Combustion-generated carbonaceous urban atmospheric UFPs: Efficiencies of face mask control of urban atmospheric particulate pollution: A pointer to control of future pandemics

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Each day an adult human inhales on average 13.6kg [1] or 10,000 litres of air that potentially contains 0.1-10 trillion particles [2]. Some of these may be ultrafine carbonaceous combustion- and traffic-generated particles (UFPs) smaller than 100nm [3]. Others may be microbiological and bioaerosols (e.g. bacteria, fungi, viruses [4], excreta of insects and spores) and larger particulate (PM2.5 or PM10) pollutants [3]. The corona COVID-19 virus is about 60-140nm [5,6]. Since we 'cannot cease breathing for more than a few minutes' [7] the atmosphere that bathes each of us is critical; locally this air is part of our personal ecosphere [8]. It has been suggested that pollution of urban air in London contributed to the death of Ella Kissi-Debrah in 2013. It is therefore worthy of assessing how filtration of critical atmospheric pollutants by face masks can be most beneficial. The ultrafine particles prevailing in the urban air in a covered carpark at UK postcode UB7 7GN were used to test the filtration efficiency of these masks using the P-Trak 8525.

Fine (100mmx100mm) and coarse (500mmx500mm) stainless steel filters had UFP filtration efficiencies of 50.87% and 7.29%. As one would expect, the bandana UFP filtration efficiency increased progressively from 45% to 90% as the number of bandana layers used to cover the face increased from 1 to 4. This is an important finding for control of current particulate air pollution and future pandemics. The UFP filtration efficiency of cycle and DIY masks was no better than a single layer bandana. The diodic valve KN95 mask was more than twice as efficient at filtering UFPs in an inhalation mode than in an exhalation mode, presumably protecting the wearer more than those around them.

Here the authors report which type of urban carbonaceous UFPs are filtered out and how this can be made selective with filter surface modification. The authors were also intrigued that passage through water stripped out carbonaceous UFPs from the atmosphere and this may affect the impact of the particles on our health and the modification of masks to protect us from these (and other) airborne hazards. Control of airborne infection and particulate pollutants is important as we protect personal ecospheres. Here we explore the varying respiration and retention of airborne carbonaceous UFPs by those of different gender, age group, fitness level and ethnic background so that they may be better protected in the future. For the moment, face masks show varying efficiencies for protecting us from inhaling combustion-generated airborne ultrafine particles (UFPs). Real-time technology to spot ineffective facemasks at their end-of-useful-life may need deploying. In addition, our understanding of the design of facemask filtering out carbonaceous UFPs will enable us to design even better masks for future pandemics.

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