Yale

UNIVERSITY OF TORONTO | Civil + Mineral Engineering

Bakker A, Siegel JA, Mendell MJ, Peccia J. 2018. Building and environmental factors that influence bacterial and fungal loading on air conditioning cooling coils. *Indoor Air*, **28**, 689-696. DOI: 10.1111/ina.12474.

Abstract

Heat exchanger surfaces within air-conditioning (AC) units are nearly ubiquitous in modern buildings and provide an environment of variable moisture and temperature that is favorable for microbial growth. We investigated bacterial and fungal concentrations on cooling coils of large, commercial AC units and quantified associations between microbial loads and AC unit or building operational parameters. A field campaign was conducted to sample 25 AC units in the humid, subtropical climate of Southern CT, USA and 15 AC units in the hot-summer Mediterranean climate of Sacramento, CA, USA. The average concentrations (± standard deviations) of bacteria and fungi on the cooling coils were $2.1 \times 10^9 \pm 1.1 \times 10^{10}$ cells/m^2 and $6.6 \times 10^8 \pm 2.4 \times 10^9$ spore equivalents (SE)/m^2, respectively. Concentrations varied from unit to unit with median unit concentrations ranging three orders of magnitude for bacteria and seven orders of magnitude for fungi. Controlled comparisons and multivariable regressions indicate that dominant factors associated with AC coil loading include the nominal efficiency of upstream filters (p = 0.008 for bacteria and $p < 0.001$ for fungi) and coil moisture, which was reflected in fungal loading differences between top and bottom halves of the AC coils in Southern CT (p = 0.05) and the dew points of the two climates considered (p=0.04 for fungi). Environmental and building characteristics explained 42% (p<0.001) of bacterial concentration variability and 66% (p<0.001) of fungal concentration variability among samples.

Practical Implications

The damp surfaces of AC units are known to promote bacterial and fungal growth. The resulting microbial load has been shown to diminish heat transfer efficiencies and increase fan power requirements, and it may also result in microbial emissions into occupied building spaces. This study demonstrated that the growth in well-maintained AC systems varies significantly from unit to unit, and this variability may be explained by environmental and building parameters including climate (dew point temperature of outdoor air) and upstream filter efficiency. The fungal and bacterial coil concentration data and the association between loading and environmental factors provide a baseline understanding for future efforts to reduce microbial fouling of AC heat exchanger surfaces.

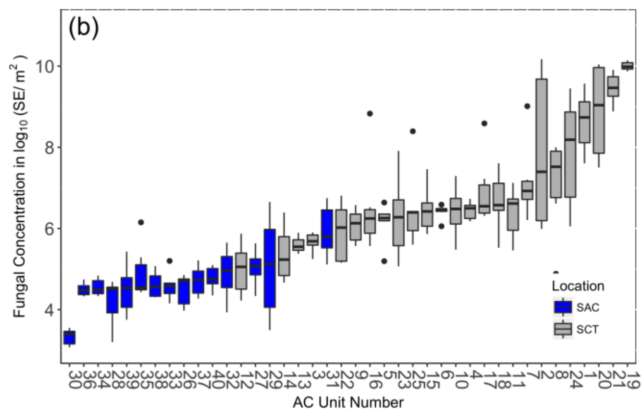

Figure 3b. Ranked fungal concentrations on AC units. Boxes frame the interquartile ranges (IQRs), middle lines represent medians, whiskers represent values up to 1.5 * IQR, and points represent the outliers. N = 6 for each unit.

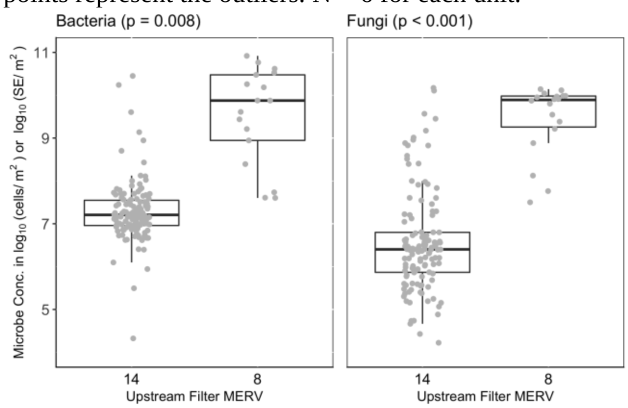

Figure 4. Comparison of bacterial and fungal concentrations for coil samples taken from units with MERV 14 upstream filters and units with only MERV 8 upstream filters. Boxes frame the interquartile ranges (IQRs), the middle lines represent medians, and whiskers represent values up to 1.5 * IQR. From left to right: n = 18, n = 129, n = 12, n = 130.

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