Ultrafine Particle Deposition in Subjects with Asthma

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Pulmonary deposition

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Background

- Breathing
- Why?
- “... relationship between mortality and the concentration of ambient particulate matter in compromised persons.”
- “Increased levels of particulate air pollution are associated with asthma exacerbations, increased respiratory symptoms, decreased lung function, increased medication use, and increased hospital admissions.”

Asthma

- Until this paper, only looked at effects on healthy people
- Asthma patients suffer more from air pollution

- PEF (peak expiratory flow)
- FEV (forced expiratory volume)

- Air remains in the lungs

Build up

- 16 people with mild/stronger asthma
- 18-55; no smokers
- Particle breathing during 2 hours

- Much more
- Standard procedure

Particles

- From pure graphite electrodes by spark discharge
- Size distribution
- UFP: carbon with Ø-diameter of 23 nm

- Danger:
- Big surface area, oxidant capacity, pulmonary inflammation, …
- Deeper in lungs, remain more easily

Settings

In these 2 hours: 4 tests of 15 minutes.

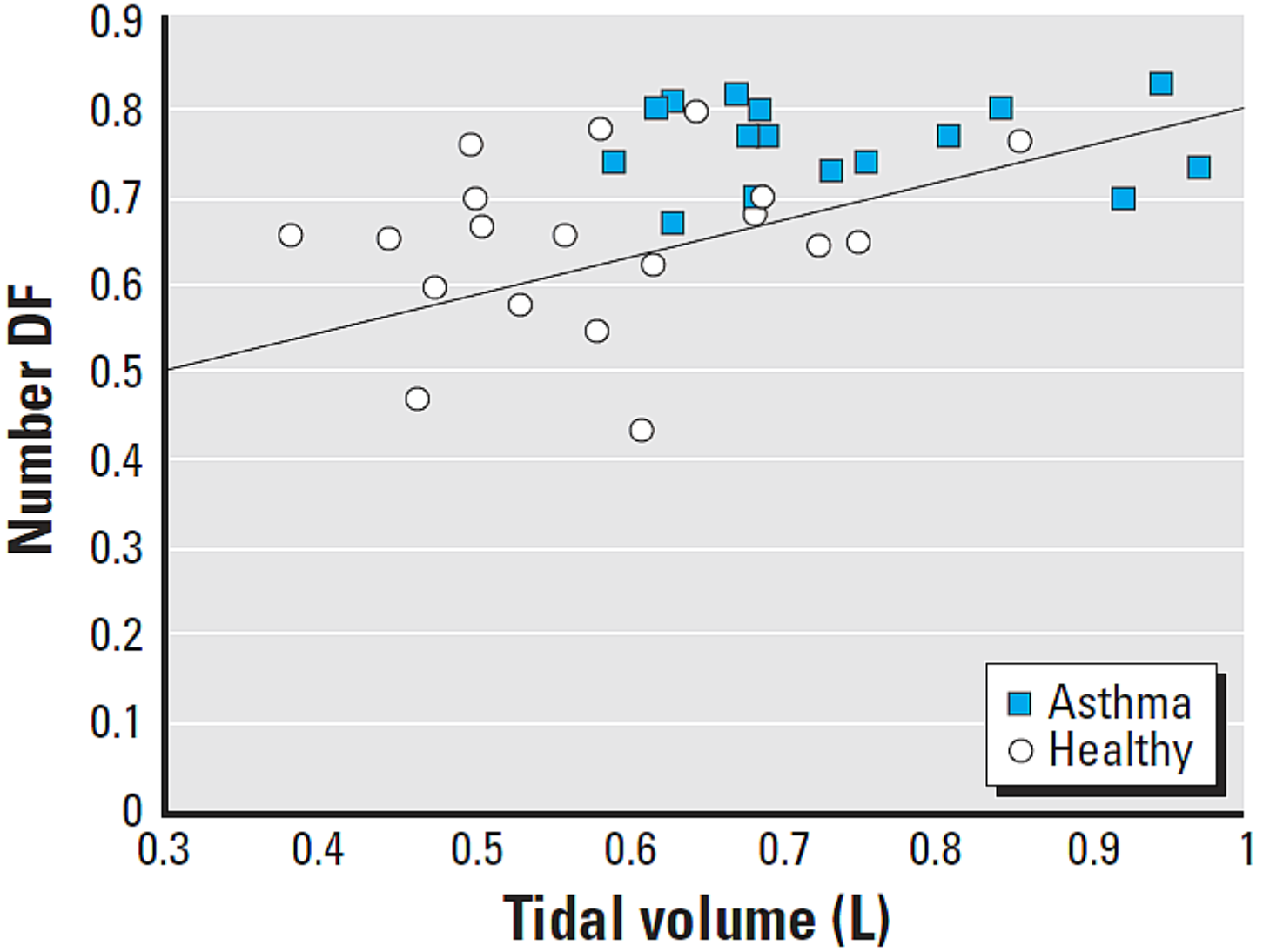
- 2 different tests, repeated once
- Rest phase and after exercise

Rest vs Exercise

Table 2. Breathing parameters (mean ± SD, $n = 16$).

