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Conclusions

Deposition of < 0.1 µm particles increase with activity in the alveolar region while the deposition in the entire lung does not change considerably.

This increased deposition in the alveolar region is driven by a larger breath volume at increased activity.

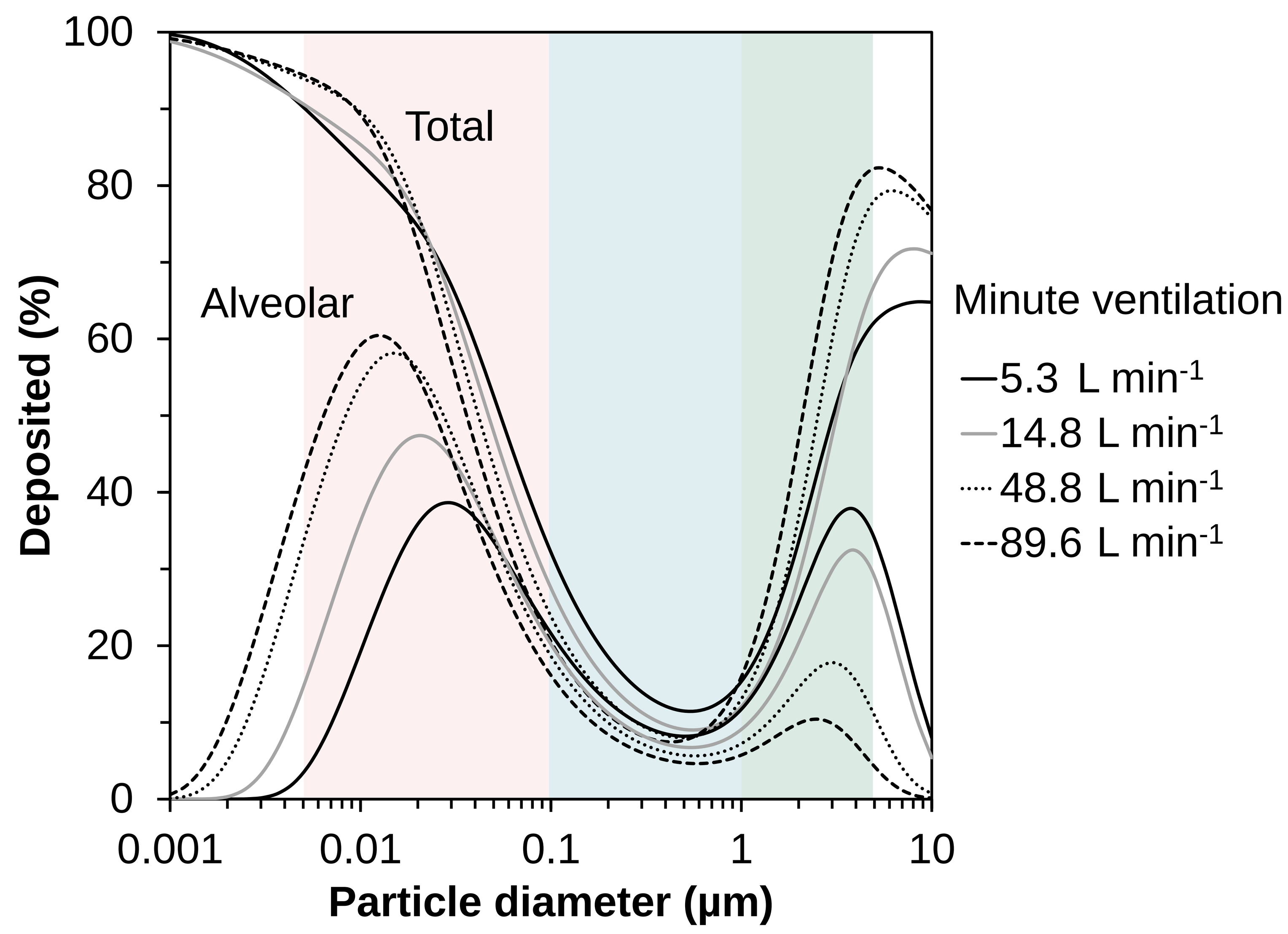

Fig.1. Size-resolved particle deposition in the entire respiratory tract (total) and alveolar region of an adult (oral breathing). Similar patterns were seen for children.

Motivation

The **deposited dose** of particles in the respiratory tract is an important **factor for understanding health effects of aerosol particles**. It is a combination of the exposure, volume of inhaled air and particle deposition.

At **increasing activity** the minute ventilation (volume of breath x number of breaths) increase. Little is known about if and how this **affects the regional particle deposition**.

