Indoor/Outdoor Seasonal Variability of Different Particle Metrics

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Summary

Background and objective A number of studies in the Mediterranean area showed much higher (up to 10 times higher) short term health effects of airborne particles (e.g. mortality[1]) during the warm compared to the cold season. We analyzed whether seasonal variability of air exchange rate and of various metrics of airborne particles may be responsible of these differences in the health effects.

Conclusions We found relevant differences between seasons in the I/O relationships of various physical and chemical characteristics of particulate matter. Air exchange rates are not capable to entirely explain the seasonal variability of the health effects. Higher percentage of sulfates, vanadium and nanoparticles for a unit $PM_{2.5}$ concentration could play a role in increased toxicity during the summer season.

[1] Samoli et MED-PARTICLES Study Group. Associations between fine and coarse particles and mortality in Mediterranean cities: results from the MED-PARTICLES project. Environ Health Perspect. 2013 Aug;121(8):932-8.

Methods

Figure 1. Location of the urban area of Modena

Two 15-days monitoring campaigns were conducted in February and June 2014. **Measurements** were performed **simultaneously indoor and outdoor** in an **uninhabited apartment** in the city of Modena (Italy). The city is located in one of the most urbanized, industrialized and polluted areas of Europe. Measurements included **size distribution, mass and chemical composition of** $\mathbf{PM_{2.5}}$ (metals, ions, organic and elemental carbon). Air Exchange Rates were measured in both seasons in open as well as closed windows. We simulated the **typical behaviour of elderly people in regulating natural ventilation** based on the data collected on an hourly basis in a previous survey.

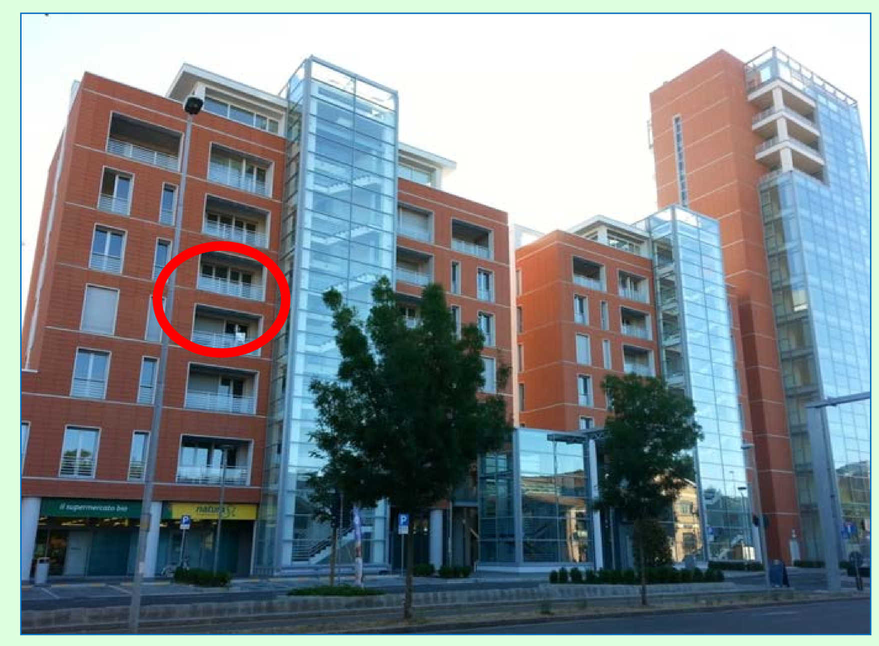

Figure 2. Measurement site

Results

$PM_{2.5}$ mass and UFP concentration

Much higher I/O ratio during the warm compared to the cold season both for $PM_{2.5}$ (0.91 vs 0.51) and UFP (1.01 vs 0.55)

