



HEALTH

Can Trees Heal Heart Disease?

Researchers in this polluted city are planting thousands of trees in a bold health experiment aimed at lowering rates of cardiovascular disease.

By Nancy Averett | Apr 9, 2021 1:00 PM



Volunteers buzz around the front lawn of a Baptist church in Louisville on a bright October morning. Sporting navy T-shirts with the words Citizen Forester emblazoned across the back, they divvy up spades and shovels, grab buckets and hoses. Behind them looms the church's imposing white-columned entrance and a sign that declares, "Prayer Works." Across the street, a row of small clapboard-sided homes stretches down the block. A pair of dogs bark furiously behind a chain-link fence. Then everyone turns to the man in leather loafers and a linen suit coat. His ambitious idea — one that may or may not work — is the reason they're here.

“We all intuitively believe trees are good for you. But we don’t know if it will help the health of the population to be living among trees,” Aruni Bhatnagar says to the volunteers. “Come back in a year to see if it’s working.”

Bhatnagar, director of the Christina Lee Brown Envirome Institute at the University of Louisville, is overseeing an effort called the Green Heart Project. The team behind the initiative is betting \$14.5 million on the idea that trees could prevent heart disease in humans. The big test involves injecting a massive amount of vegetation — up to 10,000 trees over the past three years — into neighborhoods throughout Louisville.

“It’s a clinical drug trial,” the scientists based at the Envirome Institute like to say. “But trees are the pill.” Oak trees were once plentiful here in the Oakdale neighborhood, along with the ashes, maples and elms, that once lined many of the city’s streets. But in recent decades, worsening heat, storms, diseases and attacks from invasive beetles have ravaged the trees. The city government, facing plummeting funding for such projects, failed to replant, leaving neighborhoods like this one with a rapidly diminishing canopy. Each day, about 150 trees perish in this city.

Residents struggle to survive here, too. Homicide, suicide, cancer and drug addiction all take a toll, as do the volleys of upheaval after the killing of Louisville resident Breonna Taylor last year. Heart disease, too, has become a major threat. Louisville has some of the highest rates of cardiovascular disease in the country. It also has dirty air, which Bhatnagar suspects is more than coincidence. The American Lung Association consistently gives Louisville a failing grade for its pollution levels. And over the past 15 years, researchers have become increasingly aware that air pollution plays a key role in the development of heart disease.

The guiding mission behind the Envirome Institute is to conduct environmental research to create healthier cities. That has included discovering how the chemicals that pour out of exhaust pipes and smokestacks can cause blood to thicken and arteries to constrict. The Envirome Institute recently ran a pilot project and found that planted trees reduced 60 percent of the pollution around a local school.

The National Institutes of Health (NIH) and the Nature Conservancy have each donated millions of dollars to the group, and researchers from universities around the country have signed on to do supplementary investigations. Still, the Green Heart Project, which began in 2018, is a gamble. Dozens of studies have examined the effects of trees on human health, yet they are all based on associations, meaning people’s health improved when they were around trees but other factors — perhaps their exposure to trees occurred when they were also exercising — could not be ruled out.



Aruni Bhatnagar (Credit: Tom Fougousse, University of Louisville)

In other words, none has shown definitely that exposure to trees actually caused human health to get better. Bhatnagar knows that this more complicated science is needed to influence policy and those in power — pharmaceutical executives, hospital administrators, Rust Belt mayors. “It’s hard enough inside the lab to show a relationship between two variables,” Bhatnagar says. “Then we go out into the real world, and it’s amazing that we make any sense of it at all.”



Landscapers and volunteers plant a sweetbay magnolia within the Green Heart volunteers. (Credit: Randy Olson)

From Labs to Neighborhoods

When Bhatnagar arrived at the University of Louisville in 1998, he hadn’t planned to specialize in environmental cardiology. He was studying nitric oxide, a molecule essential to heart health; it both regulates insulin in the body and increases circulation by relaxing the inner muscles of blood vessels. One day, while perusing the literature, he discovered both cigarette smoke and pollution impair nitric oxide production in the body. Intrigued, he and his staff began toxicology studies to see how all sorts of pollutants affect the cardiovascular system.

