Human aerosols and drops

Prof. Dr. Dr. h.c. Eberhard Bodenschatz

Max Planck Institute for Dynamics and Self-Organization (MPIDS), Göttingen

Understanding infection transmission between individuals, as well as evaluating the efficacy of protective measures, are key issues in pandemics driven by human respiratory particles. The key is a quantitative understanding of the size and concentration of particles exhaled and their variability across the size range for a representative population of all ages, genders, and different activities. Here we present data from more than 100 healthy volunteers aged 5 to 80 years, measured over the entire particle size range for each individual. Conventional particle spectrometry was combined with in-line holography under well-controlled conditions for common activities such as breathing, speaking, singing, and shouting. We find age to be the most important parameter for the concentration of small exhaled particles, which doubles over a 7-year period in adolescents and over a 30-year period in adults. Gender, body mass index, smoking, or exercise habits have no discernible effect. We provide evidence that small particles originate from the lower respiratory tract from the larynx/pharynx, and larger from the oral cavity. The concentration of small particles can vary by one order of magnitude within a person, while inter-person variability can span two orders of magnitude, largely explained by differences in age. We found no discernible inter-person variability for larger particles. Our results show that the cumulative volume of small particles is 2-8 times higher in adults than in children. In contrast, the number and volume concentration of larger particles, which are produced predominantly in the upper respiratory tract, is largely independent of age. Finally, we examined different types of airborne-transmissible respiratory diseases and provided insights into possible modes of infection transmission with and without several types/fits of face masks.