

CHAPTER 2

BICYCLE TRANSPORTATION

BICYCLING IN AMERICA

Bicycles gained prominence as transportation vehicles in the late 19th century. In the United States, many early efforts to improve road conditions were sponsored by organizations such as the League of American Bicyclists. After the rise in popularity of the automobile in the mid-20th century, the situation changed rapidly, with motor vehicles dominating the country's roadway infrastructure; bicycles were not taken into consideration in the development of the transportation infrastructure for much of the 20th century.



Katherine Towle (Kittie) Knox (born in Cambridgeport) was a bicycle racer and the first African American to be accepted into the League of American Wheelman (later renamed League of American Bicyclists) in 1893 at a time when few women were members.

In 2019, the City of Cambridge named the Kittie Knox Bike Path in her honor.

In the 1960s, more people started using bicycles for both transportation and recreation, and many off-road bike paths were developed throughout the 1970s. Since the road system provides the majority of public connections between destinations, streets also need to be designed or redesigned to enable people of all ages and abilities to bicycle safely and comfortably on them.

Bicycles are found in many American households, with an average of 0.86 adult-size bicycles per household.¹ Between January and October 2020—during a bike boom triggered by the COVID-19 pandemic, Americans spent \$4.1 billion on bicycles (a 62% increase from the same period in 2019) and \$491 million on electric bikes (up 144%).² The bicycle industry has a positive robust economic benefit. In 2017, people biking spent \$83 billion on 'trip-related' sales and generated \$97 billion in retail spending, while bicycle recreation spending contributed to the creation of 848,000 jobs in the U.S.³ Additionally, in 2018, the Bureau of Economic Analysis estimated that bicycling contributed \$96 billion in annual retail sales.⁴



THE BENEFITS OF BICYCLING

Bicycling is energy efficient, has many health benefits, and is a more affordable transportation option, among many other benefits. Bicycling can also increase freedom of movement for people of all ages and incomes and offers more schedule flexibility than fixed public transportation services, particularly for people who work nontraditional hours (e.g., restaurant workers, night shifts).

Bicycling is an important element of the transportation system and a critical resource for many in Cambridge, where approximately one-third of households have no car.⁵ This has been evidenced by the continued use of Bluebikes by essential workers during the COVID-19 pandemic and even during inclement weather events.

This section explores the variety of benefits of bicycling. For further information, refer to the endnotes section.

I love the exercise. I love that it's free. I love that there's no traffic. I try to encourage people to do this all the time. I'm on Instagram all the time. I'm on Facebook all the time. I'm always putting up the pictures, 'Look at me, not in traffic.'

—Female bicycle commuter between Harvard and Arlington

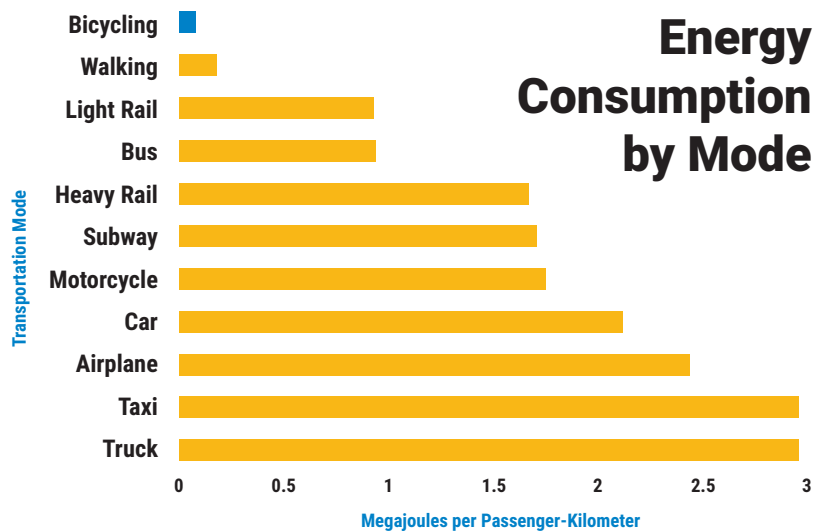


Figure 2.1: Energy consumption by mode. Bicycling is the most energy efficient form of transportation, getting the energy equivalent of over 1,000 miles per gallon.^{6,7}

