Indoor and outdoor concentrations of ultrafine particles in selected homes of SAPALDIA subjects in Switzerland

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SAPALDIA
Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults

SAPALDIA 1 started 1992/1993
with 9'651 subjects in 8 areas

SAPALDIA 3, 2010/2011
with ~ 6’200 subjects in 8 (?) areas

Data collection:
- Interview
- Health examination
- Air pollution measurements

=> Exposure models and assessment of health impact
Air pollution is usually measured outdoors
Air pollution is usually measured outdoors
Ventilation determines indoor exposure to outdoor pollutants
Indoor sources contribute to exposure to various pollutants
Indoor sources contribute to exposure to various pollutants

Main research question

- What are the long-term exposure levels to traffic air pollution among general Swiss population?

Objective of this study

- Describe indoor and outdoor levels of air pollutants with a focus on ultrafine particles (UFP) within and across four SAPALDIA areas
- Investigate indoor/outdoor relationships

Aim

Development of indoor models to predict indoor exposure to air pollutants with outdoor origin
SAPALDIA 3 indoor and outdoor air pollution monitoring

20 sites per area
Repeated measurements
3 seasons x 2 weeks

Questionnaires

UFP, PM$_{2.5}$, PM$_{10}$, PM$_{\text{absorbance}}$, NO$_2$
Ultrafine particles
- miniDiSC
- 1-2 week real-time measurements
- Size range ~15-300 nm

$\text{PM}_{2.5}$ & $\text{PM}_{10}$
- Harvard Impactors (4 L/min)
- 37mm Teflon filter (23±2°C 35±5% RH)
- 2-week samples
  $\Rightarrow \text{PM}_{\text{absorption}}$ (smokestain reflectometer)

$\text{NO}_2$
- Passive samplers (passam)
- 2-week samples
Indoor UFP: numbers are lower and diameters are higher

Weekly averages from 90 measurements (48 sites) without tobacco smoke influence
High temporal variation indoors and outdoors

Hourly averages from measurements without tobacco smoke influence

Number of averages:
- Spring: 4'568 hours
- Summer: 7'290 hours
- Winter: 6'579 hours

Averages below 1'000 particles/cm³ not plotted
Correlation of indoor and outdoor hourly PNC are generally higher in summer

<table>
<thead>
<tr>
<th></th>
<th>Basel</th>
<th>Geneva</th>
<th>Lugano</th>
<th>Wald</th>
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<td>All seasons</td>
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<td>0.43</td>
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<td>Spring</td>
<td>-0.22*</td>
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<td>Winter</td>
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</table>

Measurements without tobacco smoke influence
*based on only one weekly measurement
Outdoor PNC are reflected indoors

Traffic peaks

Cooking*

Diurnal 15 min averages from measurements without tobacco smoke influence

*or other indoor source
Large variability of I/O ratios between sites

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Sites</th>
<th>I/O ratio</th>
<th>Pearson Correlation</th>
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<tr>
<td><strong>PNC</strong></td>
<td></td>
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<td>Median (10th; 90th Percentile)</td>
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<td>All areas</td>
<td>90</td>
<td>48</td>
<td>0.72 (0.27; 1.54)</td>
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<td><strong>PM$_{2.5}$</strong></td>
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<td>Median (10th; 90th Percentile)</td>
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<td>156</td>
<td>64</td>
<td>0.73 (0.37; 1.28)</td>
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<td>156</td>
<td>64</td>
<td>0.74 (0.41; 1.12)</td>
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<tr>
<td>All areas</td>
<td>175</td>
<td>66</td>
<td>0.55 (0.21; 0.99)</td>
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</tbody>
</table>

One week (PNC) and two week measurements (PM$_{2.5}$, PM$_{abs}$, NO$_2$) without tobacco smoke influence
Conclusions

- In general, indoor UFP levels were lower compared to outdoor levels
- Average indoor and outdoor PNC were 7'300 particles/cm$^3$ (IQR=6'500) and 9'100 particles/cm$^3$ (IQR=9'500), respectively
- Diurnal patterns of outdoor ultrafine particle levels were distinctly observed indoors
- Large variability of I/O ratios between sites was found
- Data will be used for indoor models to estimate indoor exposure to air pollutants with outdoor origin

Acknowledgements

SAPALDIA team and study participants;
BAFU & NABEL; Cantonal air monitoring agencies
## Spearman correlations between time-matched measurements of air pollutants

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<th>PNC&lt;sub&gt;_out&lt;/sub&gt;</th>
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Measurements without tobacco smoke influence (in parenthesis the number of co-located and time matched measurements)