

# Living 'green' walls may have adverse health effects on office workers living in hot, polluted climates

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Green wall in Milan, Biber Architects. Credit: inhabitat.com

New research by University of York academics reveals that living 'green' walls may have adverse health effects on office workers living in hot, polluted climates.

Investigating levels of [air](#) pollutants in modern office buildings, Dr Nicola Carslaw from York's Environment Department led a modelling study focusing on ultrafine particles (UFPs). Such particles are a health concern as they can carry potentially toxic species into the lungs.

Using a detailed chemical model for indoor air, concentrations of UFPs were simulated for offices in Athens, Helsinki and Milan during a

heatwave across Europe in August 2003, and again during more typical summer temperatures in August 2009. These three cities were selected to compare contrasting climates and locations across Europe.

The researchers found that indoor concentrations of UFPs were highest in the Milan and Athens offices, reflecting high outdoor [air pollution levels](#) in these cities. Such pollutants make their way indoors through doors, windows and ventilation systems as well as through gaps in the building fabric.

Indoor UFP levels were also predicted to be higher during the 2003 heatwave compared with 2009, particularly in Milan which experienced the highest temperature and pollution concentrations outdoors during this event.

However, indoor UFP concentrations were well above those expected through penetration of outdoor particles alone. On further investigation, the researchers found they were a result of high concentrations of reactive volatile organic compounds (VOCs) outdoors, emitted by plants and trees.

These reactive VOCs include limonene, a naturally occurring compound emitted by plants and trees responsible for the citrusy smell in lemons and oranges, and pinene, emitted by pine trees. Once in the atmosphere, such compounds rapidly oxidise to form a range of gas-phase and particle-phase products, which exist in a dynamic equilibrium depending on the conditions.

During heatwaves such as that experienced during 2003, emissions of VOCs increase in high temperatures and the formation of the secondary gas and particle-phase products becomes very efficient.

When outdoor air is drawn into an office air inlet, it is often filtered to

partially remove outdoor particles. However, removing these particles disturbs the equilibrium of the secondary products and in order to re-establish a balance, new particles quickly form once the air reaches the office environment.

Therefore, indoor UFP concentrations are seen to be much higher if reactive VOCs exist outdoors near an office air inlet, as the impact of air filtration is lessened.

This finding is significant as, for the first time, indoor UFP formation is shown to be linked to the oxidation of outdoor plant and tree species in heatwave conditions. Given the increasing popularity of green walls covered in plants and vegetation, their prevalence in hot, polluted locations could exacerbate [indoor air pollution](#).

The filtration of air in modern office blocks is also seen to be less effective than expected, and this may explain why expected health benefits are often not realised when particle filters are added to a building.

Dr Carslaw, Reader in the Environment Department, said: "Although significant attention is paid to the role of outdoor air pollution and its adverse impact on health, little thought is given to indoor [air quality](#) even though in developed countries we spend 90 per cent of our time indoors. If we want to fully understand our exposure to air pollution, it is crucial to understand the processes that lead to exposure to pollutants indoors, whether in the office or in our homes.

"In this study we investigated indoor air quality in offices in varying climates and found that emissions of reactive species from vegetation in hot temperatures can have a direct adverse effect on air quality in air-filtered office environments in polluted locations.

"This has important implications for [indoor air](#) quality, particularly given the current trend for green walls on buildings, which could provide a potential source of biogenic emissions near to air inlet systems. Whilst no doubt visually arresting and aesthetically pleasing to many, such features may inadvertently introduce a problem for [indoor air quality](#) in city centre offices in hot, polluted locations.

"This research shows that we may need to find other ways to maintain safe pollutant levels indoors, particularly under heatwave conditions."

Provided by University of York

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