They learned that exposure to the compound acrolein, found in both cigarette smoke and car exhaust, results in extensive cardiovascular injury in rats and mice. In addition, the fine-particulate matter in air pollution causes vascular damage in humans and suppresses stem cells, which are needed to repair blood vessel damage, in mice.

“People think poor diet and lack of exercise are the only things that lead to heart disease,” Bhatnagar says. “But in reality, the heart and the blood vessels are very sensitive to environmental pollutants.”

One of his labs in the Envirome Institute is now testing how benzene, another chemical in car exhaust, impacts mice. Long ago, research found it to be a cancer-causing agent. But no one has done a study to examine how it changes the heart and blood vessels. “Surprisingly,” Bhatnagar says, “it’s not known.”

Unlike the mice in the lab, the 700-some Louisville residents enrolled in the Green Heart Project don't stay in glass containers for six hours a day, inhaling one specific type of polluted air. And no graduate student scoops an exact amount of nutrient-dense pellets into everyone's food twice daily. Instead, the participants move from home to the office to the grocery store. Some work the day shift, some nights. But toxicological studies on both the mice and humans should track important changes.

In 2018, Rachel Keith, a nurse practitioner and physiologist at the Envirome Institute, collected blood, urine, hair and toenails, along with cheek swabs, from Green Heart participants. Those samples were analyzed for biomarkers of cardiovascular disease with the idea that Keith would compare a residents' cardiovascular profiles with the pollution profile collected outside their homes. When the coronavirus pandemic hit, the researchers had to recalibrate. Keith plans to begin taking new samples by mid-2021. Included will be an antibody test to see if any of the participants contracted COVID-19. Data for those patients will be analyzed separately to see if the virus had an effect on their cardiovascular system.



The human measurements will continue throughout the study. "Traditionally with a clinical trial, participants get something out of it, such as a pill that may cure their cancer," says Keith. "But with our trial, all we can say is we're going to put trees in the neighborhood and maybe you'll see some benefit." On the other hand, she says, "when you give someone medication, it treats one person. These trees could treat a whole neighborhood."

Nature for People's Sake

Trees are dying in Louisville, faster than they are being replaced. That was the grim conclusion in a 2015 report on the city's tree canopy. Just 37 percent of the city had tree coverage, the 114-page document noted, and much of that was in city parks rather than residential spaces. Louisville was losing 54,000 trees a year. What's more, the report warned, due to the arrival of the emerald ash borer, an invasive beetle from east Asia, "tens of thousands of ash trees will be lost" within five to 10 years.

Around the time that report came out, scientists were publishing a plethora of studies on urban trees and their ability to absorb different pollutants. Some showed that the hairs on tree leaves, called trichomes, may increase a tree's ability to capture fine-particulate matter. Others revealed the importance of tree placement and vegetation type — in particular, conifers like pines are more effective than deciduous trees, since they stay green year-round.

This emerging research was on Bhatnagar's mind one day in 2015 when he met with Christina Brown, the local philanthropist who funded the Envirome Institute. Their discussion turned to the city's dirty air and high heart disease rates. "We always say we need better regulations and less traffic," Bhatnagar recalls Brown saying. "Is there something else we can do to make a difference in the air quality?"

He replied, “Well, we could certainly plant trees to absorb some of the pollution.” But he knew a study to validate such an effort would be enormously expensive and complicated. Brown perked up. “Let’s do that.”

It took two years for Bhatnagar to convince the NIH to help fund the project. He revised grant proposals, held long conference calls and conducted several pilot studies. One of those studies planted evergreens in front of St. Margaret Mary Catholic School, which lies on the eastern edge of Louisville along busy U.S. Route 60. The not-yet-published results show the trees substantially reduced particulate pollution around the school and improved heart health biomarkers in students and teachers. Finally, a representative from the NIH told Bhatnagar he was getting close to convincing them, but warned: The NIH is not in the business of planting trees.