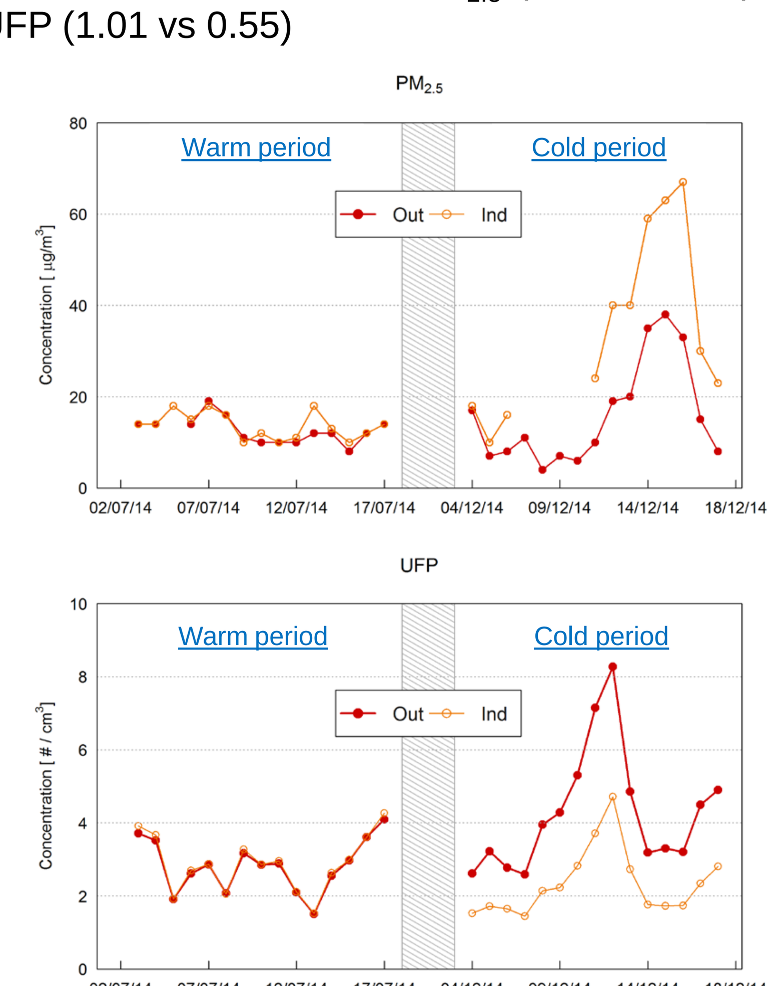

Figure 3. Outdoor and indoor mean concentrations of $PM_{2.5}$ (upper panel) and ultrafine particle concentration (UFP) during the two monitoring periods.

Higher correlation of $PM_{2.5}$ with >100 nm particles. Lower correlation were found between fine and ultrafine particles.

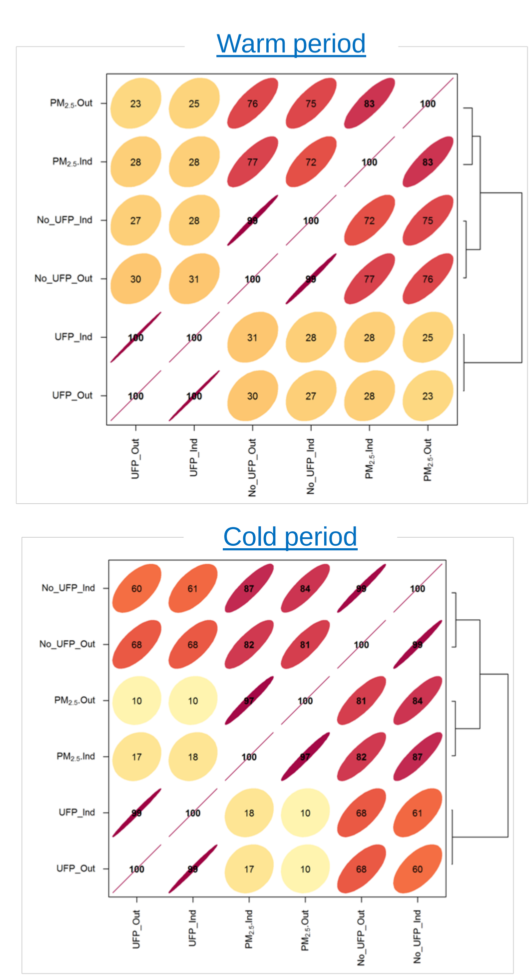

Figure 4. Correlation tables and dedrograms for indoor and outdoor daily concentrations of $PM_{2.5}$ and particles with diameter below and above 100 nm during the two monitoring periods.

Size distribution

Relevant differences in size distribution between seasons with lower concentration of ultrafine particles during the warm season but with higher percentage of particles below 30 nm.

