

Active Travel for All? The Surge in Public Bike-Sharing Programs

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In June 2017, hundreds of bicycles started showing up on sidewalks in downtown Dallas, Texas, taking city officials and residents by surprise. Perched on kickstands with their rear wheels locked, and provided by a local company called VBike, these bikes were there for anyone to use. After paying an initial damage deposit, riders could download a cell phone app that unlocked the bikes' rear wheels. Usage fees were charged to the rider's credit card.

Dallas does not have many dedicated bike lanes, and *Bicycling* magazine twice ranked it the worst city in America for cycling.¹ Nevertheless, public bike-sharing took off there. By early winter, the citywide fleet had swelled to roughly 20,000 shared bicycles supplied by five different companies. Unlike “docked” public bicycles that users return to specified docking stations, these “dockless” bikes could be left anywhere in the city. Being outfitted with GPS tracking devices, VBike would know where to find them.

The upswell of dockless bike-sharing has brought its own set of problems to Dallas. The bikes are piling up in public spaces, many of them vandalized or broken. One bike was even found sawed in half with its rear and front sections bolted on either side of a telephone pole. “We’re fielding hundreds of complaints about [dockless bicycles] sitting for weeks and even months in residential areas without being moved,” says Jared White, director of alternative transportation programs in the Dallas Department of Transportation.

Dallas’s experience illustrates the explosive growth—and growing pains—of bike-sharing programs around the world. Turning thousands of dockless bicycles out on the street has prompted a backlash in many cities beyond Dallas. Even as bike-sharing is being widely adopted globally, some towns and cities are banning it,² and companies have in some instances shut their operations down after too many of their bikes were vandalized.³

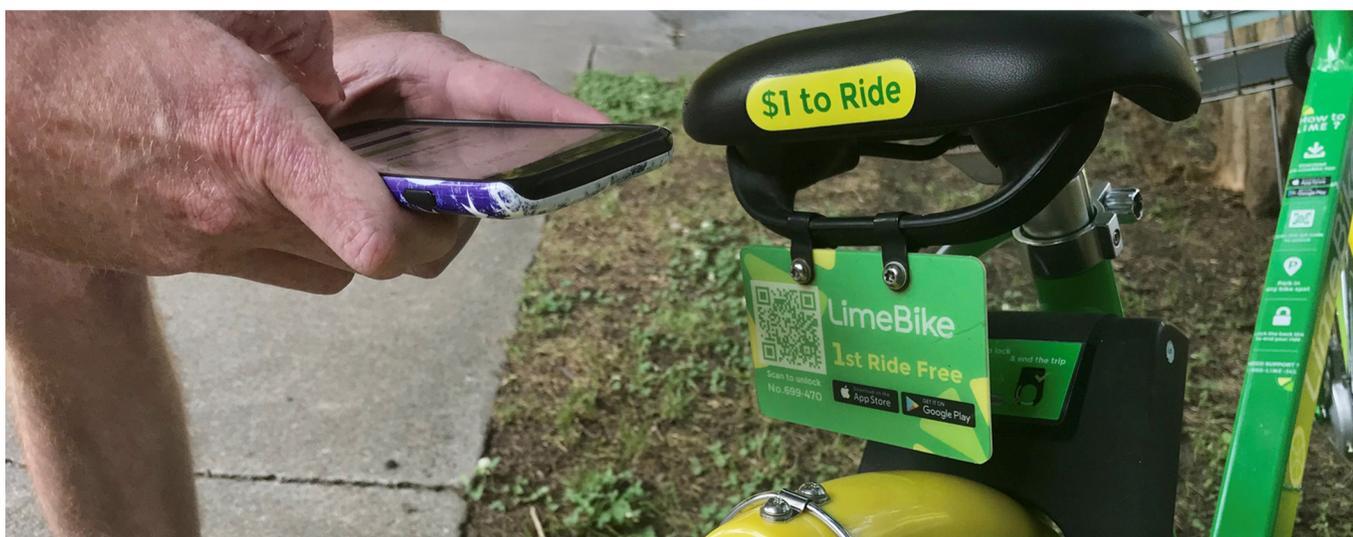
However, if managed appropriately, bike-sharing can offer a path toward easing traffic congestion with a health-promoting mode of active travel. Studies have provided ample evidence that choosing to bike instead of drive has health benefits.^{4,5,6,7,8} In fact, the authors of a 2010 study, published in *EHP*, estimated that the added physical activity of shifting from a car to a bicycle for short commuter trips could add 3–14 months to the typical life span.⁹ In addition, in a bid to combat obesity, entities such as the World Health Organization,¹⁰ the European Commission,¹¹ and the U.S. Centers for Disease Control and Prevention¹² have developed guidelines for integrating active travel—namely, cycling and walking—into daily commuter patterns.

