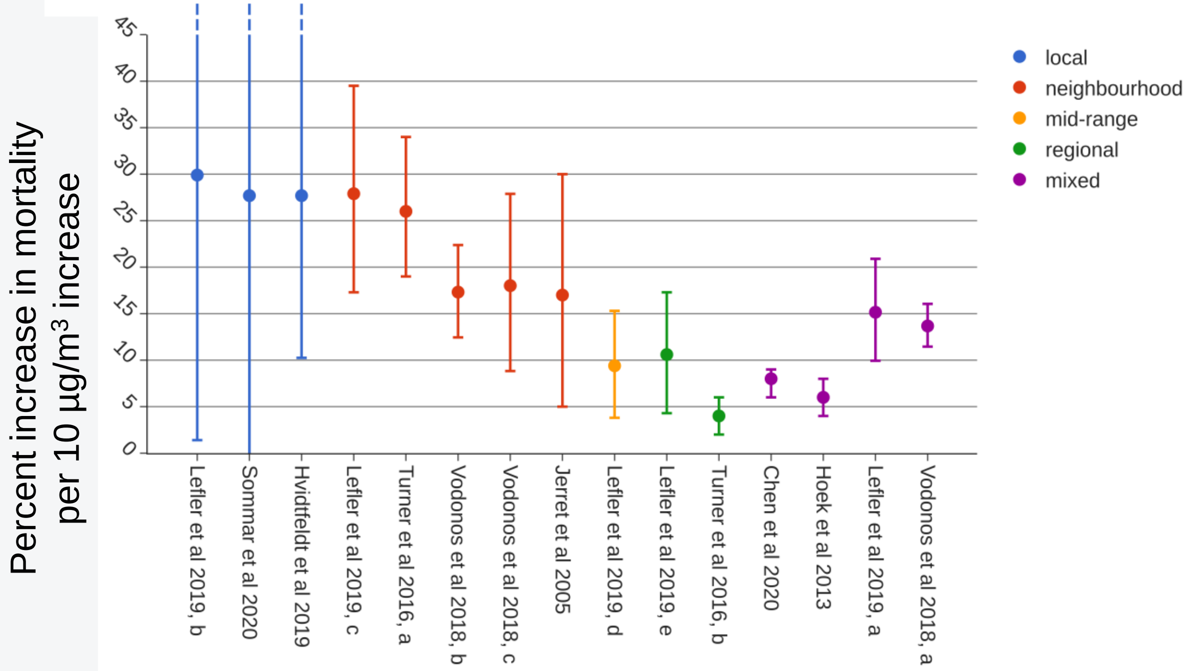
Different exposure-response functions for near-source and long-range exposure?

- *Jerret et al, 2005,* ~3 times higher increase in mortality rates per µg/m³ based on ACS kohort when studying exposure contrasts between zip-codes within Los Angeles instead of between cities
- *Turner et al 2016,* ~ 6 times higher increase in mortality rates per µg/m³ for near-source (LUR resolution < 1km) as compared to regional (model resolution 12x12 km)
- *Vodonos et al 2018,* meta-regression of 53 studies (135 estimates). Studies based on exposure resolving contrasts within cities (zip-code scale) or with relatively large traffic contribution show ~ 1.6 – 2 times higher increase per µg/m³ in mortality rates
- *Lefler et al 2019,* Systematic decomposition of effect of exposure at different scales, ~ 3 times higher but less precise risk increase per µg/m³ for local (< 1km) and neighbourhod (1-10km) as compared to regional and mid-range