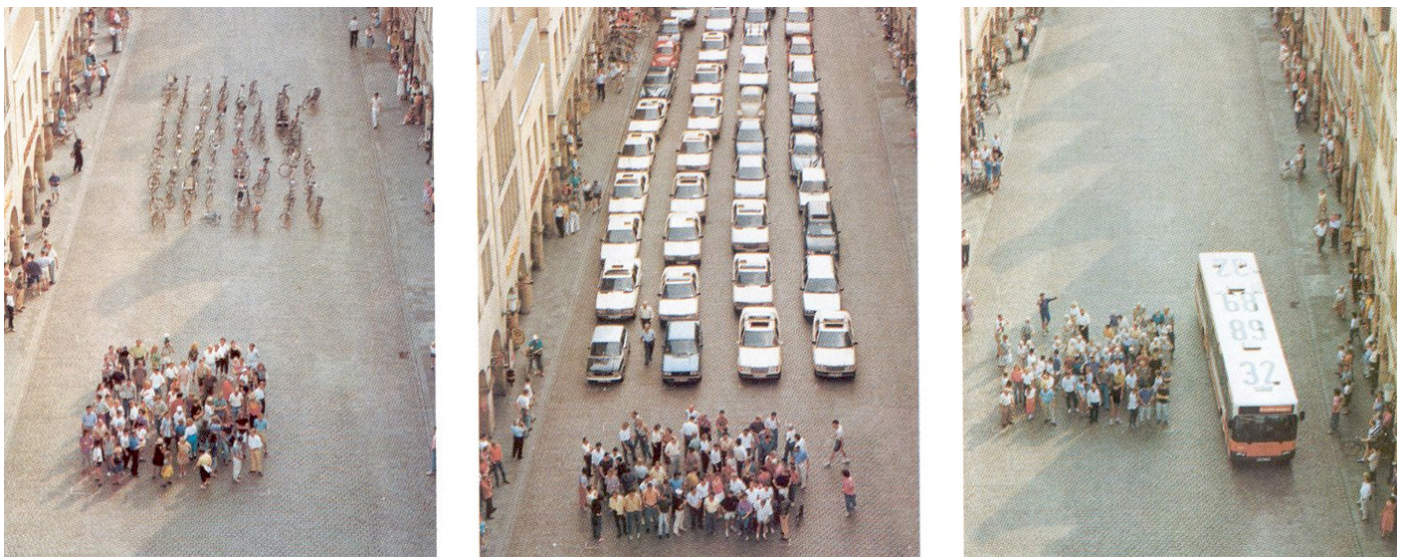


Figure 2.2: Relative space for different travel modes. In this influential photo, the City of Münster, Germany demonstrates the relative space required to move the same number of people by bicycle, car and bus.⁸

ENVIRONMENTAL BENEFITS

Bicycling has significantly lower environmental impact than motor vehicle use:⁹

- + Bicycling consumes the least amount of energy compared to other transportation modes.
- + Reduced greenhouse gas emissions and lower contribution to global climate change. One study in Montreal showed a reduction of close to 2% in transportation-related GHG emissions for an increase of 7% in the length of the bicycle network.¹⁰
- + Reduced pollutants related to air quality and public health.
- + Reduced pollutants that are related to ancillary facilities; the manufacturing of automobiles contributes more pollution than the manufacture of bicycles.

