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Air pollution and lung development in the child

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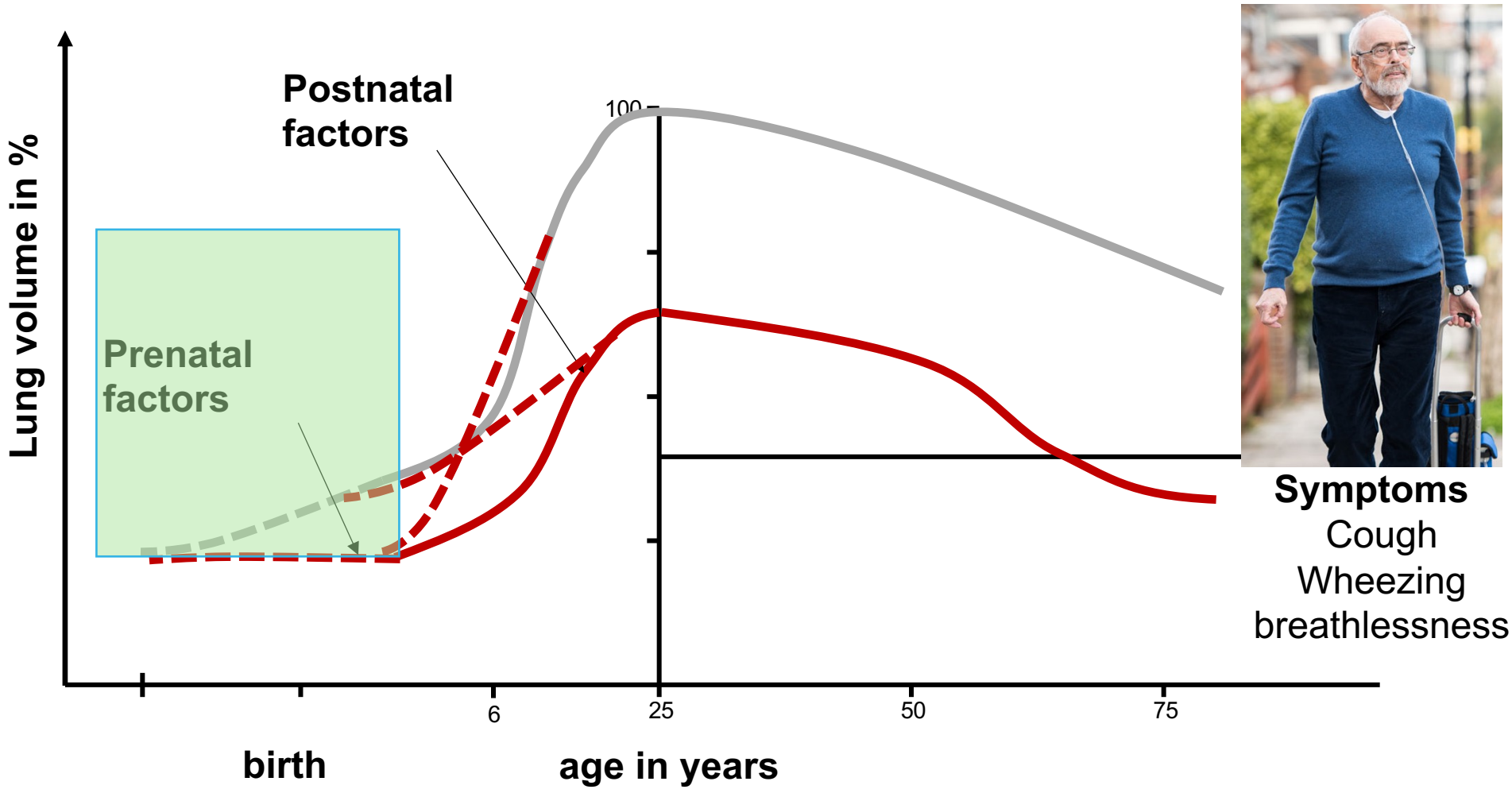
Agenda

- **Background**
- Lung development, focus on pregnancy
- Air Pollution

- **Impact of small particles on early lung development**
- Nanoparticles

- **Impact of “larger” particles on early and later lung development**
- Particulate matter