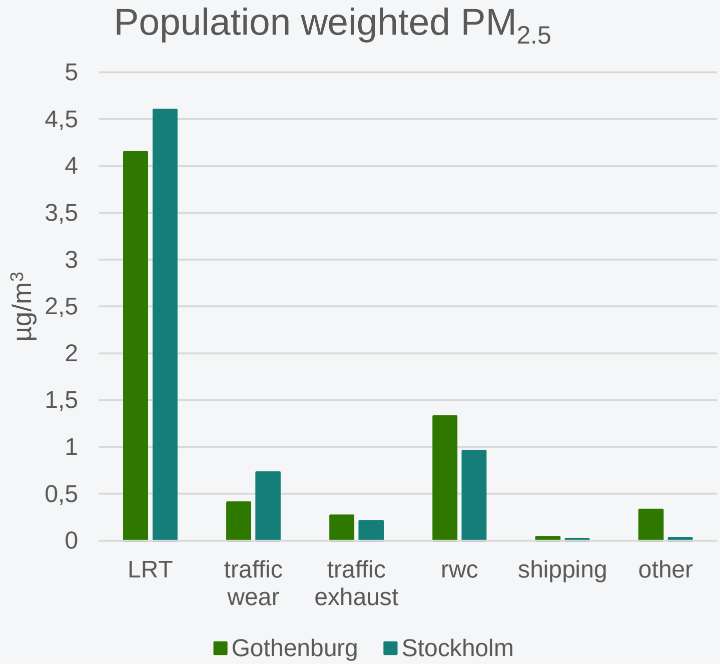
(1) Jerret et al, 2005. Spatial analysis of air pollution and mortality in Los Angeles. Epidemiology
(2) Turner et al 2016. Long-Term Ozone Exposure and Mortality in a Large Prospective Study. Am J Resp Crit Care Med.
(3) Vodonos et al 2018. The concentration-response between long-term PM2.5 exposure and mortality; a meta-regression approach. Env Res.
(4) Lefler et al 2019. Air pollution and mortality in a large, representative U.S. cohort: multiple-pollutant analyses, and spatial and temporal decompositions

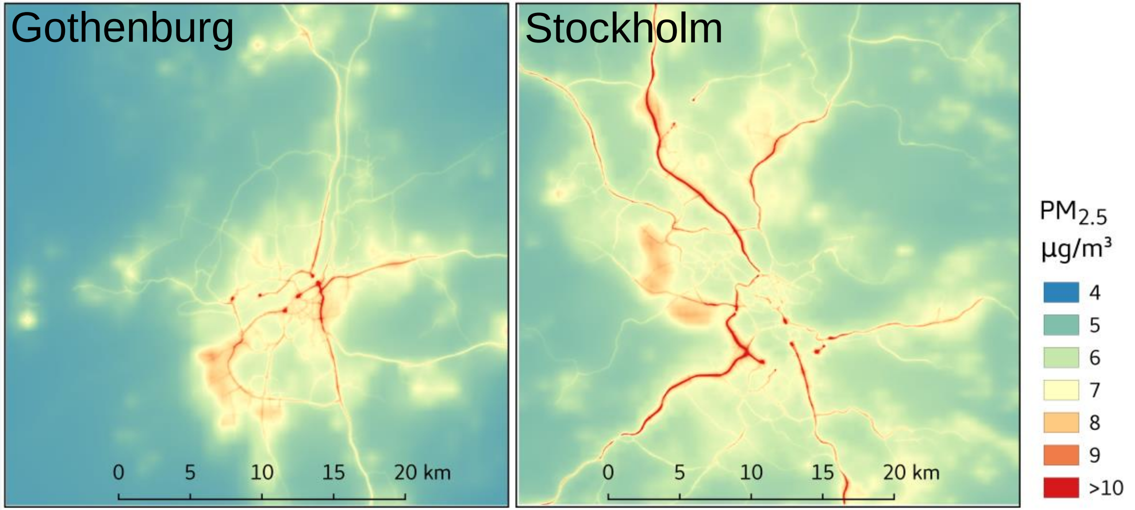
Studies based on exposure data at different scales



Segersson et al. 2021, Near-source Risk Functions For Particulate Matter Are Critical When Assessing the Health Benefits of Local Abatement Strategies.

Case study: Evaluating abatement strategies Baseline: Population exposure to $PM_{2.5}$, 2011





Yearly average concentration $PM_{2.5}$

Segersson et al 2017, Health impact of PM10, PM25 and Black Carbon Exposure Due to Different Source Sectors in Stockholm, Gothenburg and Umea, Sweden. Int J Env Res Public Health.

