

## Resources: Selected References from High-Performance Ventilation and Energy Conservation Building Science

### Ventilation Effects on Health and Cognition

Schools and offices need more outside air, and less carbon dioxide, to support working brains, period. A growing number of studies conclude this. Most studies are first finding that average ventilation and CO<sub>2</sub> conditions are well below ASHRAE standards. Yet, going well above ASHRAE levels of ventilation keeps right on improving human health and productivity. These six studies, as detailed in our AHR 2017 Presentation on school classroom air quality, provide calibrated evidence on "how much?" negative impact can be measured--in illness-related absences or on cognitive tests--with each downgrade in ventilation level.

(1) Mendell, Mark J, Eliseeva, E.A. et al (2013, December) "Association of Classroom Ventilation with Reduced Illness Absence: A Prospective Study in California Elementary Schools" Lawrence Berkeley National Laboratory: Indoor Environment Group, Environmental Energy Technologies Division. *Indoor Air-International Journal of Indoor Environment and Health*: Vol 23(6), Pages 515-528.

Publicly available at LBNL:

[https://indoor.lbl.gov/sites/all/files/lbnl-6259e-association\\_of\\_classroom\\_ventilation.pdf](https://indoor.lbl.gov/sites/all/files/lbnl-6259e-association_of_classroom_ventilation.pdf)

(2) Corsi R L, Torres V M, et al (2002) "Carbon dioxide levels and dynamics in elementary schools: results of the TESIAS study." Proceedings of Indoor Air 2002 (9th International Conference on Indoor Air Quality and Climate) held in Monterey, CA June 30 - July 5, 2002: Vol 1 (2)

*Abstract available at*

<http://www.aivc.org/resource/carbon-dioxide-levels-and-dynamics-elementary-schools-results-tesias-study>, or ask [maria@ventacity.com](mailto:maria@ventacity.com) for individual copy.

(3) Shendell, D G, Fisk, W J et al (2004). "Associations between classroom CO<sub>2</sub> concentrations and student attendance in Washington and Idaho." *Indoor Air*, Vol 14: 333–341.

Publicly available from Washington State University Extension Energy Program at:

<http://www.energy.wsu.edu/Documents/CO2%20Concentrations%20and%20Attendance-12-032.pdf>

(4) Allen, Joseph P, MacNaughton, P et al (2016, June) "Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments." *Environmental Health Perspectives*, Vol 124 (6): pp. 805-812.

Open Access available at <https://ehp.niehs.nih.gov/15-10037/>

(5) Haverinen-Shaughnessy U, Shaughnessy R J (2015) "Effects of Classroom Ventilation Rate and Temperature on Students' Test Scores." *PLoS ONE*, Vol 10(8).

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<https://ventacity.box.com/s/1b9zsghkrybemagxghby4dga9if192t>

(6) Shaughnessy, R.J., Haverinen-Shaughnessy, U. et al (2006, December) "A preliminary study on the association between ventilation rates in classrooms and student performance". *Indoor Air*, Vol 16(6): p. 465-468

Abstract available <http://onlinelibrary.wiley.com/doi/10.1111/j.1600-0668.2006.00440.x/full> .

Abstract for a later 2010 follow up available from National Institute of Health at:

<https://www.ncbi.nlm.nih.gov/labs/articles/21029182/>