Lung development throught life and influencing factors



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adapted from Baraldi & Fillipone et al. *NEJM* 2007
www.blf.org.uk/support-for-you/oxygen/life-with-oxygen

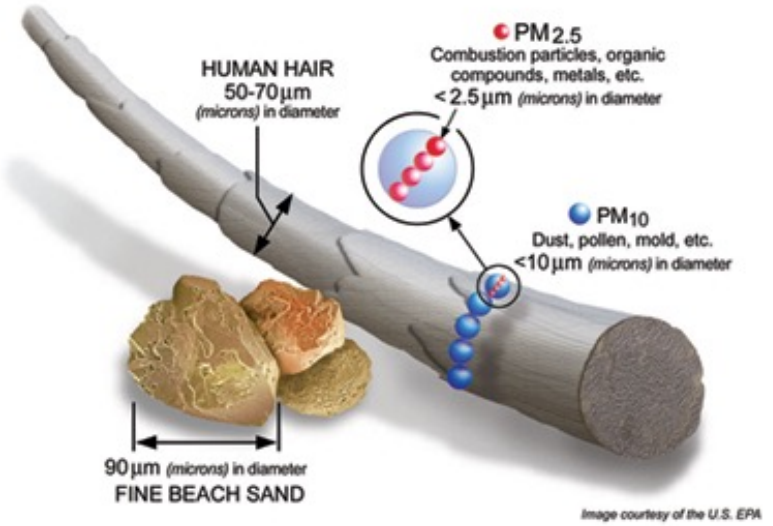
Background on pollutants

Outdoor air pollutants

Particulate matter (PM_{10}, $PM_{2.5}$, PM_1), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), lead, polycyclic aromatic hydrocarbons (PAH)

PM: particulate matter / size in µm

- Origin mostly traffic and industry
- Rather homogenous spatial distribution



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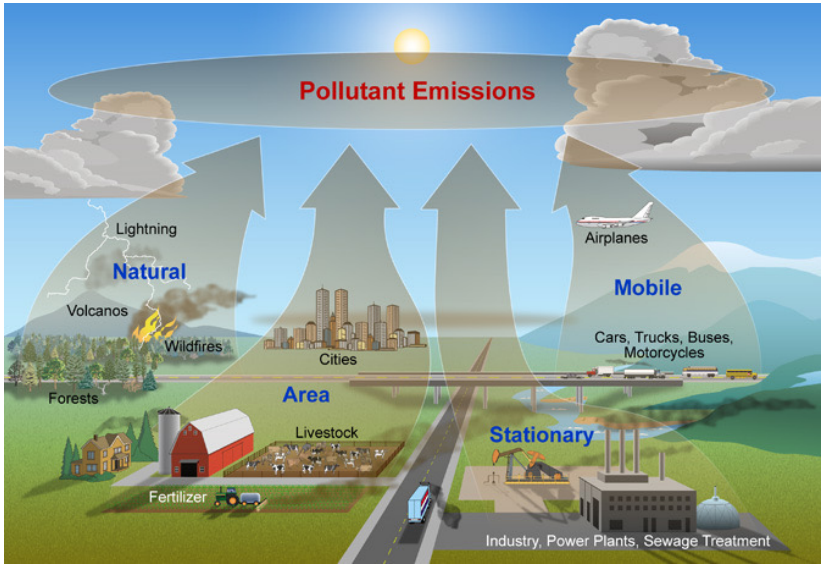
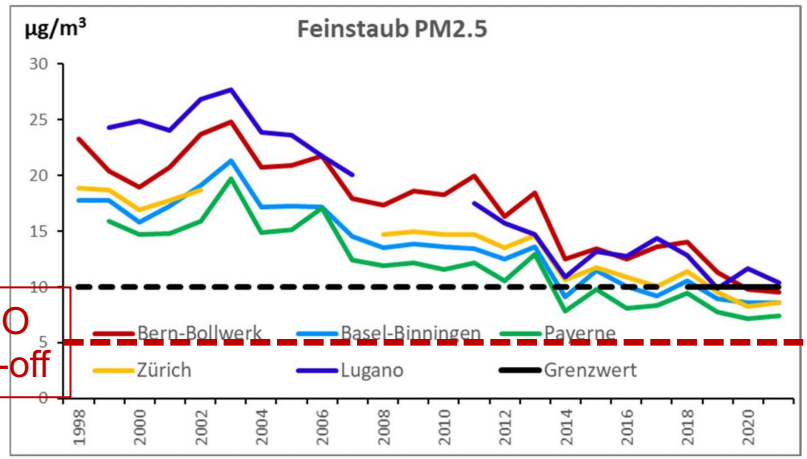


