

Well-being, learning efficiency, and ventilation

Pawel Wargocki

*International Centre for Indoor Environment and Energy
Department of Environmental and Resource Engineering (DTU Sustain)
Street address
Address, Country*

ABSTRACT

Ventilation in buildings improves indoor air quality. Improved indoor air quality will improve the comfort, well-being, health, work performance, and learning of building occupants. Recent studies also show a positive effect on sleep quality. The effects are non-negligible. Although it is difficult to quantify the economic effects on comfort and well-being, the financial benefits on health and cognitive performance were made. Ventilation will reduce health effects by decreasing the exposure to pollutants inhaled indoors. These pollutants can have indoor and outdoor origins; those with outdoor origins can be effectively removed by the technical solutions installed in the systems delivering air for ventilation into indoor spaces. The European EnVie and IAIAQ projects that around 2 million healthy life years are lost due to exposure to air pollution in buildings in Europe; the HealthVent project estimated that this burden can be halved when ventilation with effective source control indoors is applied (one healthy life year is estimated to be more than €100k). Since indoor air contains numerous pollutants, ventilation is a proxy of the potential effect. These considerable economic benefits were also the case when the effects on work performance were examined. The summary of these studies suggested a 1-2% increase in work performance for every doubling of the ventilation rate. Estimations of economic implications suggested that investment in building ventilation will be paid back in less than two years (usually quicker). At the same time, comfort, satisfaction, and well-being will be improved. Studies in schools suggest even larger effects corresponding to a 5-10% increase in learning speed and performance on national tests when ventilation is increased within the range of ventilation rates measured in schools (traditionally with the rates so that carbon dioxide in classrooms is between 2,100 ppm and 900 ppm). The improved ventilation will also increase daily attendance, with the effect estimated to be around 0.5-1%. Very few economic calculations exist regarding the financial benefits of improved ventilation in schools, but estimations for Danish conditions in Europe suggest them on the order of magnitude of 0.07% GDP. In all these estimations, the effect of ventilation on the long-range transmission of infectious diseases has not been accounted for. Ventilation effectively reduces the risk of infection, as represented, among others, by the recent Standard 241 from ASHRAE. Financial benefits are straightforward. Another essential aspect is sleep quality. Only recently, through a series of studies, has it been documented that ventilation of bedrooms keeping carbon dioxide levels below 800 ppm will be optimal for sleep, and lower ventilation rates may cause disturbance to sleep with consequences for health, next-day well-being, and work performance and learning. This level roughly translates to doubling prescribed bedroom ventilation if the requirements exist. Only recently, the estimations of the economic consequences of sleeping too short (<6-7 hours a night) would cause >1.2 million days lost in the US. Concerning indoor air quality, the most important is reducing exposure to indoor pollutants. Since there are multitudes of pollutants, this task may never be achieved, and we will have to secure adequate ventilation in every building to avoid the effects described above.

KEYWORDS

Ventilation; Outdoor air; Schools, Offices; Bedrooms