# Effect of mechanical ventilation on mould in an Auckland home: A pilot study

**Marleen Baling[1], Erin Doyle[1], Tianyi Tang[1], German Hernandez[2], Joanne Low[2], Terri-Ann Berry[2] and Dan Blanchon[1]**

1 Applied Molecular Solutions Research Centre, Unitec Institute of Technology, Auckland.

2 Environmental Solutions Research Centre, Unitec Institute of Technology, Auckland.

## Introduction

**Ventilation** is an important aspect in reducing dampness in houses. The increase in moisture indoors is generally caused by the need for heating and insulation in homes, particularly during winter seasons. However, mould can accumulate in constantly damp and poorly ventilated houses. Prolonged exposure to mould can cause chronic health problems for the occupants.

**Positive pressure ventilation system (PPV)** is one mechanical approach to improving indoor airflow in homes. However, there is no published data available to show that this system can effectively reduce dampness and therefore, mould in homes.

The **aim** of our study is:

***To investigate if positive pressure ventilation systems (PPV) can effectively reduce dampness in homes.***

In this pilot study, we visited one house in South Auckland (September-October 2020) to conduct the following objectives:

***Objective 1:*** *To test changes in indoor mould species in three rooms after installation of a PPV system in a home.*

***Hypothesis 1:*** *Lower number of mould species in all rooms after installation of PPV.*

***Objective 2:*** *To investigate the difference between two dust sampling techniques in detecting mould species.*

***Hypothesis 2:*** *Doorframe swabs detect more mould colonies from airborne spores than floor vacuum samples.*

## Highlights

- *Six weeks after installation of PPV:*
  - *The overall mould reduced by 3 species.*
  - *Highest decrease in mould species was in the bathroom (45%).*
  - *Less mould species on the doorframe (50%) than floor samples (no change).*
  - *Significant reduction in relative humidity in all rooms, especially the bathroom.*
- *Results suggests fewer airborne mould spores after PPV installation, but the floors may still contain a mix of airborne spores and ones brought in via surface contact.*

## Methods

***Environmental variables***

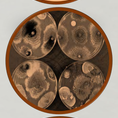
We recorded temperature and relative humidity per hour using data loggers (EL-USB-2, Lascar Electronics, Hong Kong).

***Dust sampling***

*Doorframe*: We sampled the dust on the the upper part of the doorframes of the main entrance in living room, bedroom and bathroom using sterile swabs. Then we cleaned the doorframe with distilled water and 70% ethanol after each sample.

*Floor*: We collected dust in a 0.25 $m^2$ area in each room using a vacuum cleaner with a dust collector (DUSTSTREAM Collector, Indoor Biotechnologies, USA) for two minutes.

Samples were collected six weeks prior (to remove old colonies), on the day of the installation and six weeks after the installation of PPV. A total of 12 samples (three samples each for doorframe swab and floor vacuum) were used the final analysis.



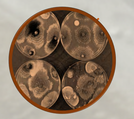
***Fungal culture***

We developed fungal cultures from each sample on plates of potato dextrose agar (PDA) with chloramphenicol. After multiple innoculations to produce pure cultures, we collected samples from these colonies for DNA sequencing.

***DNA extraction, PCR and DNA sequencing***

All spore aliquots were extracted using DNeasy Plant Mini Kit (Qiagen, Germany). We then conduct PCR amplification and sequencing of the ITS region. We identified species by comparing our DNA sequences to reference sequences from online database Genbank.2

## Results



Six weeks after PPV installation, the overall number of mould species decreased in the house (15 to 12 species), with a 45% drop in species number in the bathroom (11 to 5 species) (Fig. 1). There was also significant reduction in humidity (average 4–8% difference in average relative humidity) in all rooms, particularly the bathroom (8%).

There were fewer mould species from the doorframe swabs (6 to 3 species) than floor vacuum samples (11 vs 11 species). Some moulds that could affect human health and were initially present were not detected six weeks following installation of the MVS (e.g. *Chaetomium globosum*, *Cladosporium spearospermum*, *Penicillium digitatum*). However, others persist in the house (e.g. *Aureobasidium pullulans*, *Penicillium* spp., *Cladosporium* sp.).