Air pollution – Temporal development in Switzerland

Temporal development $PM_{2.5}$



WHO Cut-off

Source: NABEL, results of national measurement stations, BAFU, EMPA, accessed 31.03.2022

Air Pollution during pregnancy: mechanisms

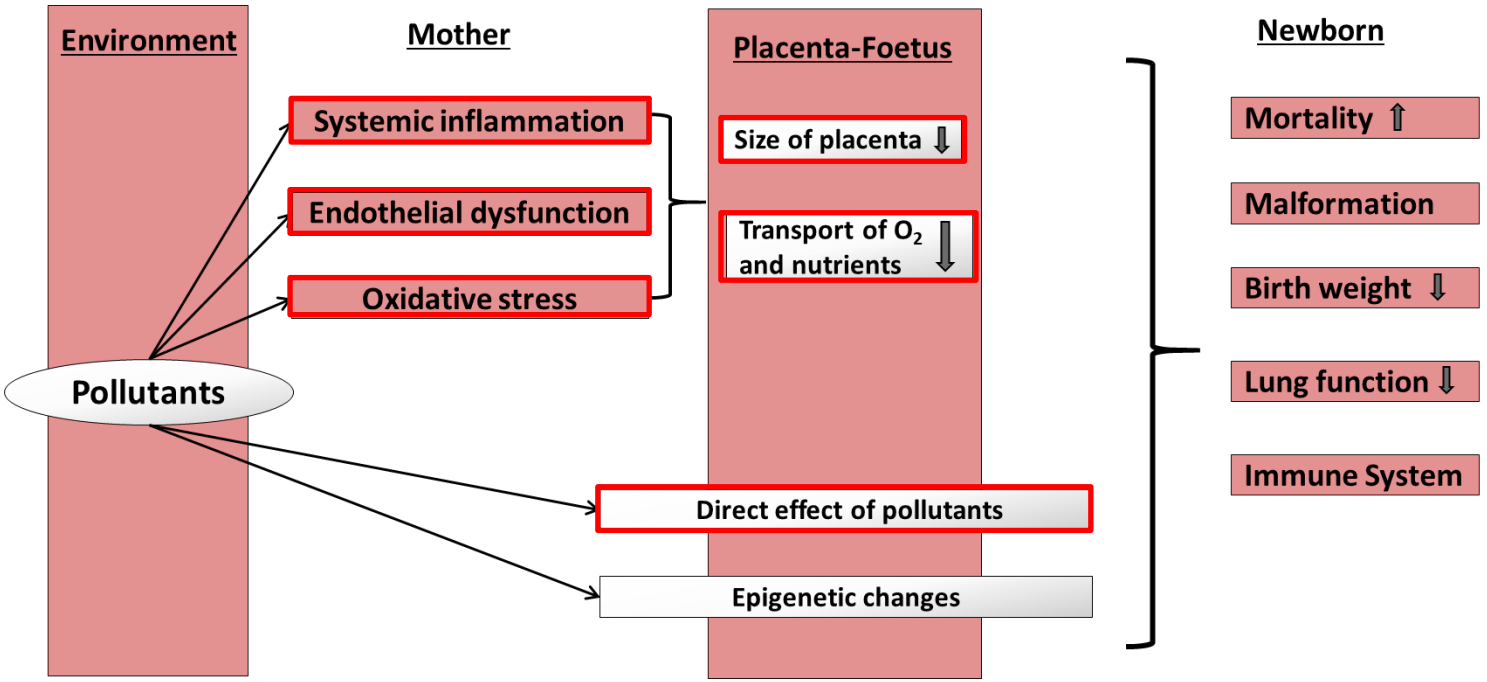
- Dependent on stage of development
- Systemic effect on the mother:
  - reduced placental perfusion
  - reduced nutrient exchange
- Direct toxic effect through placental transfer of pollutants e.g. nanoparticles