A study of four shared use paths in different Massachusetts communities found that the paths encouraged more than 90,000 active commute trips and reduced motor vehicle travel by over 700,000 miles. This led to \$2.2 million in savings from reductions in the social costs of greenhouse gas and other emissions during the four-month study period.¹¹

TRANSPORTATION INFRASTRUCTURE BENEFITS OF INCREASED CYCLING¹²

When people bike more and drive less, it decreases the amount of public money that needs to be spent on roadway maintenance and other traffic-related services. Benefits include:

- + Less traffic congestion.
- + Greater efficiency: more people can travel in less space.
- + Less wear and tear on our roads.
- + Less consumption of petroleum resources.
- + Fewer costly crashes and property damage.
- + Less need for additional roads, motor vehicle travel lanes, and parking areas – and more space for other priorities such as green space.

The reduction in single-occupancy vehicle trips attributed to shared use path commuting reduces harmful pollutants like particulate matter, nitrogen oxide, volatile organic compounds, and carbon dioxide released into the atmosphere.

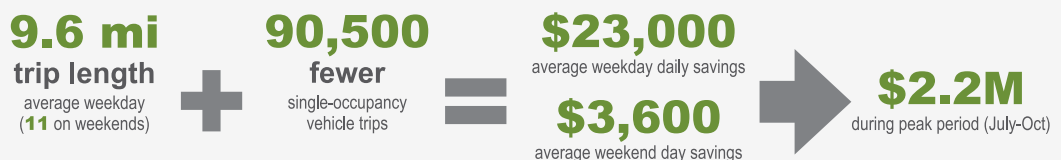


Figure 2.3: Shared use paths can reduce single-occupancy vehicles trips, which reduce harmful pollutants.¹¹

HEALTH BENEFITS

- + Reduced air and noise pollution for everyone. Operating a bicycle results in 92% less CO₂ emissions per mile than driving a car.¹³ Air pollutants generated by motor vehicles are associated with a range of health impacts, including asthma and other respiratory symptoms, impaired lung function, total and cardiovascular mortality, and cardiovascular morbidity.¹⁴ A San Francisco Bay Area study found that increasing biking and walking from 4 to 22 minutes a day on average would decrease greenhouse gas emissions by 14%.¹⁵

I'm in the union, I do construction. The wear and tear on my hip just wore it down. I got real severe arthritis. It's so bad that they have to give me a total hip replacement. I'm stuck in the house all day. I'm out of work now. The only exercise I can get is riding my bike. Riding a bike – you're not putting any weight on the hip, you're just doing a pedal motion. It's the only exercise I can get all day. If I don't go for a bike ride all day, I'm going crazy.

—Roofer who rides daily with his son

- + Improved health and well-being through regular exercise. Numerous studies have shown a positive link between exercise and health in a wide range of areas, notably cardiovascular health, weight control, mental health, cholesterol, hypertension, stress, cancer, and other diseases.^{16,17} The Centers for Disease Control and Prevention recommends changing the built environment in communities to make it easier for people to bicycle and walk as a strategy to prevent chronic disease.¹⁸ Regular bike riding through adulthood protects against a variety of health issues.¹⁹



- + Bicycling provides regular exercise opportunities for children. Children who walk or cycle to school are more attentive and concentrate better.²⁰ Bicycling helps boost learning and memory in children and increases cognitive performance for teenagers with intellectual and developmental disabilities.
- + Children who walk or bike are more likely to maintain a healthy weight, have better cardiorespiratory fitness, and have more physical strength and extension.^{21,22}
- + Bicycling provides exercise opportunities without requiring gym memberships or specialized equipment.
- + Bicycling can help reduce depression, improve sleep quality, and has been shown to improve cognitive functions for older adults.

I'm 86 years old. And it if it wasn't for the bike I wouldn't get out much. I have sciatica in my legs. It's a nerve thing. I can't stand up too long. But with a bike I can be out all day long. I love bikes. If they took this bike I'd be heart-broken, crying every day. I take it home, keep it inside, right next to me, right next to my bed so I can get up and jump on it!