Around the same time, the Nature Conservancy launched a new urban initiative, picking Louisville as a target cities. It was a shift for the national organization, which for most of its existence has focused on buying up ecologically important land to preserve. “We’ve been saving nature from people, not for people,” says Chris Chandler, director of urban conservation for the Conservancy’s Kentucky chapter. When Chandler and his colleagues heard about Bhatnagar’s proposal, the study seemed to fit perfectly with their new mission. Within six months, the nonprofit agreed to spend over \$8 million on trees.

Part of that money will fund an evergreen wall near a stretch of single-story homes in Louisville’s Beechmont neighborhood. This spot is in the heart of the tree-study territory, which spans a 3-square-mile radius between Churchill Downs and the Louisville International Airport. The tree barrier will abut Watterson Expressway/Interstate 264, where a quarter-million cars fly down five asphalt lanes daily.

Currently, an 18-foot barrier blocks the traffic from the neighborhood — installed years ago by the government to dampen sound. What state highway officials didn’t realize is that when car emissions hit the wall, it creates an eddy effect. Picture a rock in a stream, where water builds up only to flow more forcefully around it.

So, instead of dispersing into the atmosphere, fine-particulate matter from exhaust pipes concentrates on the traffic side, travels up the wall, then spills over the top and dumps into the neighborhood.

To fix the problem, the Nature Conservancy will plant huge conifers on both sides of the wall, using semi-trailers and cranes to drop them into place.



The dual-tower Bosco Verticale in Milan houses more plants and trees than human residents. (Credit: Balazs Sebok/Alamy)

“We’re looking to extensively green up these corridors that run alongside major highways,” Chandler says. They’re aiming for landscaping that will either capture pollution at its source, or help it disperse back into the atmosphere, rather than fill neighborhoods.

The Hard Part

After Bhatnagar’s brief speech to the volunteers in front of the church, the planters disperse around the study’s six neighborhoods. One group ends up a half mile from the church on Beecher Street, in front of a yellow vinyl-sided bungalow. Shovels clang from



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the side of the house as half the group chips away at a dry, rocky channel of soil along the driveway; the other half are on their knees in the front installing two different kinds of junipers.

Months before these volunteer planters stepped foot in someone’s yard, canvassers knocked on doors. They asked homeowners if they’d like to participate in the study and possibly get some trees in their yard. Some residents, like 37-year-old Jenell Glymph, jumped at the chance. “Anything we can do to get people off their couches and outside is a good thing,” she said. But not all residents were as enthusiastic.

“Some people say, ‘Oh this is great!’ and they want to stand on the porch with you and talk for an hour,” Bhatnagar says. “Others say, ‘I have all these problems, who cares about your f----- trees!’ ”

He laughs heartily then turns more serious as he contemplates how the notion of using trees for health intervention has captured the popular imagination despite any hard science to back it up. For example, in 2014, Italian developers completed Bosco Verticale (Italian for “vertical forest”) in Milan. The double skyscraper was built to hold 800 trees, 15,000 perennials and 5,000 shrubs that spill over terraces and cover most of the facade. The architects claimed it offered health effects for its residents. Two years later, Chinese officials took the idea one step further and commissioned the same developers to build the first “forest city,” in the province of Guangxi. Slated for completion this year, the community will have 1 million herbaceous plants and 40,000 trees.

Bhatnagar has also found dozens of studies that show correlations between living near green spaces and health outcomes: lower stress levels, asthma rates, depression rates and more. One notable 2013 study by the U.S. Forest Service found an association between the recent loss of over 100 million ash trees nationwide and increased death from cardiovascular and lower respiratory tract illness.

None, though, showed causation. “So, OK,” Bhatnagar says. “Everybody agrees, ‘Let’s plant trees to make people healthier.’ But if you ask why, nobody knows.” He throws up his hands. “So we need to do the science ... and that’s the hard part.”