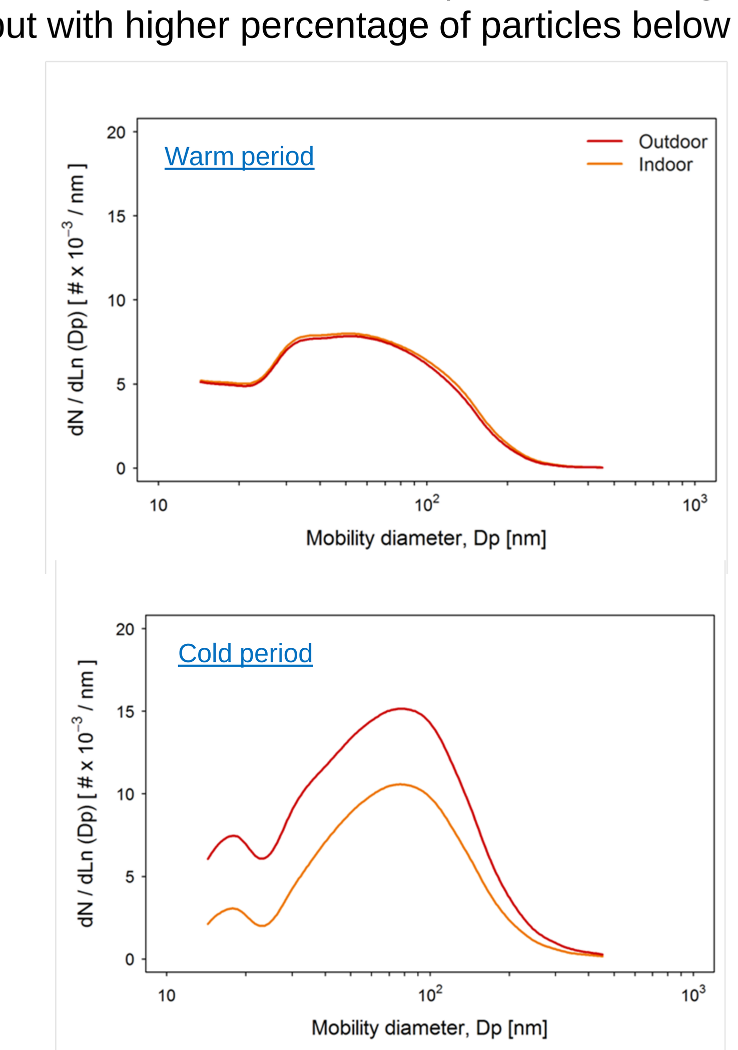

Figure 5. Indoor and outdoor particle size distribution during the two monitoring periods.

