

# Environmental exposure to fine particles in Gothenburg

- personal exposure and its variability, indoor and outdoor levels, and effects on biomarkers

Akademisk avhandling

som för avläggande av medicine doktorexamen vid Sahlgrenska Akademin vid Göteborgs universitet kommer att offentligen försvaras i sal Hamberger, Arbets- och miljömedicin, Medicinaregatan 16A, Göteborg, fredagen den 12 april 2013 kl. 9:00

av

Sandra Johannesson

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Professor Mattias Hallquist, Inst. för kemi och molekylärbiologi, Göteborgs universitet  
Professor Erik Swietlicki, Avd. för kärnfysik, LTH, Lunds universitet

Avhandlingen baseras på följande arbeten:

- I. Johannesson S, Gustafson P, Molnár P, Barregard L, Sallsten G. Exposure to fine particles (PM<sub>2.5</sub> and PM<sub>1</sub>) and black smoke in the general population: personal, indoor, and outdoor levels. *Journal of Exposure Science and Environmental Epidemiology* 2007; 17(7): 613-624
- II. Molnár P, Johannesson S, Boman J, Barregård L, Sällsten G. Personal exposures and indoor, residential outdoor, and urban background levels of fine particle trace elements in the general population. *Journal of Environmental Monitoring* 2006; 8(5):543-551.
- III. Johannesson S, Rappaport S M, Sallsten G. Variability of environmental exposure to fine particles, black smoke and trace elements among a Swedish population. *Journal of Exposure Science and Environmental Epidemiology* 2011; 21(5): 506-514.
- IV. Johannesson S, Andersson E M, Stockfelt L, Barregard L, Sallsten G. Urban air pollution and effects on biomarkers of systemic inflammation and coagulation: a panel study in healthy adults. *Submitted manuscript*



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## ABSTRACT

Urban particulate air pollution has been associated with adverse health effects in epidemiological as well as experimental studies. The overall aim of this thesis was to characterize environmental exposure to fine particles (PM<sub>2.5</sub>), black smoke (BS) and particulate trace elements among the general adult population in Gothenburg. Exposure was assessed during 24 hours by personal sampling on 30 subjects, along with parallel residential indoor and outdoor measurements and fixed-site urban background monitoring. Repeated samplings were performed for 20 individuals. In a subsequent study, short-term effects of exposure to urban air pollution on blood biomarkers were examined in healthy volunteers.

The mean personal exposure to PM<sub>2.5</sub> was 12 µg/m<sup>3</sup> (95% CI 9.6-14 µg/m<sup>3</sup>). There was a strong correlation ( $r_s=0.71$ ) between personal exposure and indoor levels of PM<sub>2.5</sub>, and a moderate correlation between personal exposure and urban background levels ( $r_s=0.61$ ). Personal exposure exceeded residential outdoor levels for PM<sub>2.5</sub> and for several of the trace elements also the urban background levels. Air mass origin affected urban background levels of PM<sub>2.5</sub>, BS and several trace elements, and also personal exposure to some elements derived from combustion processes. Determinants of personal exposure to PM<sub>2.5</sub> were season, smoking and the urban background levels. The within-person variance component dominated the variability of personal exposure to PM<sub>2.5</sub>, BS and trace elements for non-smokers. Large within-person variance components point to the importance of performing repeated sampling when assessing environmental exposures. Levels of biomarkers were not found to be increased after days with elevated levels of ambient air pollution compared with low levels in healthy adults. Since there is no evidence of a threshold level below which no health effects of PM occur, further reduction of exposure to particulate air pollution would result in significant health benefits within the population of Gothenburg.

**Keywords:** personal exposure, air pollution, fine particles, black smoke, trace elements, exposure variability, determinants, panel study, biomarkers

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