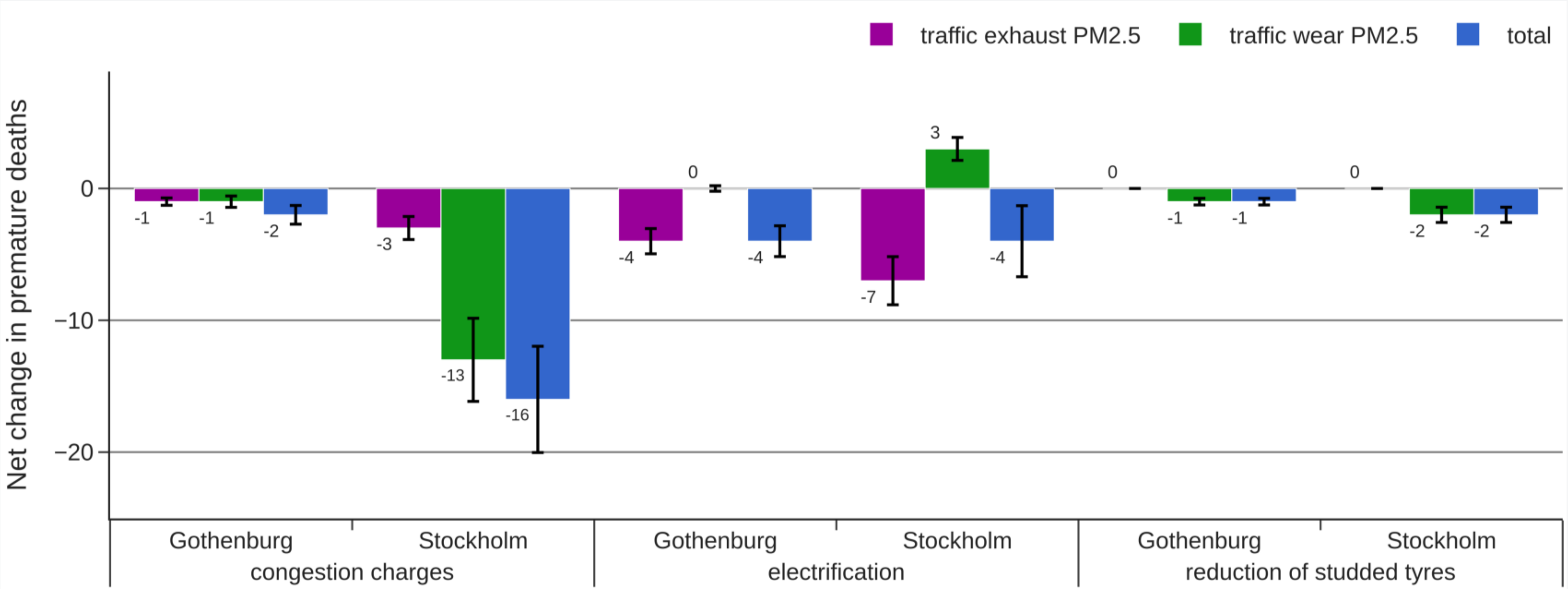
Abatement strategies

- Electrification of 50 % of light vehicles (-exhaust, +wear)
- Introduction of congestion charges (-exhaust, -wear)
- Reduced use of studded tires (-wear)

Local ban for studded tyres

Vehicle exhaust emissions

Net-change in pre-term deaths due to abatement strategies relative risks according to WHO(1)



Segersson et al. 2021, Near-source Risk Functions For Particulate Matter Are Critical When Assessing the Health Benefits of Local Abatement Strategies.

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Sensitivity analysis – different choices of relative risks

- **A. WHO standard**
  - 8% for all PM2.5 (Chen et al. 2020)
- **B. Different relative risks for near-source and long-range $PM_{2.5}$**
  - 4 % for long-range $PM_{2.5}$ (Turner et al. 2016)
  - 26% for local $PM_{2.5}$ (Turner et al. 2016)
- **C. Also different relative risks for exhaust and non-exhaust PM**
  - 4% for long-range $PM_{2.5}$ (Turner et al. 2016)
  - 70% for local traffic exhaust BC (Sommar et al. 2020)
  - 17% for local traffic non-exhaust PM_{10} (Sommar et al. 2021)

