The sources and origins of bacteria and fungi suspended in indoor air

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Previous indoor aerosol studies on total particulate matter suggest that in the absence of combustion sources such as cooking or smoking, human occupancy—through the process of resuspension—is the dominant source of particulate matter suspended in indoor air. We hypothesize that human occupancy is also a dominant source of bacteria and fungi in occupied indoor settings. To test this hypothesis, bacterial, fungal, and total concentrations of aerosols and floor dust were determined and characterized at eleven schools in five different countries during periods of vacancy and occupancy. Floor dust and size-resolved indoor and outdoor aerosol samples were collected, and genome concentrations for bacteria and fungi were determined using quantitative PCR targeting the universal bacterial and fungal rDNA encoding genes. Multiplexed fungal (ITS and LSU regions) and bacterial (16S region) phylogenetic libraries of air samples and floor dust samples from these locations were also generated. Indoor emission rates due to human occupancy (genomes aerosolized per person per hour) were estimated from a mass balance-based approach.

Indoor air particle mass concentrations during occupancy double or triple compared to the vacant control cases, and bacterial and fungal concentrations during occupancy generally increased 100-fold, and 10-fold, respectively. Per person emissions (total of the all sizes) ranged from 7 to 31 mg/person hr, 2 to 88 million bacterial genome copies/person hr, and 0.6 to 12 fungal cells/person hr. Phylogenetic comparisons based on UniFrac analysis demonstrate similarities between occupied indoor air and floor dust, and strong differences between indoor air/floor dust and outdoor air. Taxonomy data generated thus far reveals microbial diversity differences in airborne particulate matter of varying size and demonstrates a strong presence of human associated bacteria in indoor aerosols and floor dust. Such analysis reveals useful insights into how humans can be exposed to bacteria and fungi in the indoor environment and provides details on the origins of these organisms.