



Finnish Institute of  
Occupational Health



MINISTRY OF  
SOCIAL AFFAIRS AND HEALTH  
Finland

# Pulmonary inflammation in foundry workers - the follow-up study

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# The expert group

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# Background

- Foundry work is associated with exposure to a mixture of dusts, gases and fumes.
- The most important component of foundry dust is probably crystalline silica (quartz).
- Irritation of airways by occupational exposure to dusts may evoke biological reactions that can be measured by the production of different inflammatory markers.



# Inflammation in the airways

- Exhaled NO measurement is a non-invasive tool for assessing lung inflammation.
- Peripheral and central NO output can be separated by measuring exhaled NO at multiple exhalation flow rates.
- Markers of pulmonary inflammation can be non-invasively sampled by collecting exhaled breath condensate (EBC).
- Systemic inflammation is present in many lung diseases, and it can be assessed by measuring levels of inflammatory mediators in plasma.



# Previous study

(Koskela et al. Pulmonary inflammation in foundry workers. J Occup Environ Med. 2015 Feb;57(2):124-8)

- In 2006 we examined 476 dust-exposed and non-exposed foundry workers, and assessed the individual cumulative exposure to dusts and respirable quartz.
- After adjusting for pack-years of smoking, increased levels of alveolar NO, serum C-reactive protein, and interleukin-8 were associated with a higher level of cumulative exposure to dust.
- Bronchial NO, other inflammatory markers in serum or in exhaled breath condensate did not show increasing trends along with increasing cumulative dust exposure.
- Conclusion: Dust exposure in foundry work may induce both systemic and alveolar inflammation.

# The objective of the new study

To assess the changes in inflammatory markers of dust-exposed foundry workers and non-exposed controls after a follow-up period (approximately 6.5 years)

# Participants

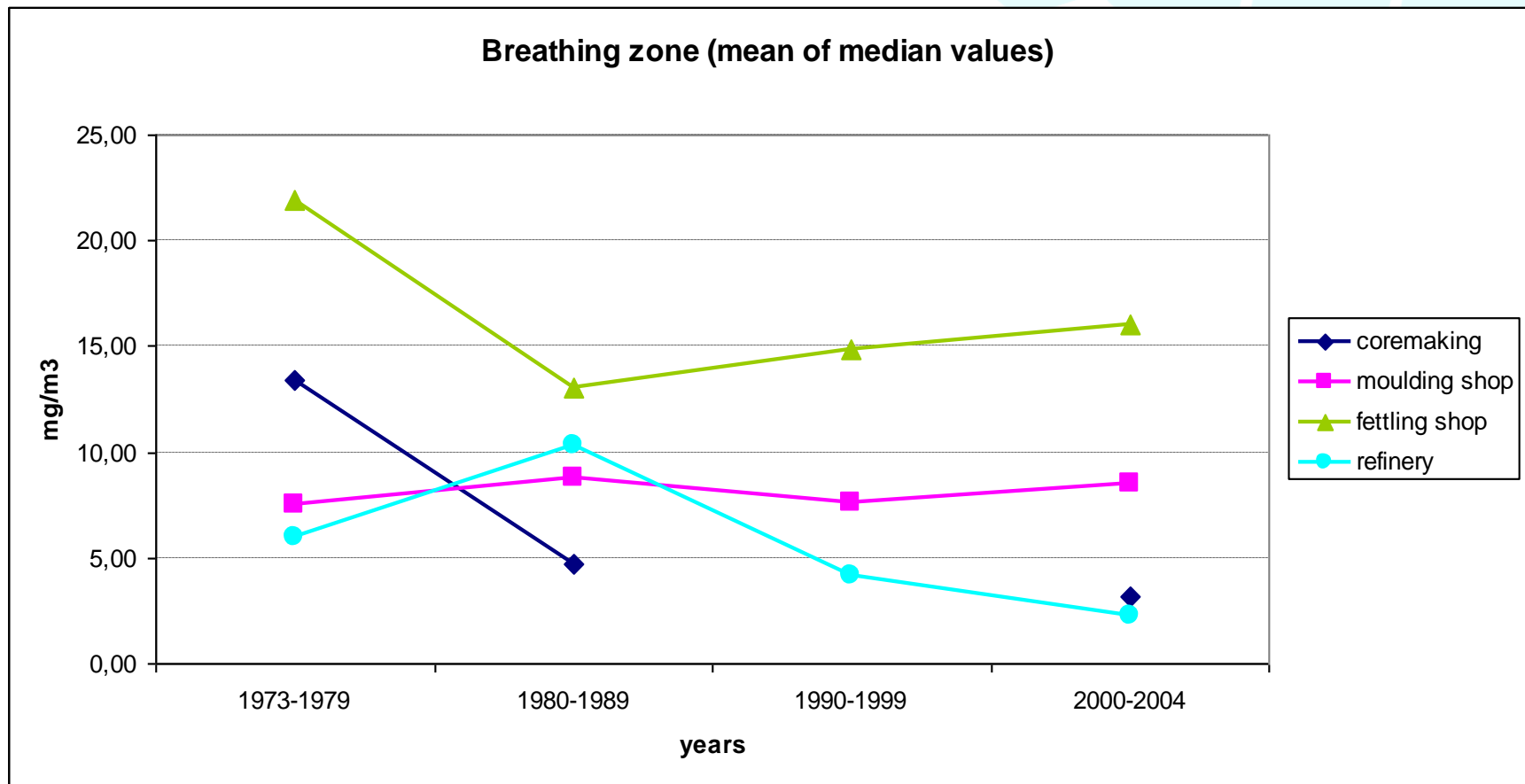
- The follow-up study was conducted in a Finnish steel cast foundry during 2011-2013.
- A total of 135 people participated in the follow-up study. The results of 116 participants were included in the study.
- Inclusion criteria: Participation in the baseline study.
- Exclusion criteria:
  - Asthma diagnosed by physician (n=9)
  - Possible confounding occupational exposure in the foundry or in the new workplace (n=8)
  - Female gender (n=2)