How Bike-Sharing Works

Commercial bike-sharing began with a docked model that has become more sophisticated over time. The earliest docking stations



Many cities are exploring ways to increase rates of active travel by making it easier for people to walk or bike where they need to go. In Seattle, Washington, the Tilikum Crossing bridge was designed as a car-free route across the Willamette River. The bridge has special lanes for pedestrians and cyclists, and only mass transit and emergency vehicles are allowed to drive across. Image: Tedder/CC BY-SA 4.0.



(top) Docked bicycles are rented from and returned to docking stations equipped with electronic payment kiosks. (bottom) Dockless bikes can be picked up and left anywhere in the city. Riders simply use a cell phone app to unlock the bikes. Images, top to bottom: © anystock/Shutterstock, EHP.

were coin operated; today they are outfitted with electronic payment kiosks and chip readers that track the use of each bike.

Modern docking stations started becoming widespread in 2005 after the French advertising agency JCDecaux sponsored a 1,500-bike system in Lyon, France, followed by a 7,000-bike system in Paris two years later. The first large-scale docked program in the United States, SmartBike DC (now known as Capital Bikeshare), was established in Washington, DC, in 2008.¹³ Today, Hangzhou, China, runs the largest docked bike-sharing program in the world, says Russell Meddin, a Philadelphia-based blogger who catalogs bike-sharing companies worldwide and curates the online Bike-Sharing World Map (www.bikesharingmap.com).

The transition to dockless bike-sharing began roughly a decade after the advent of docked bikes. In 2014, students at China's Peking University contributed about 2,000 bikes to a collective that anyone on campus could use. Each bike was outfitted with a lock that immobilized the rear wheel. By scanning a bike-mounted data matrix code with a cell phone app, users could unlock the wheel and go riding. That system proved widely popular, Meddin says, and spread quickly across Chinese campuses.

The student organizers formed a company to commercialize the system for bigger markets. They called it ofo—a name chosen because the word itself resembles a cyclist. The ofo phone app

used GPS to record where riders ended their rides. This enabled the company to track where its bikes were located at any given time.

Another Chinese company, Mobike, soon introduced a tracking technology linked to the bike's locking mechanism. This newer "smart-lock" technology, which guides prospective riders to the closest bike, now dominates the dockless bike industry worldwide.

The number of bike-sharing programs worldwide grew from 5 in 2005 to 1,571 in 2018, according to Meddin. On a global basis, he says, an estimated 16–18 million dockless bikes are currently in use, compared with 3.7 million docked bikes. ofo has led the dockless market, although the company recently announced that it is sharply reducing its U.S. operations.¹⁴

Samantha Herr, executive director of the North American Bikeshare Association in Portland, Maine, says that large-scale venture capital and cheaper equipment are the game changers that propelled the explosive growth of dockless companies like Mobike and ofo. She explains that dockless bikes are of lower quality than their docked counterparts and do not require expensive technologies to interface with a docking station. That makes them cheaper to mass produce and drop off in new markets.

Dockless companies also pay for their own equipment and operations, Herr adds, whereas docked biking companies rely on public-private partnerships to cover their expenses. Given the

high cost of building and operating docking stations, those expenses are substantial. Dallas officials, for instance, estimated it would cost US\$6 million to build a 400-bike docked program in that city and operate it for five years, according to White. “We tried unsuccessfully to find a local city group to sponsor it, but nothing ever materialized,” he says.

With a current fleet of 12,000 bikes, New York City’s docked bike-sharing program, called Citi Bike, is unusual in that it is funded exclusively by a single private sponsor, Citibank, which puts its logo on the bikes and docking stations. Riding fees and yearly subscriptions cover much of the operational overhead, and Citibank picks up the rest of the tab.