—Street interview at Carl Barron Plaza

- + People who bicycle often report greater satisfaction with their commute than people who drive to work.²³ Bike commuters report lower stress and greater feelings of freedom, relaxation, pleasure, and excitement than car commuters.²⁴ One study found that women that commute by bike have higher levels of satisfaction than men.²⁵

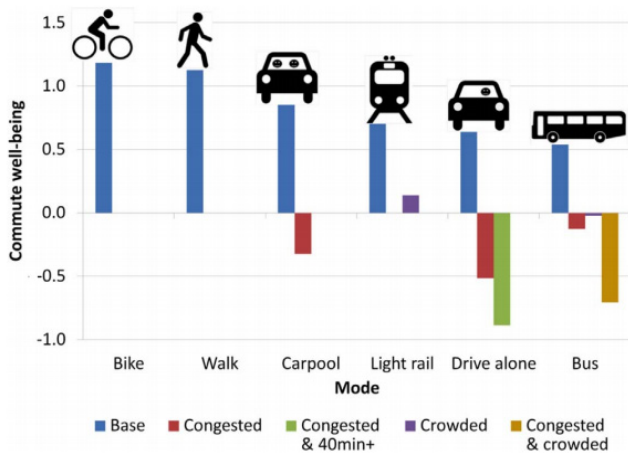


Figure 2.4: Bicycling has the highest predicted commute well-being of various modes.²⁶

- + Even after adjustment for other risk factors, including leisure time physical activity, those who did not bicycle to work experienced a 39% higher mortality rate than those who did.²⁷
- + In studies across multiple countries (including the U.S.), the health benefits of bicycling outweigh the mortality risks related to traffic crashes and air pollution.²⁸ Additionally, bicyclists are exposed to less pollution than drivers, bus riders (including school buses), or taxi passengers because enclosed vehicles tend to capture and recirculate air pollution.²⁹

³⁰ ³¹

The Impact of Bicycling on Life Expectancy

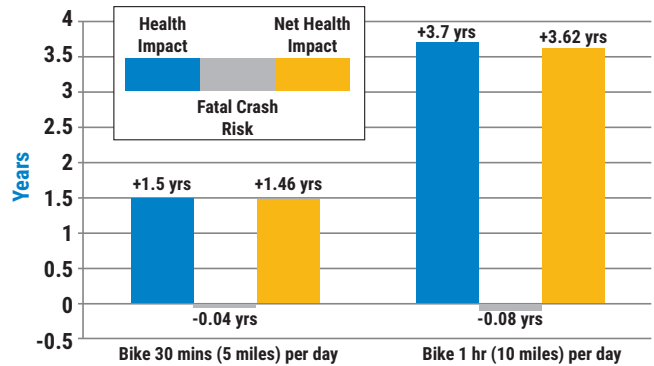


Figure 2.5: Bicycling has positive impacts on life expectancy, even with crash risk factored in.²⁸

- + Transportation made up 41.5 percent of 2017 greenhouse gas emissions in the state of Massachusetts and is the sector that generates the largest share of greenhouse gas emissions. Greenhouse gas emissions from transportation primarily come from burning fossil fuel for our cars, trucks, ships, trains, and planes.³²
- + A study of four shared use paths in Massachusetts found that they increased the level of physical activity for those who live nearby, saving a combined \$2.8 million on healthcare expenditures across the four paths in 2019.¹¹

I never have to worry about traffic or where to park. It takes the same time every trip and is faster than driving. Also, even though I don't drink coffee, I come in raring to go. Regardless of how much sleep I had the previous night. That is the greatest feeling in the world, especially as a school teacher.

—Cambridge public school math teacher

ECONOMIC BENEFITS

- + Bicycling is a low-cost means of transportation, being the least expensive way to get around next to walking. Estimates of annual costs for a personal bicycle range from less than \$100 to around \$300 annually (annualized over 10 years).³³ Average cost for car ownership in 2019 were \$9,282/year or \$773.50/month.³⁴ The relative affordability of bike ownership compared to car ownership make bicycling an important part of creating more equitable access for people of all incomes and ages.

I live in Cambridge and bike to save money. It is less expensive transportation. In the past twenty years I've used public transportation maybe twenty times. That's more money in my pocket!