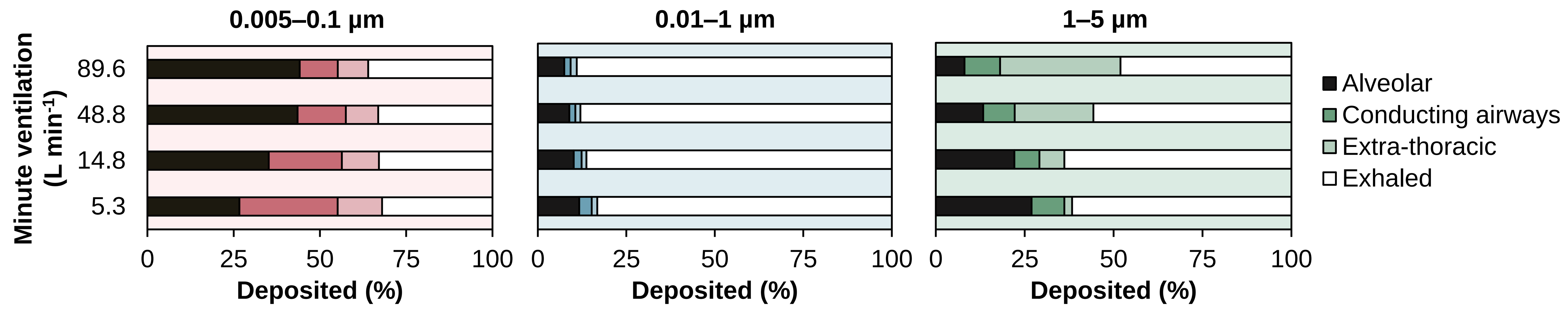

Fig.2. Regional deposition for three particle size ranges for an adult (oral breathing). Similar patterns were seen for children.

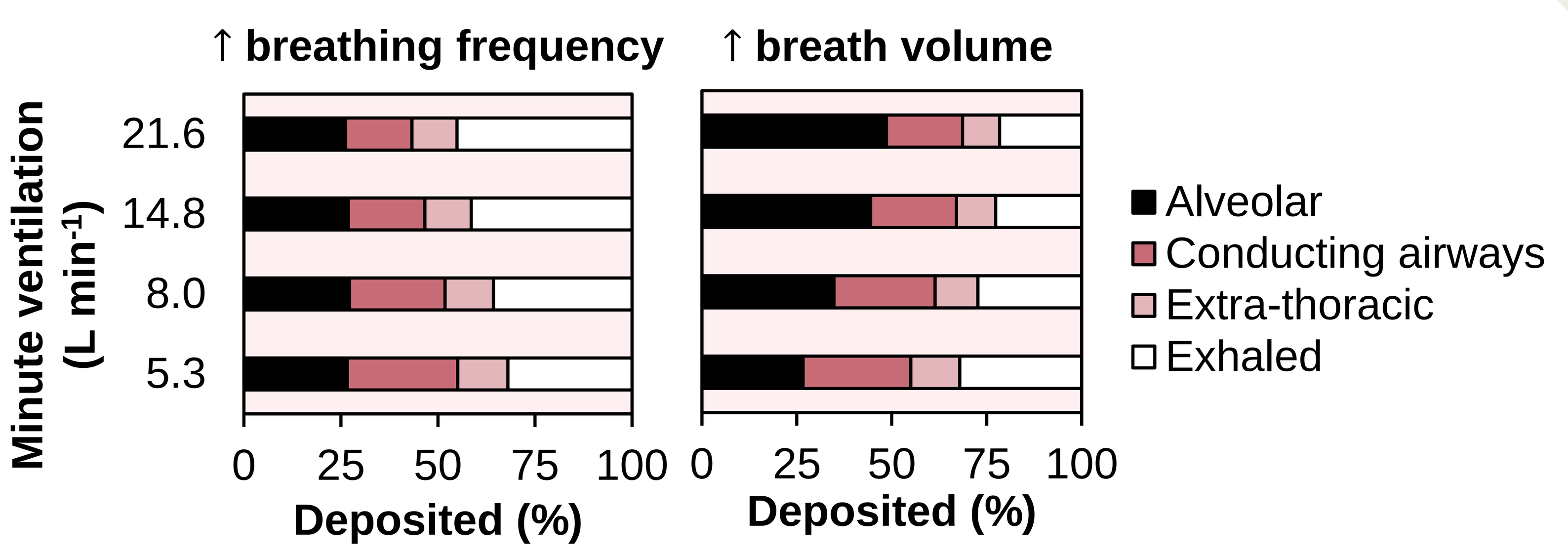

Fig.3. Deposition of 0.005–0.1 µm particles keeping the breath volume constant while increasing the breathing frequency (left) and keeping the breathing frequency constant while increasing the breath volume (right).

Results

Particle deposition was altered with activity for different particle sizes in the entire respiratory tract at increasing activity (Fig.1). The largest effects were seen in the alveolar region where the peak deposition was shifted from ~30 nm to 15 nm (Fig.1).

Deposition in the alveolar region increased for < 0.1 µm particles while it decreased for > 0.1 µm particles at increasing activity (Fig.2). Similar patterns were seen for both adults and children.

The deposition of < 0.1 µm particles in the alveolar region seemed unaffected by an increased breathing frequency (Fig.3).

The increased deposition for < 0.1 µm particles in the alveolar region was driven by an increased volume of the inhaled air (Fig.3) and a decreased diffusional deposition in the conducting airways (Fig.2).

Method

The alteration of breath volume and minute ventilation during increasing activity was parametrized using data from previous studies. The results were used to model the effect of activity on lung deposition for children and adults.

The extra-thoracic deposition model from NCRP (1997) and the thoracic deposition model and lung anatomy model from Yeh and Schum (1980) were used in the software Mimetikos Preludium™ (Olsson and Bäckman, 2018).

Outlook

Increasing activity lead to a shift in the size distribution of particles that deposit in different regions of the respiratory tract. This can be important to consider when calculating deposited doses for health risk assessments.

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