Proinflammatory/oxidative/hormonal stress effect

- Changes to the immune system development
- Changes to lung growth and development
- Genetic interactions/epigenetic effects

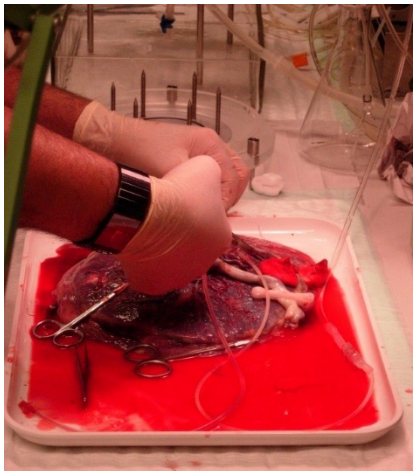
Lee et al. *Epidemiology 2011*, reviewed in Slama et al. *Env Health Persp 2008*

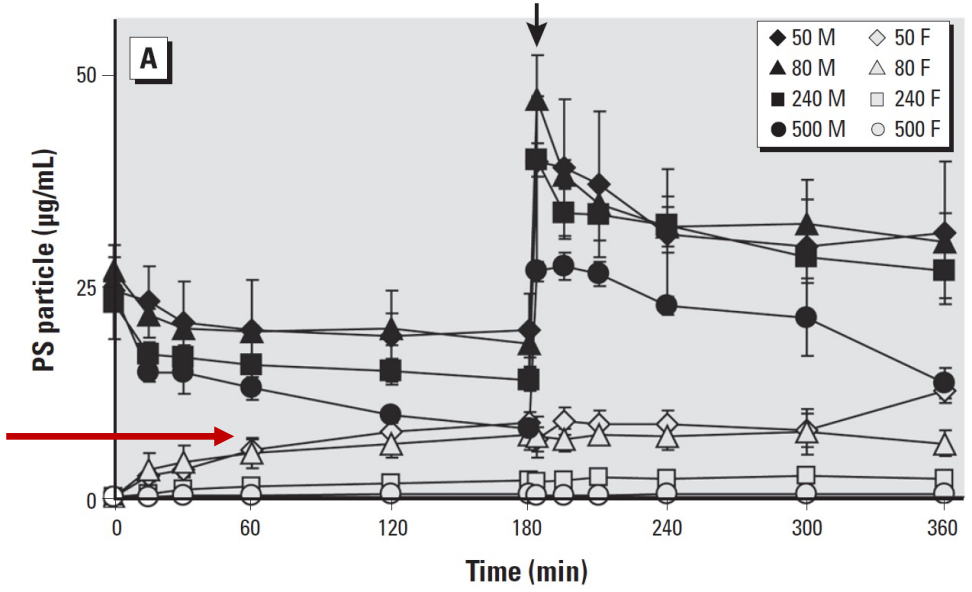
Air Pollution during pregnancy



Lee et al. *Epidemiology 2011*, reviewed in *Slama et al. Env Health Persp 2008*
adapted from Korten et al. *Ped Resp Rev 2017*

