Factors governing the dispersion of exhaled particles during vaping of an e-cigarette

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Electronic cigarettes (e-cigarettes) are a relatively new alternative to conventional cigarettes and the prevalence of use is increasing amongst smokers worldwide. This raises new questions for example on the potential impact of e-cigarette use on indoor air quality and bystander exposures; evidence on this topic is still emerging. To that end, the aim of this study was to investigate the impact of different factors on the dispersion of exhaled e-cigarette particles at a bystander's position, namely vaping topography, distance from bystander and room ventilation rate, following use of a commercial e-cigarette.

A room-simulating chamber with controllable ventilation rates with a temperature-regulated mannequin as a bystander was employed. Three experienced e-cigarette volunteers vaped an e-cigarette according to a set puffing regime, 0.5, 1.0, and 2.0 metres from the bystander. Inhaled puff, "hold" in body, and exhaled puff durations were recorded in order to represent volunteers' different vaping topography. Four-way mixing ventilation was chosen as this is commonly used in residential buildings, with ventilation rates of 0, 1 and 2 air changes per hour. The supply air temperature and relative humidity was set to 20°C and 35%, respectively. Aerosol particles were analysed using a Fast Mobility Particle Sizer (FMPS) spectrometer, an Electric Low Pressure Impactor (ELPI) at the bystander's position. The obtained data was fitted to regression model using partial least squares method to obtain the relationship between factors affecting exhaled particle concentrations in the room at the bystander's position. Exhaled e-cigarette particles were also collected using a vacuum-assisted filter pad capture system and the chemical composition analysed.

The distance and the vaping topography exhibited the highest influence on dispersion of exhaled particles during vaping of an e-cigarette. As expected, a greater distance between e-cigarette user and a bystander resulted in lower maximum particle concentrations, although even at a close distance the decay of particle concentrations was very rapid. Although vaping topography was rather similar, significant differences between particle number concentrations were observed, which may be related to physiological differences and e-cigarette use behaviours amongst the volunteers. The ventilation rate did not significantly influence particle size distributions or maximum particle concentrations. This can be attributed to the fact that most of the exhaled particles evaporated immediately after exhalation thus affecting the removal of particles through evaporation, not displacement by ventilation air. This is not surprising as the chemical composition of the exhaled particles was shown to be largely composed of water.

Key words: Air quality, electronic cigarette, exhaled particles, dispersion, exposure chamber