The Facts Matter: Peer-Reviewed Studies on Air Quality & Windows

By David E. Jacobs, PhD, CIH, Chief Scientist, National Center for Healthy Housing

At the recent “March for Science” in Washington and elsewhere, thousands filled the streets chanting: “What do you want? Peer Review.” Although it seemed odd at the time, I was struck by how many still depend on the knowledge (not opinion) of what works and what doesn’t to take action. The indoor environmental quality, healthy homes, and home performance (weatherization) allied fields have done much to build a sound evidence base over the past few decades and to insist that the nation act on that evidence. This article explores two recently published articles in the peer-reviewed press and how such publication has stimulated recent action.

The first article describes a window replacement pilot effort in Chicago and Peoria. As of this writing, the Illinois legislature has passed a bill to expand this program to the tune of $35 million, based on the evidence that it protects children from lead poisoning, creates jobs, and has financial benefits that significantly outweigh the costs. It was included in the governor’s budget, despite a state budget that seems otherwise paralyzed.

The second article is one of only a handful of randomized controlled trials that evaluated two different ventilation standards. The results show that weatherization improves indoor air quality and health when accompanied by a ventilation standard. As a result, ventilation is now part of most weatherization work.

A scientific evaluation of the “Comprehensive Lead Education and Reduction through Window Replacement” program was recently published in the *Journal of Public Health Management & Practice*. Windows have the highest levels of lead dust and lead paint compared to any other building component. Dust wipe sampling, visual assessment, and structured health interviews were conducted in a convenience sample of 96 households drawn from the 466 housing units served by CLEARWin before, immediately after, and nominally one year following window replacement. Lead dust sampling was conducted using the standard HUD wipe method, followed by analysis in laboratories participating in the EPA Environmental Lead Laboratory Accreditation Program. Statistical analysis employed log transformation of dust data, the Cochran-Mean Haenszel (CMH) test, Weighted Least Squares (WLS), Fisher’s exact test and two-sample t-tests.

Results show that large reductions in floor, window sill and window trough lead dust (PbD) were achieved and sustained through one-year followup. Geometric mean PbD at baseline and one year followup for interior floors, interior sills and exterior troughs declined by 58%, 88% and 98% respectively ($p<0.001$ for all).

The percentage of units failing clearance dust standards for floors, sills and troughs immediately following cleanup and window replacement was 2%, 3% and 2% of the units, respectively, showing that clearance testing is necessary in such programs. All houses did eventually pass clearance dust lead testing. A year later, the percentage failing such standards rose slightly on floors, sills and troughs to 5%, 8% and 11%, respectively, suggesting the need for ongoing cleaning.

There was no statistically significant difference in PbD trends between Peoria and Chicago, suggesting the program worked equally well in both urban and rural jurisdictions.

Health interviews showed that the percentage of children with headaches, respiratory allergies, and three or more ear infections significantly improved a year later. The percentage of adults reporting sinusitis and hay fever improved significantly and the percentage of households reporting uncomfortable indoor temperatures in both summer and winter significantly improved. There were also fewer water or dampness issues due to broken pipes, leaks, heavy rain, floods, or other reasons.

Total economic benefits were estimated at more than $5 million compared to a cost of $3 million. On average, residents gave the program high marks, reporting that they were "very satisfied" with the window replacement using a 5-point scale (very satisfied, satisfied, neither satisfied nor dissatisfied, somewhat dissatisfied, very dissatisfied).

The second article, "Housing and Environmental Aspects Linked to Health through Ventilation," was recently published in *Indoor Air Journal*. Ventilation and moisture control are intertwined and have become an important feature of weatherization, but the effect of specific ventilation strategies on health and indoor air quality has not been adequately examined. This randomized trial examined how two commonly used ventilation standards (ASHRAE 62-1989 and ASHRAE 62.2-2010) influenced indoor air quality and self-reported physical and mental health outcomes in low-income housing undergoing weatherization in the Chicago area and Indiana. Passive air samples were collected for one-week periods before and immediately after weatherization work was completed, while temperature and relative humidity data were collected before and for up to six months post-weatherization.

Structured health interviews were conducted at baseline and at a nominal six-month post-weatherization period. Between baseline and post-weatherization, moisture balance decreased significantly in each group, with the ASHRAE 62.2-2010 group's decrease significantly greater than that of the ASHRAE 62-1989 group. (Moisture balance is the difference of water vapor pressure between indoors and outdoors; low moisture balance represents drier conditions indoors with less potential for mold and other problems.)

For the 62.2-2010 group, formaldehyde, total volatile organic compounds and carbon dioxide levels were all significantly lower following weatherization, and radon concentrations were higher in the basement and lower on the first floor. For the 62-1989 group, the only contaminant that decreased significantly was formaldehyde ($p<0.05$).

Based on self-reported health interview responses by household caregivers, children in each group had fewer headaches after weatherization, with the ASHRAE 62.2-2010 group's reduction significantly greater than the ASHRAE 62-1989 group's reduction. Marginally significant reductions in the number of children with eczema and skin allergies occurred in each group. Children's respiratory allergies improved in each group.

The percentage of adults in ASHRAE 62-1989 and ASHRAE 62.2-2010 reporting psychological distress between baseline and post-weatherization showed significant and similar improvements ($p=0.082$ and 0.008, respectively). The study indicates that air quality and health outcomes improve when weatherization is accompanied by an ASHRAE residential ventilation standard and that the 2010 ASHRAE standard optimizes such improvements on certain outcomes.

More studies such as these are needed if we are to achieve policy and funding changes to meet the needs of our nation. Weatherization and window replacement can both be considered to be examples of infrastructure improvements that pay off. And no matter which side of the health care debate you are on, everyone agrees that reducing health care costs is desirable. Improving housing, whether by window replacement or by improved ventilation (or both) is a sound investment that will reap enormous benefits in health and finances. Let's act on what we know.

About the Author:

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He is one of the nation's foremost authorities on childhood lead poisoning prevention, and was principal author of the President's Task Force Report on the subject in 2000 and the Healthy Homes Report to Congress in 1999. He has testified before Congress and other legislative bodies and has published many peer-reviewed papers.

Dr. Jacobs is the former director of the Office of Lead Hazard Control and Healthy Homes at the U.S. Department of Housing and Urban Development, where he was responsible for program evaluations, grants, contracts, public education, enforcement, regulation, and policy related to lead and healthy homes. His current work includes research on asthma, international healthy-housing guidelines, lead-poisoning prevention and green sustainable-building design. He is a Certified Industrial Hygienist and has degrees in political science, environmental health, technology and science policy and a doctorate in environmental engineering.