Most other docked programs depend on riding fees, commercial sponsors, and heavy infusions of public subsidies. Taxpayers in Montreal, Canada, for instance, have been subsidizing that city’s BIXI docked bike-share program for nearly 10 years, at a cost of Can\$60 million so far. Some observers question whether Montreal’s investment has paid off in terms of environmental and health improvements for the population. A Canadian think tank called the Montreal Economic Institute produced one analysis in which the authors concluded that “If the goal of launching [BIXI] was to increase the frequent use of bicycles among Montrealers,

this has not occurred. . . . What is more, [the program’s] impact on the environment is probably negligible, since it seems to essentially replace walking, other cycling, or public transit use.”¹⁵

Biking and Health

Proper infrastructure is a critically important component of reaping the benefits associated with active travel. “Having a bike-sharing system only works if it is safe enough for people to cycle,” says research professor Mark Nieuwenhuijsen, who studies healthy urban environments at the Barcelona Institute for Global Health.

Nieuwenhuijsen et al. recently conducted a health impact assessment of cycling infrastructure in 167 European cities.⁷ They estimated that expanding the availability of bike lanes by even 10% would have a substantial impact on the number of people who choose to bike. They further estimated that if each of those 167 cities could persuade a quarter of its population to travel via bike, a total of more than 10,000 premature deaths could be avoided each year. Those estimates accounted for heightened risks of injury and exposure to exhaust fumes due to choosing a bike over a car.



(top) Bike-share companies are supposed to periodically rebalance their fleets to ensure bikes do not end up littering streets. However, sometimes city streets end up cluttered with bikes for longer than residents, pedestrians, and public officials might like. (bottom) In China, older bikes with outdated technology accumulate in huge piles around the country. Images, top to bottom: EHP, © VCG/Getty Images.

Growing evidence suggests that biking's health benefits do indeed outweigh the risks in most areas. In a 2016 report, researchers at the Mineta Transportation Institute at San José State University concluded that, so far, bike-sharing safety has compared well with that of general recreational cycling,¹⁶ even though many bike-share users are inexperienced riders, and relatively few of them wear helmets.¹⁷ The authors say one factor is that shared bikes are big and slow, so they often are ridden less aggressively than privately owned bikes. Some studies cited in the report also found that drivers in bike-sharing communities tend to develop a greater awareness of the cyclists around them.

Other lines of research have focused on exposures to vehicular emissions. Breathing rates increase while biking, and urban riders contend with traffic-related pollutants such as nitrogen oxides, sulfur dioxide, various hydrocarbons, and fine particulate matter (PM_{2.5}). The biking research to date has focused almost exclusively on cyclists' exposures to PM_{2.5}, which burrows deep into the lungs, crosses into the bloodstream, and elevates risks for respiratory illnesses, cardiovascular diseases, and cancer.^{18,19,20,21}

Audrey de Nazelle, a lecturer at Imperial College London, says that bike riding and other forms of exercise may protect against disease in part by reducing systemic inflammation. Conversely, PM_{2.5} exposures are thought to heighten disease risk in part by *increasing* levels of systemic inflammation in the body. When air levels of PM_{2.5} reach a certain threshold, de Nazelle explains, the harm from the increased intake of air pollution may start to diminish or even negate the benefits of exercise.

In her research, de Nazelle focuses on two critical exposure thresholds: a "tipping point" at which the harms and benefits from cycling begin to cancel each other out, and a "breaking point" at which cycling is no longer good for people. In 2016, de Nazelle et al. published a study showing that cyclists in most cities could ride for hours without ever reaching the tipping point for long-term mortality impacts. Specifically, they reported that it would take annual ambient PM_{2.5} levels of 95 µg/m³ and 160 µg/m³ to reach the tipping and breaking points, respectively.²² Only a few of the world's cities reach those sorts of pollution levels on an annual average basis, such as Delhi, India.²³ "So in most cities, the net effect of cycling is going to be positive," de Nazelle says.

Darby Jack, an assistant professor at the Columbia University Mailman School of Public Health, and Steven Chillrud, a research scientist at Columbia University's Lamont-Doherty Earth Observatory, codirect a study in New York City that is exploring how doses of inhaled pollutants compare with levels measured in ambient air. Volunteer participants use a cell phone app to record their locations. They also wear a skintight biometric shirt that records heart rate and breathing volume, as well as a harness outfitted with air pollution and blood pressure monitors.²⁴ Worn over six 24-hour periods, the monitoring kit collects real-time and location-specific information on breathing rates, cardiovascular indicators, and pollution levels.