—Cook at Harvard Square restaurant

- + For those who cannot or don't wish to own their own bike, bike share can be another affordable and convenient option. A membership for Bluebikes, Greater Boston's bike share, costs as low as \$109/year for unlimited 45-minute rides (2021). Many people living and working in Cambridge are eligible for even lower rates through their employers or Bluebikes' income-eligible program. Income-eligible members pay \$50/year or \$5/month.
- + A quality bicycling environment reduces economic barriers and creates opportunities for people to participate in the social, cultural, and economic life of the community without using a car.
- + Evidence from around the country shows that bicycle or multi-use paths foster new and expanded business.³⁵

- + People who walk or bike are more likely to shop locally and therefore spend more in local businesses.³⁶ Research in Portland, Oregon, found that customers arriving by bike spend \$75.66 per month on average at bars, restaurants, and convenience stores.

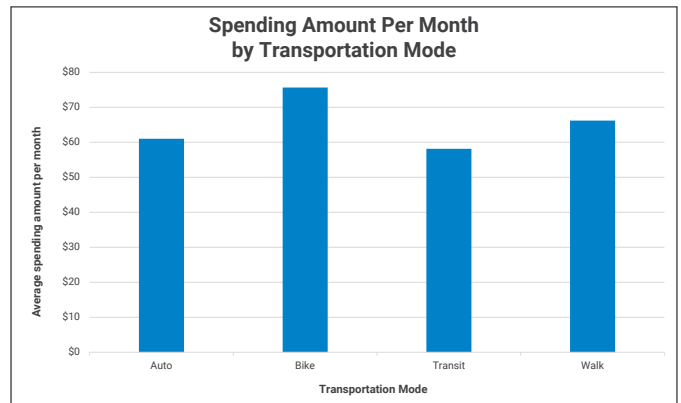


Figure 2.6: Portland customers who arrive by bike spend more per month on average at bars, restaurants, and convenience stores than people that arrive by other modes.³⁷



- + Investments in bicycle facilities have been correlated with increases in retail sales. Research on 14 street projects around the US found that additions of active transportation infrastructure have either no significant impact or significant positive impact on retail sales and employment.^{20 35 38}
- + Tourism is an important industry, and a bicycle-friendly environment can attract many riders from elsewhere. A bicycle-friendly environment also allows and encourages tourists to bike as a means of transportation when visiting.^{39 40 41}
- + Cities with higher bicycling populations have been shown to have lower overall crash rates, which in turn reduces related costs, such as for police, medical care, and insurance.^{42 43 44}
- + Greater reliance on bicycling and other sustainable transportation modes enables economic growth on a large scale. The Kendall Square area of Cambridge added 4.6 million square feet of development in a decade and increased commercial and institutional space by 40 percent without a concomitant rise in automobile traffic.
- + Safe and easy opportunities to bike to jobs can reduce the burden on households with limited motor vehicle access. Biking expands mobility choices and is a powerful strategy for improving upward economic mobility.⁴⁵
- + People who bicycle to work are healthier, with fewer sick days per year.⁴⁶ Employees who engage in regular physical activity have lower healthcare costs, require less sick leave, and are more productive at work.⁴⁷ In addition, employees who spend more time actively commuting have greater mental wellbeing.⁴⁸



I like biking because it's an effective way to travel, it reduces my carbon footprint and it tones my calves

- Salam Tesfaye

- + A 2015 study by the National Highway Transportation Administration estimated the economic cost of traffic crashes in the United States at \$242 billion, the equivalent of \$784 per US resident or 1.6% of US gross domestic product. The economic burden of traffic-related injuries and deaths includes costs associated with emergency response, medical care, legal proceedings, and lost productivity.
- + Biking is much cheaper than driving a private car. In 2017, 17% of the average U.S. household's annual expenditures were transportation-related, making transportation the second largest expense category after housing.⁴⁹ Bicycling for some trips

I use the bike for commuting, going to work, taking the kid to the doctor, taking the kid to the day care and going grocery shopping. Before we used to take Uber to Market Basket. I would say that in the past seven months, we have saved easily about \$500.

