Environmental monitoring to inform built environments vulnerability to airborne disease transmission

Z.A.Nasir[1], L.Campos[1], M. Canales[1], L.Ciric[1] and I. Colbeck[2]

[1]Department of Civil, Environmental and Geomatic Engineering, University College London, WC1E 6BT, UK
[2]School of Biological Sciences, University of Essex, Colchester, Essex, CO4 3SQ, UK
Keywords: Air Health, Particles, CO_2, Offices.
Presenting author email: Z.nasar@ucl.ac.uk

In the 21st century, environmental heath in the built environment is central to public health. The way we design, construct, use and manage indoor environments can have substantial impact on our wellbeing. Of the wide range of indoor air contaminants, infectious agents are of the greatest concern due to their potential to cause huge damage to global public health. In recent years we have witnessed the emergence of new diseases (e.g. influenza H1N1 and SARS) and their potential to cause wide spread disease in societies across the globe. The uncertainty about when a pandemic may occur and the unpredictability of its severity leave no option but to prepare in advance. A range of environmental factors can enhance the probability of disease transmission in built environments. These include: prolonged exposure to infectious individuals/sources in small enclosed spaces, inadequate ventilation, and recirculation of contaminated air. Therefore, there is an urgent need to develop practical tools to assess the relative risk that built environments pose in infection transmission.

The present study aims to highlight the use of environmental monitoring as a tool to assess air health in built environments and to inform their vulnerability to airborne disease transmission. Measurements were carried to monitor the number concentration of particles in 6 different sizes (Lighthouse laser particle counter, 5016), CO_2, temperature, relative humidity (IAQ4 – BW Technologies) and airborne culturable bacteria (Andersen 6 stage sampler) in a mechanically ventilated office during October 2012 under two different scenarios: ventilation system off and on. The floor area and volume of the office was 28 m^2 and 80 m^3, respectively, and it had five work stations.

The summary of results presented in Figure 1 and Table 1 clearly shows the impact of poor ventilation on the concentration of airborne bacteria, particles in all the size ranges and CO_2.

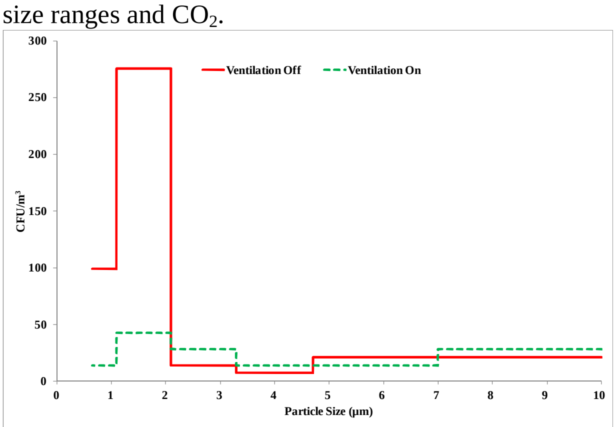

Figure1.Size distribution of culturable airborne bacteria

Table 1. Hourly average number concentration of particles and CO_2 in a mechanically ventilated office

NUMBER CONCENTRATION (#/m^3)				
	Ventilation OFF		*Ventilation ON*	
	Mean	**SD**	**Mean**	**SD**
Day Time (8.00 – 19.00)				
0.5 µm	8,804,986	7,511,997	265,594	112,764
0.7 µm	1,459,121	1,226,868	86,991	36,838
1.0 µm	358,566	160,785	79,104	38,742
3 µm	41,176	28,699	21,853	13,339
5 µm	5,525	5,078	4,059	2,501
10 µm	2,802	3,890	2,009	1,605
Night Time (20.00 – 07.00)				
0.5 µm	10,370,265	6,179,079	220,588	158,489
0.7 µm	1,792,998	1,203,352	69,081	40,972
1.0 µm	388,301	228,027	42,505	28,374
3 µm	16,898	17,953	3,851	4,511
5 µm	995	2,123	445	813
10 µm	212	602	120	227
CO_2 (PPM)				
Overall	783	325	529	139
Day	1,005	297	626	127
Night	534	83	420	26

Inadequate supply of outdoor air relative to occupant density resulted in the accumulation of particles and CO_2 in the office air. It also impacted greatly on relative humidity. (49-63% during ventilation system off and 35-46% during ventilation system on). It is evident that in the presence of an infectious source in this built environment the occupants' risk of exposure will be enhanced under an inadequate ventilation scenario. It is important to highlight that very often the need for ventilation is governed by psychological and physiological needs of the occupants and the current guidelines and codes proposed by different organizations on indoor air quality in work places are focused on thermal comfort and odour removal rather than preventing infection transmission.

Environmental monitoring of airborne particles and CO_2 can play a pivotal role in evaluating air health in built environments and identifying ill/malfunctioning elements. This can assist in the design of venue and scenario specific mitigation strategies to reduce vulnerability of the built environment to airborne infection transmission.

This study was funded by the Engineering and Physical Science Research Council, United Kingdom, grant reference EP/G029881/1