The results will provide important information for assessing cyclists' exposures and their potential health effects while biking in urban neighborhoods. "We're asking if there's enough evidence



Researchers Steven Chillrud and Darby Jack fitted study participants with equipment to assess how biking near traffic affects cardiovascular indicators. The black biometric shirt has sensors that measure heart rate, heart rate variability, and respiration. The blue harness holds monitors to measure exposures to black carbon and PM_{2.5}. Image: © Masih Babagoli.

of an impact on cardiovascular indicators from biking in close proximity to traffic that individuals who want to improve their long-term health even more might be induced to pick a different route or time of day to exercise,” Chillrud says. “Or better yet, will there be evidence that urban traffic planners could further improve health by separating traffic, especially older diesel trucks, from being in close proximity to biking pathways?”

Steve Hankey, an assistant professor of urban affairs and planning at Virginia Polytechnic Institute and State University, addressed similar questions in a study published in *EHP* in 2017.²⁵ Hankey et al. wanted to see whether the areas where Minneapolis bicyclists and pedestrians typically travel are especially likely to be highly polluted. Hankey used himself as a proxy, taking approximately 40 bike rides through the city between late August and the end of October. His bike pulled a trailer outfitted with air monitoring instruments.

The team used these data to estimate air quality block by block across the city. Then they identified “sweet” and “sour” spots: Sweet spots had high rates of active travel and low levels of air pollution, whereas sour spots also had high rates of active travel but high levels of air pollution. For about 20% of the blocks assessed, the authors estimated that simply moving one block over, from a highly traveled to less busy road, could reduce cyclists’ and pedestrians’ exposures to PM_{2.5}, ultrafine particles, and black carbon by about 15%.

Sharing the Wealth of Bikes

Bike-sharing is showing much promise in terms of increasing people’s access to healthy exercise while reducing pollution. However, disparities in bike-sharing usage are evident around the country, with users skewing towards younger white men. For instance, a recent report²⁶ from Capital Bikeshare found that roughly 80% of its Washington, DC, customer base is white, and about 60% are male; almost all customers are employed.

Now some cities are pushing companies to expand their operations into lower-income neighborhoods where bike-sharing opportunities are more limited. Chicago, for instance, has introduced a program called Divvy for Everyone (D4E). When the city launched its original Divvy docked bike-sharing program five years ago, docking stations were located primarily in the more affluent civic center, which is popular with tourists. Divvy currently serves some 37,000 members. Annual memberships with unlimited rides cost US\$100, or riders can choose a US\$3 one-time ride or US\$15 pass.²⁷

The newer D4E program offers a one-time \$5 annual membership to people who qualify based on income, with a discount in the second year as the member transitions to a full-price membership.²⁸ City officials have also increased the number of stations located in highly disadvantaged areas of South and Central Chicago, according to Sean Wiedel, the assistant commissioner for citywide services in the Chicago Department of Transportation.



Investigator Steve Hankey rode his bike throughout Minneapolis, pulling a mobile air sampler behind him. The sampling data yielded a block-by-block picture of spots where cyclists and pedestrians are likely to encounter the lowest and highest levels of air pollution. Image: © Steve Hankey.

“We’ve made a big push to make bike-sharing affordable and available in the neighborhoods that need it most,” he says. D4E currently has 1,700 active members, and Wiedel says the ridership is racially diverse and is split fairly equally between men and women.

As for improving urban air quality, can bike-sharing really make an impact? The authors of a 2015 report²⁹ from the Institute for Transportation and Development Policy and the University of California, Davis, estimated the potential savings in energy use, carbon dioxide emissions, and costs to travelers resulting from significant numbers of people switching from cars to bikes. “It would take a very large expansion of bike sharing systems around the world to have a significant effect [on outcomes such as emissions reductions],” they wrote. Nevertheless, they added, “Given that bike share systems have catalyzed dramatic increases in private bike use in many cities, especially when paired with bicycle infrastructure and other policies that support cycling, these systems can have strong indirect impacts on total cycling levels and benefits.”

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