Placental crossing of nanoparticles

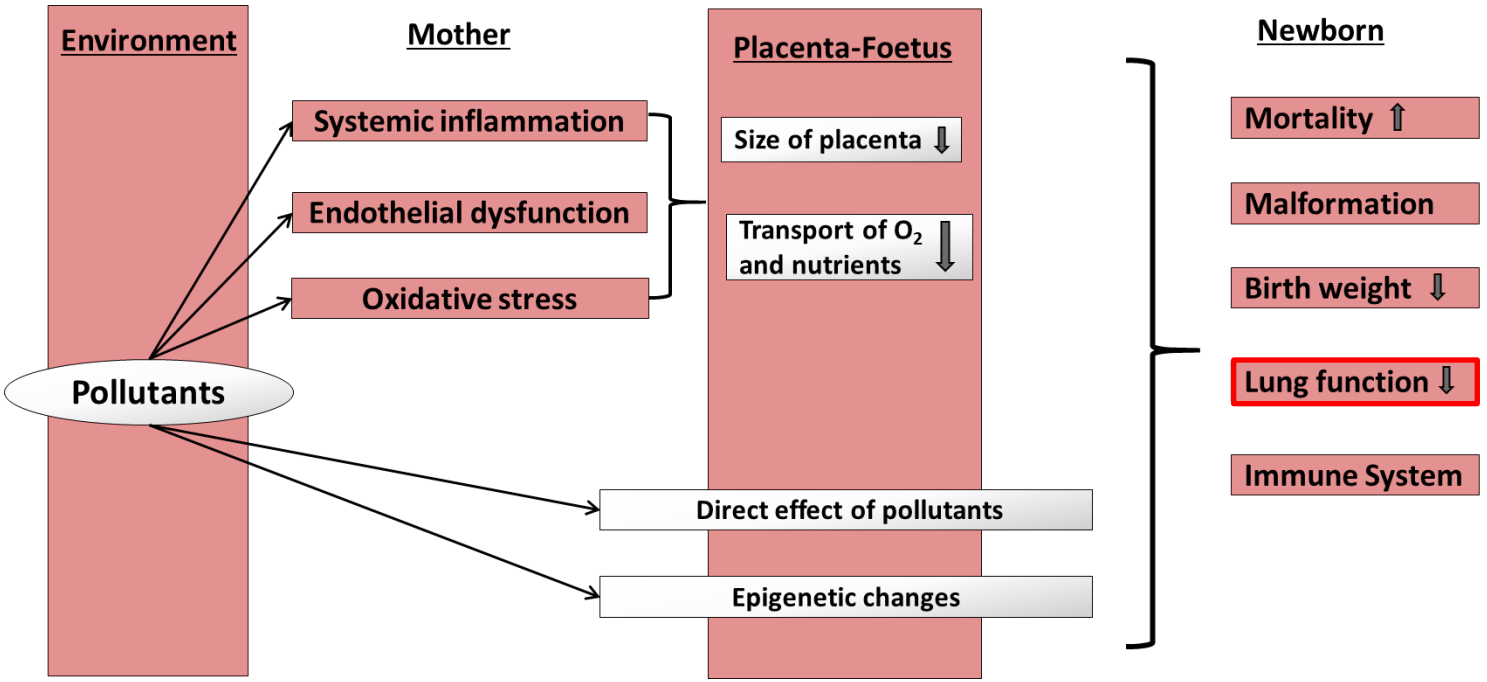




WHO guideline for protection of exposed groups – outcome respiratory health

- Higher biomarker for oxidative stress in exposed groups compared to unexposed groups
- Lung function did not differ between groups
- Prevalence of allergic dermatitis and sneezing was higher among those exposed to nanomaterial

Air Pollution during pregnancy



Lee et al. *Epidemiology 2011*, reviewed in *Slama et al. Env Health Persp 2008*
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Infant lung function – Switzerland

BILD Cohort
Basel Bern Infant Lung Development Cohort

- 241 term-born infants from the BILD cohort
- Exposure towards PM_{10} and NO_2 during pregnancy
- Lung function at around 4 weeks