	Tidal volume (L)	Respiratory frequency (breaths/min)	Minute ventilation (L/min)
Rest	0.78 ± 0.14	18 ± 2.5	13.3 ± 2.0
Exercise	1.71 ± 0.46	25 ± 3.8	41.9 ± 9.0

Tidal Volume



DF = deposition fraction

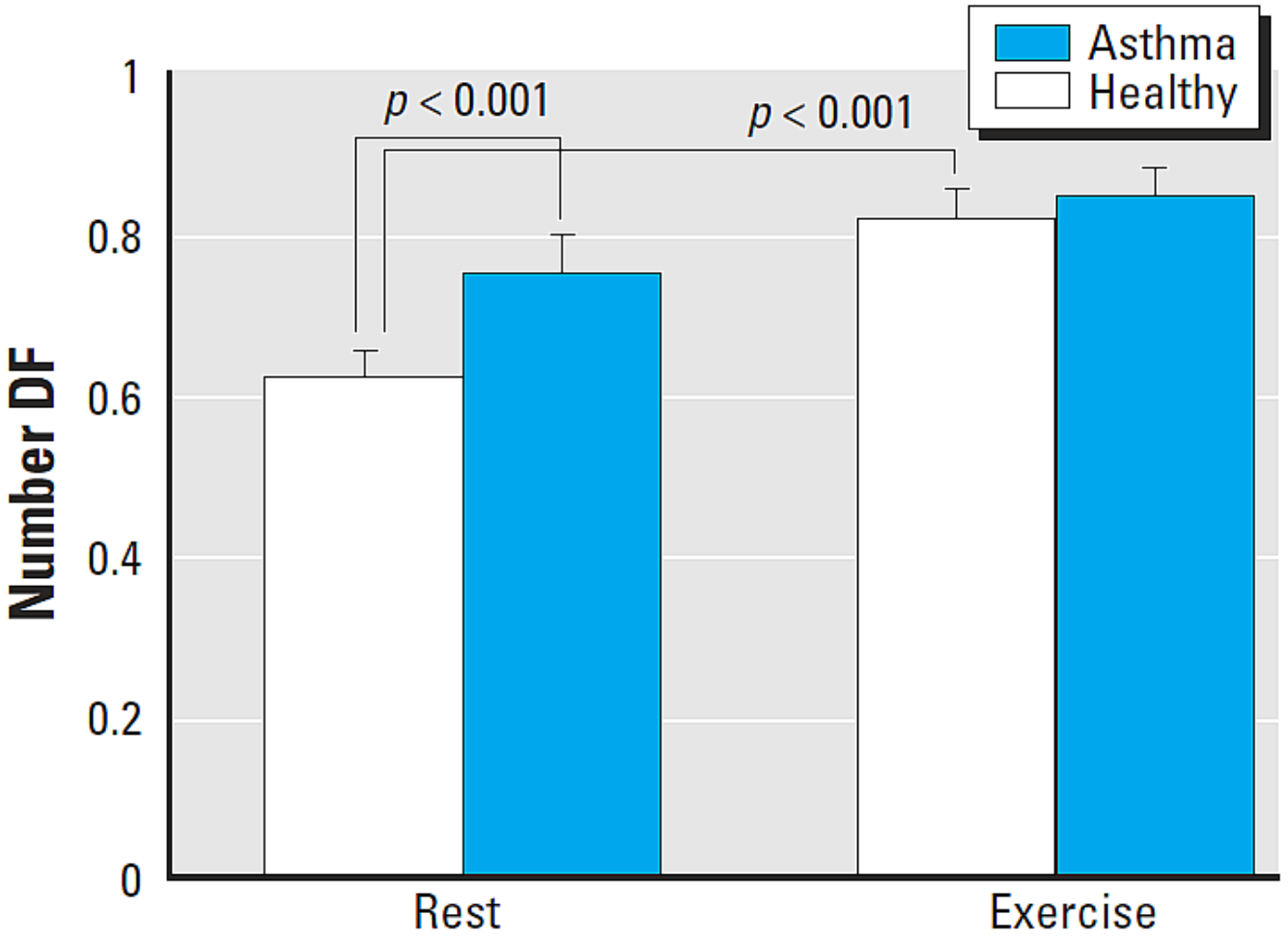
Results

Table 3. Particle number DF by particle size (n = 15).

Midpoint diameter [range (nm)]	DF at rest (mean ± SD)	DF during exercise (mean ± SD)
8.7 (7.5–10.0)	0.84 ± 0.03	0.93 ± 0.02
11.6 (10.0–13.3)	0.83 ± 0.04	0.91 ± 0.03
15.4 (13.3–17.8)	0.80 ± 0.05	0.89 ± 0.03
20.5 (17.8–23.7)	0.77 ± 0.06	0.86 ± 0.04
27.4 (23.7–31.6)	0.72 ± 0.07	0.82 ± 0.05
36.5 (31.6–42.2)	0.68 ± 0.08	0.77 ± 0.06
48.7 (42.2–56.2)	0.66 ± 0.08	0.75 ± 0.06
64.9 (56.2–75.0)	0.65 ± 0.09	0.73 ± 0.07
Total DF by particle number	0.76 ± 0.05	0.86 ± 0.04

Only look at the trends

Compare



- Normal breathing is forced for asthma patients; therefore: higher starting point and little increase

Sources of errors

- Mouthpiece

  Changes breathing behavior => faster

- Mouth vs. nose !
  Deposition

- Mask would be the most natural
  => but how distinguish the two air flows?

Conclusion

	No. DF	Total mass deposited (μg)
Healthy		
Rest	0.65 ± 0.10 (n = 19)	3.24 ± 0.96 (n = 16)
Exercise	0.83 ± 0.04 (n = 7)	15.31 ± 0.84 (n = 4)
Asthma		
Rest	0.76 ± 0.05 (n = 15)	5.83 ± 2.37 (n = 15)
Exercise	0.86 ± 0.04 (n = 15)	22.56 ± 8.96 (n = 15)

- No so big difference in DF
- Per breath!
- Higher respiration frequency

Group

- “air temperature during the winter season”
- “UFP in persons with diabetes”
- “carbon UFP exposure in young healthy persons”
- “Inhalation of ultrafine particles alters blood leukocyte (white blood cells) expression of adhesion molecules in humans”

- => Pulmonary diseases in general