Chemical composition

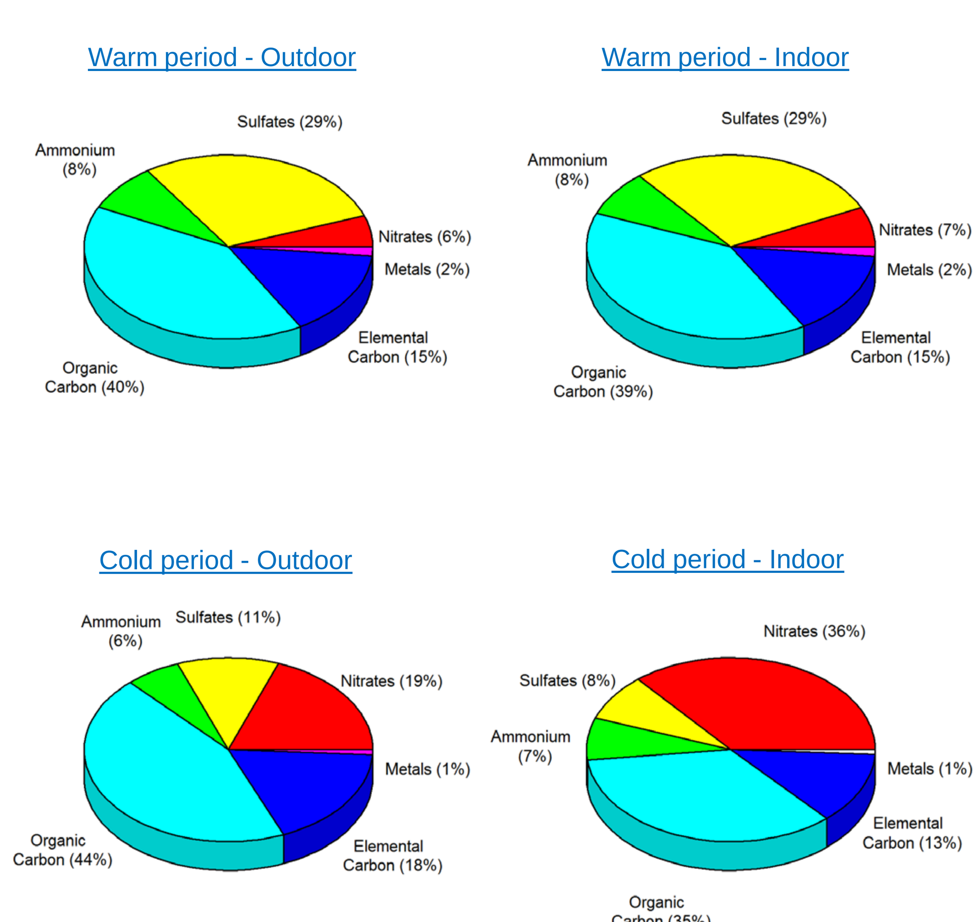

Figure 6. Indoor and outdoor mean concentrations of the major chemical components of $PM_{2.5}$ during the two monitoring periods

Very similar indoor and outdoor mean concentrations of all chemical components during the warm season

Dramatic drop of nitrates from outdoor to indoor during the cold season

Higher absolute (and obvioulsy relative) concentrations of Vanadium during the warm compared to the cold season

Much lower proportion of sulfates during the cold season, both indoor and outdoor

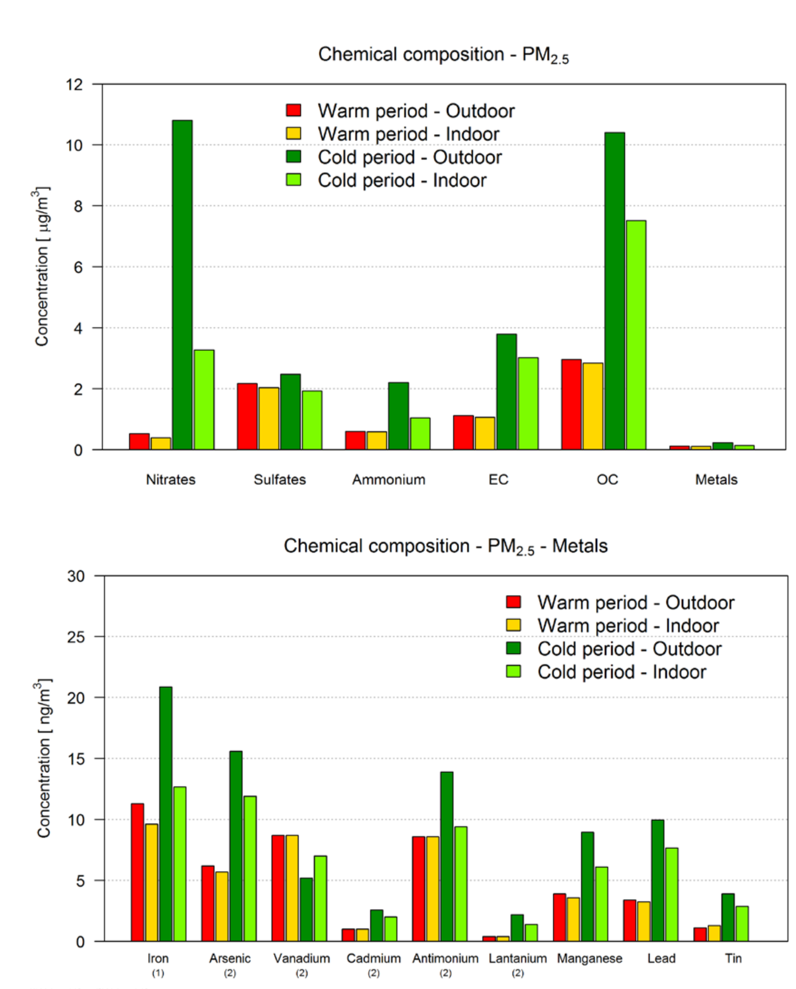

Figure 7. Indoor and outdoor mean concentrations of several metals during the two monitoring periods

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