

The Evidence of Nature and the Nature of Evidence

Howard Frumkin, MD, DrPH

“Thousands of tired, nerve-shaken, over-civilized people,” wrote conservationist John Muir over a century ago, “are beginning to find out that going to the mountains is going home; that wilderness is a necessity; and that mountain parks and reservations are useful not only as fountains of timber and irrigating rivers, but as fountains of life.”¹ Muir was not breaking new ground. Since ancient times, people intuitively have been drawn to places of natural beauty, seeking tranquility, restoration, spiritual fulfillment, and even better health.

Modern research offers tantalizing clues that corroborate this tradition. Consider the benefits of trees. Studies have found that post-surgical patients recover more smoothly when they can view trees through their hospital windows²; that public housing residents enjoy stronger social bonds, less violence, and (among girls) greater concentration, impulse control, and delayed gratification when there are trees near their apartments³⁻⁵; and that in neighborhoods with trees, newborns are less likely to be small for gestational age,⁶ children are less prone to become overweight,⁷ and elders live longer.⁸

An article in this issue of the *American Journal of Preventive Medicine*⁹ adds to the literature on the health benefits of trees. A beetle—the emerald ash borer—has wiped out millions of ash trees across 15 U.S. states over the last decade. Donovan and colleagues hypothesized that the loss of trees might threaten health—specifically, by increasing mortality from cardiovascular and lower respiratory disease. Their independent variables were the presence and duration of emerald ash borer infestation, at the county level, and the extent of ash tree loss (estimated based on county-level tree canopy data and state-level data on the proportion of ash in each state’s canopy, a parameter that nowhere exceeded 7.9%). The dependent variable was cause-specific mortality, also at the county level. Regression analysis controlled for such potential confounders as race and ethnicity, income, and education but not for smoking, diet, cholesterol, family history, or air quality. The authors found that ash tree loss was

significantly associated with cardiovascular and lower-respiratory-tract disease mortality.

This study exemplifies the challenges of research on nature contact and health. Some of these challenges relate to epidemiologic methods. For instance, how should researchers measure exposure? What is a “dose of nature”? Do people need to view leafy trees, or does a wintertime look at denuded trees do the trick? Are trees necessary, or do shrubs suffice? What density of trees is needed? How close to trees do people need to be? How long a view is needed? In this study, instead of individual-level exposure assessment through measurement or dose reconstruction, the investigators used county-level estimates of what might be called “elm deprivation.” The spatial scale of the estimates was large; we cannot know if residents of the study counties ever came near the dead and dying trees, or noticed the loss, or even knew of it. Exposure assessment in this field remains a thorny problem.

A second challenge lies in elucidating biological mechanisms of action. Clues may lie in the concepts of *biophilia*, described by biologist E.O. Wilson,¹⁰ *attention restoration*, described by environmental psychologists Rachel and Stephen Kaplan,¹¹ and/or *solastalgia* (feelings of grief, health threat, and powerlessness triggered by ecosystem degradation), described by philosopher Glenn Albrecht.¹² Physical activity, social capital, and/or improved air quality may play a role. None of these is easy to invoke in this case, in which the loss of ash tree cover—a loss representing well under 10% of local tree canopy, and to which large portions of the study populations may well have been unexposed—was associated with substantial increases in mortality due to cardiovascular and lower-respiratory-tract disease. One wonders whether an unmeasured confounder operated. Causal mechanisms in this field remain a thorny problem.

Other challenges are even broader. What threshold of scientific evidence should we reach before we draw tentative conclusions? Must we meet the high burden of proof generally associated with biomedical research (as reflected in the low *p*-value expected before accepting an association)? Perhaps not. It can be dangerous and costly to conclude, incorrectly, that a medicine or surgical procedure is safe and efficacious; recall mammary artery ligation, thymus irradiation, and post-menopausal estrogens. In contrast, the downside risk of nature contact is often no worse than a few bee stings and poison ivy rashes. The precautionary principle holds that protective steps should be taken when there is a

From the School of Public Health, University of Washington, Seattle, Washington

Address correspondence to: Howard Frumkin, MD, DrPH, Dean, School of Public Health, University of Washington, F-350 Health Sciences, Box 357230, Seattle WA 98195. E-mail: frumkin@uw.edu.