—Cargo biker who rides daily with his daughter

saves money, even without going car-free. Considering congestion reduction, roadway costs, vehicle costs, parking costs, air pollution, energy use, and traffic safety - replacing a car trip with a bike trip saves people individuals and society \$2.73 per mile.⁵⁰

- + A significant proportion of people arrive by bike to commercial districts in Cambridge and that number is increasing. Surveys performed over time have shown substantial increases at Porter Square and Inman Square. See Chapter 3 for additional information.
- + A recent study found that shared use paths in Massachusetts improved the local economy by generating between \$367,000 and \$9.2 million per path for businesses near the trails during the four-month study period alone.¹¹

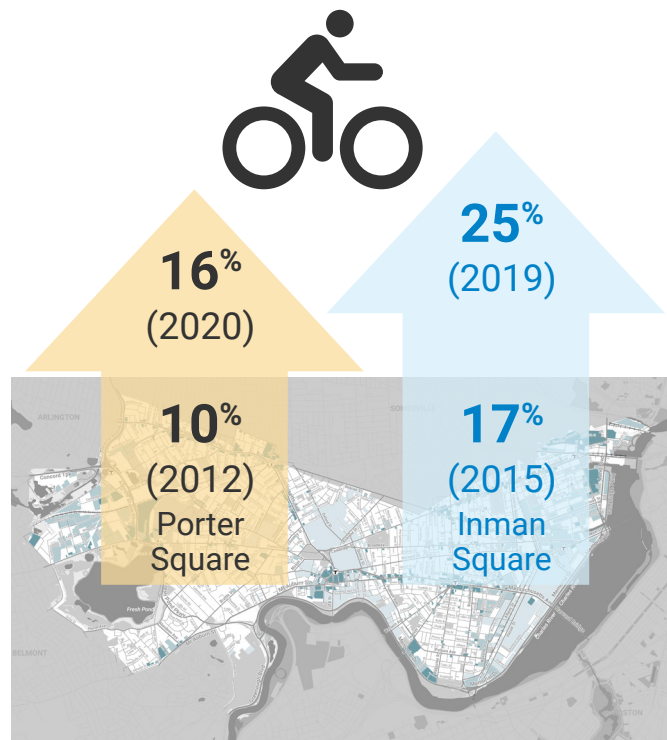


Figure 2.7: The proportion of customers that arrive by bike to Cambridge shopping districts is increasing.



QUALITY OF LIFE AND SOCIAL BENEFITS

The number of people who feel comfortable walking or riding bicycles is a measure of the quality of life in a city. The presence of many people walking and bicycling in a city indicates that there is a strong sense of community, people feel safe being outdoors, social interactions can occur openly, and people of all ages and incomes can have access to public and private facilities.

Safe bikeways increase the independence of children – helping to enable them to bike to school, providing much-needed physical activity and reducing the need for busing or automobile trips by parents. Children in cities such as Cambridge are often more mobile than suburban children because they can get around more easily on foot, by bicycle, or by transit. Studies have even shown that children who walk and bicycle to school do better academically.^{21 22}

The most memorable time riding my bike was when I was 8 years old. I was riding down Memorial Drive going to Dunkin Donuts. This is during one of those Sundays that they would close off a part of Memorial Drive to cars so that people would be able to ride bikes, skate or walk. It was the best time for me because I decided to make a grown-up decision and ride around the block ALONE after getting my donut. I considered it to be my first biking milestone. Getting a donut alone... check. Riding around the block alone...check, check. I felt GREAT!!!

—6th grader [6th grade bike joys]⁵¹



Harvard University students enjoying car-free Memorial Drive on a weekend.