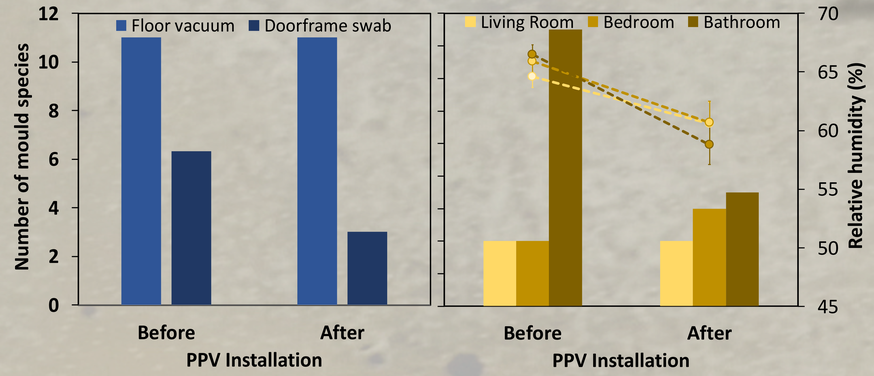



*Figure 1. Number of mould species in a South Auckland home in three rooms with mean relative humidity (n=42 days) (right), and between two dust sampling techniques (left). Samples were collected before and six weeks after installation of a positive pressure ventilation system (PPV).*

## Discussion

Our results showed that PPV reduced humidity in all rooms after six weeks, with the greatest change in the bathroom, the dampest room in the house. However, we only found reduced mould species in the bathroom. Based on the mould species present in each room, we suspect that mould diversity in living room and bedroom were colonised via additional sources other than airborne mould spores, e.g. footwear, equipment or pets on the carpet.

The results from the two dust sampling techniques were consistent with our hypothesis, where the swabs detect mould dispersed via airborne and vacuum sampling detect mould via mixed airborne and contact. For example, the vacuum samples detected mould related to fruit (*Mucor hiemalis*, *P. digitatum*) and grass (*Pithomyces chartarum*). There were fewer mould spores in the air post-PPV installation, likely because there was less mould growth at lower humidity and/ or that there were less spores because of increased indoor airflow.

This pilot study is part of a larger project investigating indoor mould and air quality in New Zealand homes. For the main study, we will also include quantification of mould DNA, where we will test whether the amount of mould in a home changes after installation of PPV.

### Literature

Black, JA & Foarde, KK (2007). *J Microbiol Methods*. DOI: 10.1016/j.mimet.2007.03.017

Cai, GH, Bröms, K, Mälarstig, B, Zhao, ZH, Kim, JL, Svärdsudd, K, Janson, C & Norbäck, D (2009). *Indoor Air*. DOI: 10.1111/j.1600-0668.2009.00600.x

Ginestet, S, Aschan-Leygonie, C, Bayeux, T & Keirsbulck, M (2020). *Build Environ*. DOI: 10.1016/j.buildenv.2019.106577

Haugland, RA, Brinkman, N, & Vesper, SJ (2002). *J Microbiol Methods*. DOI: 10.1016/S0167-7012(02)00037-4

Korpelainen, H, Pietiläinen, M, & Huotari, T (2016). *Ann of Microbiol*. DOI: 10.1007/s13213-015-1118-x

Op De Beeck, M, Lievens, B, Busschaert, P, Declerck, S, Vangronsveld, J, & Colpaert, JV (2014). *PLoS One*. DOI: 10.1371/journal.pone.0097629

Roussel, S, Reboux, G, Bellanger, A-P, Sornin, S, Grenouillet, F, Dalphin, J-C, Piarroux, R & Millon, L (2008). *J Environ Monit*. DOI: 10.1039/B718909E

Vesper, S (2011). *Crit Rev Microbiol*. DOI: 10.3109/1040841X.2010.506177

### Acknowledgements

We would like to thank David Poyner, Roger Birchmore, and Helen Gremillion, and HRV for their advice and support in this pilot study.