# Assessment of exposure

- Assessment of cumulative exposure (milligram-years, mg-y) to dust and respirable quartz during the working history until 2005 was performed as part of our previous study.
- It was based on the results of industrial hygienic measurements and the job histories of the participants.
- The exposed participants were divided into two cumulative dust exposure categories (low  $\leq 53$  mg-y and high  $> 53$  mg-y), using the median value of the cumulative dust exposure of the exposed participants.



# Results of breathing zone measurements (total dust)



Results of breathing zone dust measurements (total dust) in different compartments from 1973 to 2004 (mean of median values of each period shown as mg/m<sup>3</sup>). Results of breathing dust measurements are lacking in coremaking in 1990's.

# Results of PM<sub>10</sub>, PM<sub>2.5</sub> and <1um fine particles

Department	PM <sub>10</sub> , mg/m <sup>3</sup>	PM <sub>2.5</sub> , mg/m <sup>3</sup>	Fine particles <1 um, number/cm <sup>3</sup>
Moulding	0.32 - 0.41	0.21 - 0.22	78 000 - 128 000
Smeltery	2.88	2.54	240 000
Refinery	0.28 - 0.51	0.25 - 0.48	96 000 - 103 000

- PM<sub>10</sub> and PM<sub>2.5</sub> were measured by two DustTrak-monitors (TSI).
- An impactor was added to the other monitor.
- Fine particles were measured by P-Trak-monitor (TSI).

# Methods

- Questionnaire and spirometry
- Exhaled NO measurements
  - Alveolar and bronchial NO
- Exhaled breath condensate samples
  - 8-isoprostane
- Serum samples
  - Myeloperoxidase (MPO)
  - E-selectin
  - Interleukin-6 (IL-6)
  - Interleukin-8 (IL-8)
  - CRP



# Preliminary results, alveolar NO in exhaled breath

- At the baseline the mean concentration of alveolar NO was highest in the high exposure group and that of the control group was the lowest.
- After the follow-up period, the mean concentration of alveolar NO was still highest in the high exposure group and it had increased significantly more than in the low exposure group or in the control group.

# Preliminary results, IL-6 in serum

- The mean concentration of IL-6 in serum was highest in the high exposure group and that of the low exposure group was the lowest.
- The mean concentration of IL-6 in serum increased in all three study groups (high exposure, low exposure, controls)
- Cumulative exposure was significantly associated with the concentration of IL-6 in serum (repeated measures ANOVA, adjusted for smoking)

# Preliminary results, IL-8 in serum

- At the baseline, the mean serum concentration of IL-8 was highest in the control group.
- After the follow-up period, IL-8 tended to elevate more in low and high exposure groups compared to controls (repeated measures ANOVA, adjusted for smoking and age)

# The inflammatory reaction goes on?

- Alveolar NO of the former foundry workers increased significantly more during follow-up compared to current foundry workers or unexposed controls.
- This suggests that the inflammatory reaction in the pulmonary tissue induced by dust exposure does not stop when the exposure ceases.
- The limitation of dust exposure during working time is important also in the perspective of health after the work career.

# Conclusions

- Alveolar NO seems to be a useful tool to detect subclinical pulmonary inflammatory reaction following dust exposure.
- More studies are needed to investigate alveolar NO levels according to different occupational exposure settings and to establish reference values.
- More studies are also needed to study the feasibility of serum and exhaled breath condensate markers in detecting exposure induced reactions.





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