Latzin et al. *ERJ 2009*
www.scild.ch accesed 22.6.2023

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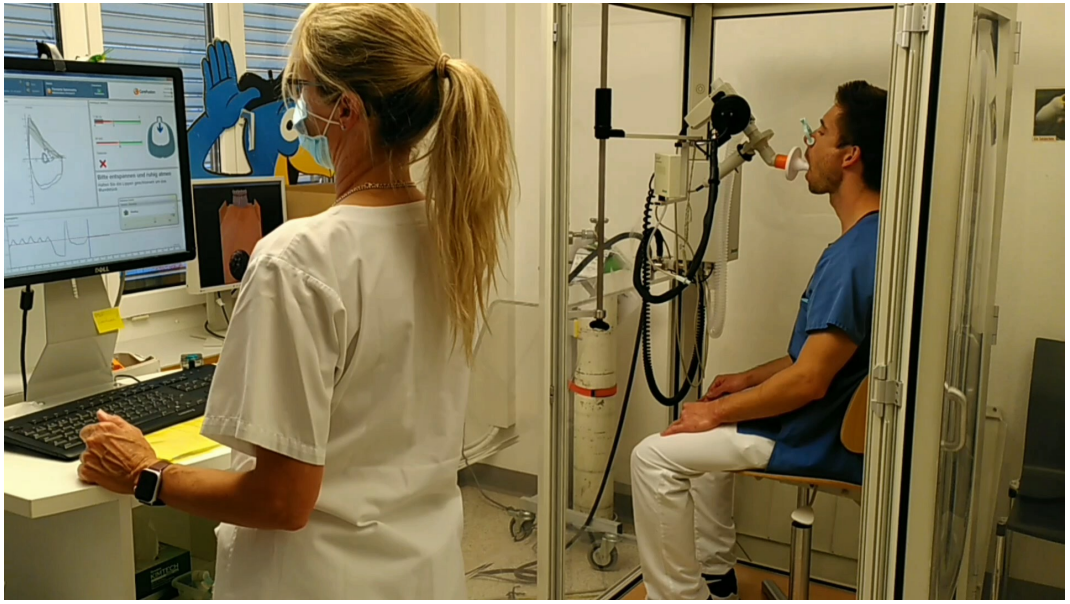
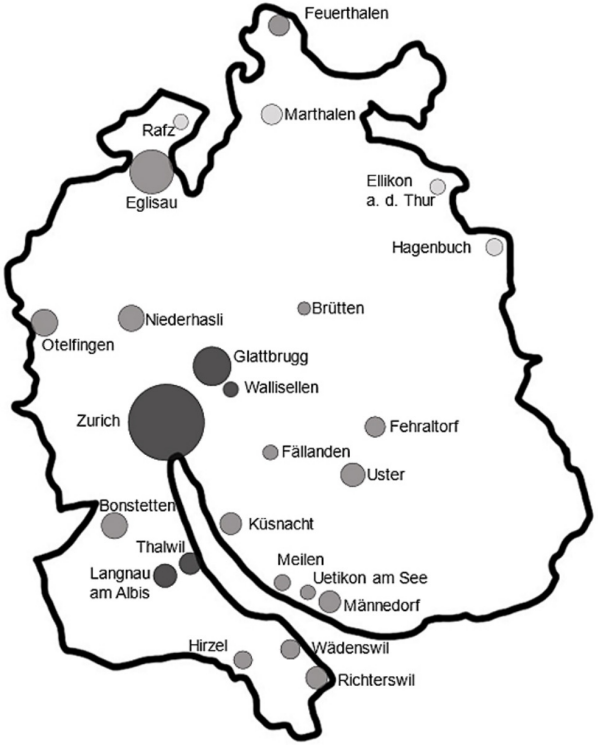
	Basic model			Full model		
	coefficient	**CI 95%**	**p Value**	**coefficient**	**CI 95%**	**p Value**
Prenatal PM_{10} and Minute ventilation [mL/min]	**19.9**	**4.7 – 35.0**	**0.010**	**24.7**	**8.9 – 40.5**	**0.002**
Prenatal NO_2 and eNO [ppb]	**0.67**	**0.23 – 1.10**	**0.003**	**0.96**	**0.44 – 1.48**	**<0.001**

Childood lung function – Switzerland
The LuftiBus in the School (LUIS) Study

- School-aged children, population based
- Air pollution exposure, outcome lung function