All risk ratios given per 10 µg/m³

Sensitivity analysis – different choices of relative risks

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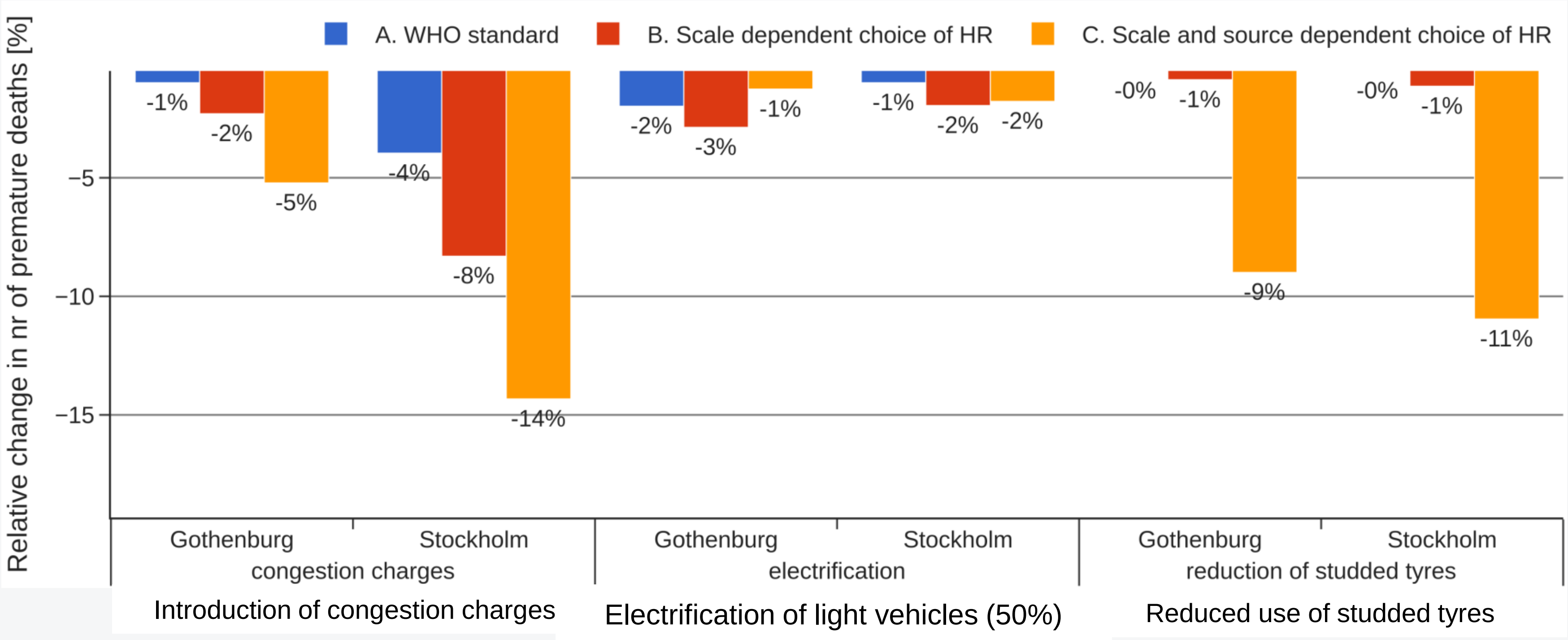

Segersson et al. 2021, Near-source Risk Functions For Particulate Matter Are Critical When Assessing the Health Benefits of Local Abatement Strategies.

Conclusions

- Not using relative risks based on “within-city” contrasts in exposure, likely leads to an underestimation of effects from local measures.
- Following WHO recommendations, increased mortality from PM in Stockholm and Gothenburg is mainly caused by long-range transport. Using different relative risks for near-source and long-range exposure, local sources become more important.
- Different measures may address different fractions of PM – application of relative risks recommended by WHO[(1)] may be misleading when comparing different abatement strategies
- Difficult to separate effects of exhaust and non-exhaust PM in epidemiological studies due to high correlation. Relative risks based on exposure to non-exhaust PM probably also to some extent include the effect from exhaust PM (and vice versa).
- If exhaust PM is assumed more toxic than non-exhaust PM, relative risks using BC as indicator are preferable. BC is not as “diluted” by non-exhaust PM and more dominated by vehicle exhaust, making it more representative.


Thank you!