0749-3797/\$36.00

<http://dx.doi.org/10.1016/j.amepre.2012.10.016>

credible risk of harm, even absent definitive proof.¹³ Do we know enough of the dangers of Nature Deficit Disorder¹⁴ to recommend more nature contact? Recognizing the limits of the biomedical research paradigm and knowing how to move from partial evidence to action are thorny problems in this field.

Finally, even the most rigorous biomedical research results would not tell the whole story. Trees offer many non-health benefits. They provide shade, which cools cities and towns in hot weather. They improve air quality and contribute to storm water management. They increase real estate values, boosting municipal revenues. They provide venues for outdoor recreation, socializing, and relaxing. They are beautiful. In a world of specialized researchers and niche journals, it is the rare study that quantifies all the benefits of trees, for human health and well-being, the environment, and the economy. For interventions with a wide range of potential benefits, well-informed decision-making requires full-benefit accounting. Biomedical research rarely delivers it.

Nature contact extends from flowers (as in horticultural therapy) to healing gardens, from viewing trees to wilderness adventures, from bird-watching to visiting zoos to owning pets. Collectively, these experiences offer enormous promise for disease prevention and health promotion. They are widely available and inexpensive; they don't need to be prescribed or dispensed by highly trained professionals; they are easily personalized according to age, ability, and cultural preference; they inflict few adverse effects; and they offer numerous co-benefits—claims, by the way, that few medical treatments can make. This field deserves far more research attention than it has had. And as results emerge, we need to be thoughtful and innovative in assessing them and applying them to bettering people's lives.

No financial disclosures were reported by the author of this paper.

References

1. Fox S. John Muir and his legacy. Boston: Little, Brown, 1981.
2. Ulrich RS. View through a window may influence recovery from surgery. *Science* 1984;224:420–1.
3. Kuo FE, Sullivan WC. Aggression and violence in the inner city: effects of environment via mental fatigue. *Environ Behav* 2001;33(4):543–71.
4. Kuo FE, Sullivan WC. Environment and crime in the inner city: does vegetation reduce crime? *Environ Behav* 2001;33(3):343–67.
5. Taylor AF, Kuo FE, Sullivan WC. Views of nature and self-discipline: evidence from inner city children. *J Environ Psychol* 2002;22(1–2):49–63.
6. Donovan GH, Michael YL, Butry DT, Sullivan AD, Chase JM. Urban trees and the risk of poor birth outcomes. *Health Place* 2011;17:390–3.
7. Bell JF, Wilson JS, Liu GC. Neighborhood greenness and 2-year changes in body mass index of children and youth. *Am J Prev Med* 2008;35:547–53.
8. Takano T, Nakamura K, Watanabe M. Urban residential environments and senior citizens' longevity in megacity areas: the importance of walkable green spaces. *J Epidemiol Community Health* 2002;56:913–8.
9. Donovan GH, Butry DT, Michael YL, et al. The relationship between trees and human health: evidence from the spread of the emerald ash borer. *Am J Prev Med* 2013;44(1):139–45.
10. Wilson EO. *Biophilia: the human bond with other species*. Cambridge MA: Harvard University Press, 1984.
11. Kaplan S. The restorative benefits of nature: toward an integrative framework. *J Environ Psychol* 1995;15:169–82.
12. Albrecht G, Sartore GM, Connor L, et al. Solastalgia: the distress caused by environmental change. *Australas Psychiatry* 2007;15(S1):S95–S98.
13. Raffensberger C, Tickner J, eds. *Protecting public health and the environment: implementing the precautionary principle*. Washington DC: Island Press, 1999.
14. Louv R. *The nature principle: human restoration and the end of nature-deficit disorder*. Chapel Hill NC: Algonquin Books, 2011.