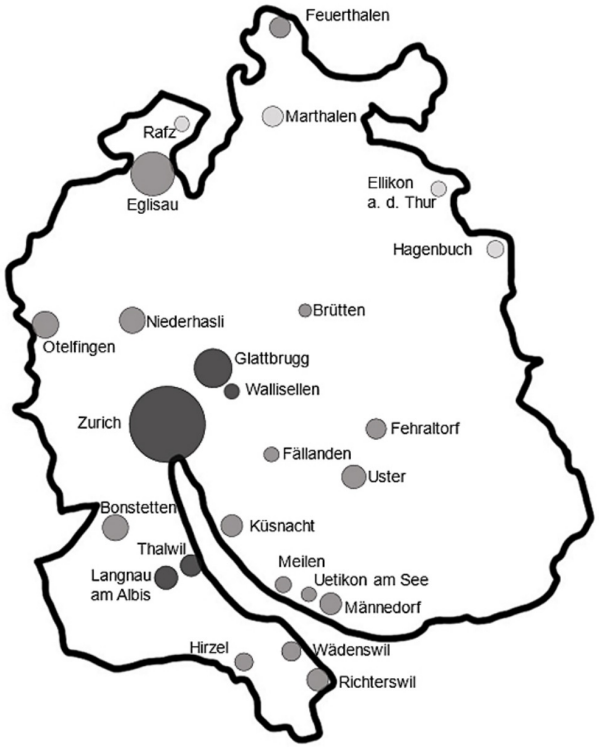




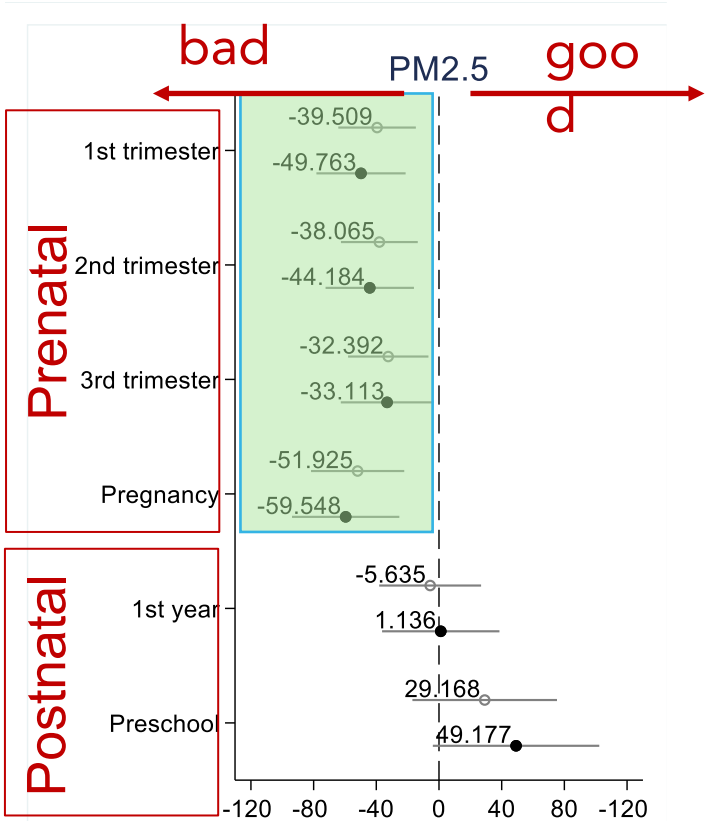
Childood lung function – Switzerland
The LuftiBus in the School (LUIS) Study

- School-aged children, population based
- Air pollution exposure and lung function

- N=2182, mean age 12 years (6-17)
- Individual air pollution assignment, different time windows
- Mean pregnancy $PM_{2.5}$ levels 23.5 $\mu g \cdot m^{-3}$



Prenatal but not later $PM_{2.5}$ exposure is associated with reduced lung function at school age



$PM_{2.5}$ exposure during pregnancy is associated with reduced lung function at school age

Conclusion and outlook

- Nanoparticles cross the placenta
- Impact of nanoparticles on childhood respiratory health is poorly understood

- Even low-to moderate levels of air pollution are association with impaired lung development
- Stronger effects seem to exist during period of fastest lung growth
- Impact of low air pollution levels (below WHO cut-off) unknown

Acknowledgements

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- Professor Philipp Latzin, Bern
- PD Dr. Kees de Hoogh & Professor Martin Röösli, Swiss TPH Basel
- Professor Möller, Zürich
- Professor Kühni, Bern

Thank you for your attention

Luftverschmutzung:
ein aktuelles und relevantes Thema

Luftverschmutzung

EU-Kommission verklagt Deutschland

New WHO Global Air Quality Guidelines aim to save millions of lives from air pollution

Air pollution is one of the biggest environmental threats to human health, alongside climate change.

WHO Updated Guideline 2021 Zusammenfassung

- Luftverschmutzung ursächlich für 7 Millionen vorzeitige Todesfälle pro Jahr
  - Kinder: Lungenwachstum
  - Erwachsene: Herzerkrankungen, Schlaganfälle
- Stickstoffdioxid (NO_2) **Feinstaub (Particulate matter PM)**

- 90% der globalen Bevölkerung exponiert zu $PM_{2.5}$ oberhalb der WHO Grenzwerte
- Einkommensschwächere Länder haben hohe Luftverschmutzung

The LUIS Study – particulate matter development