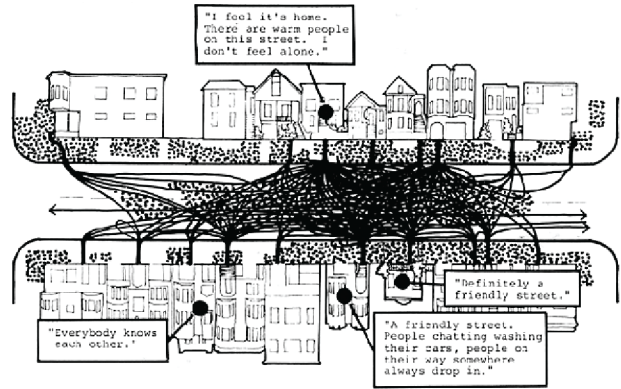


Comparison of Social Connections on Streets with Light, Moderate and High Traffic Volumes

Light Traffic

2,000 Vehicles per Day
200 vehicles per peak hour

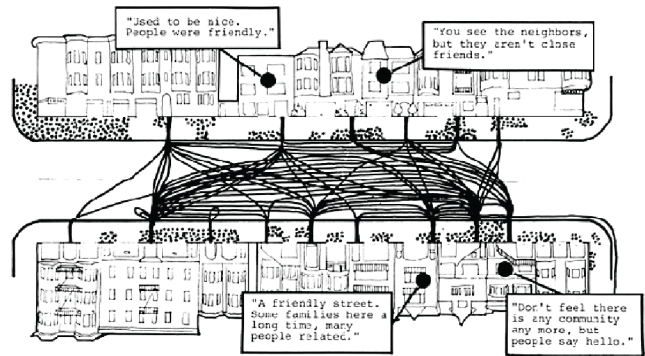
3.0 friends per person
6.3 acquaintances



Moderate Traffic

8,000 vehicles per day
550 vehicles per peak hour

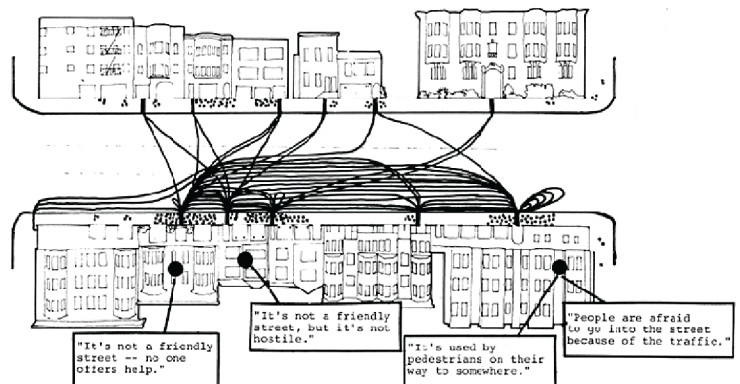
1.3 friends per person
4.1 acquaintances



Heavy Traffic

16,000 vehicles per day
1,900 during peak hour

0.9 friends per person
3.1 acquaintances



Traffic has a profound impact on community life. A renowned study by University of California, Berkeley professor Donald Appleyard compared three residential streets in San Francisco that were similar except for traffic levels. Published in the influential book “Livable Streets,” the research showed that residents of the street with the lightest traffic volumes reported having the highest average number of friends and acquaintances on their street when compared to residents of the streets with higher traffic volumes (see Figure 2.8).⁵²

Figure 2.8: Comparison of social connections on streets with light, moderate and high traffic volumes. Lines on the diagram represent social connections. Adapted from the original illustration created by Betty Drake in “Livable Streets” and used with permission from Bruce Appleyard.⁵²

THE POTENTIAL FOR BICYCLING

Bicycling is an enormously popular activity. In 2019, Americans ages 6 and older went on over 100 million bicycling outings.⁵³ People use bicycles for many purposes, not just for commuting. Commute trips make up less than 20% of all bicycle trips.⁵⁴ Bicycling gets people to work, to school, to shops, to visit friends, to parks, to soccer practice, to music lessons, to the T, or to see the sights.

MAJOR REASONS PEOPLE BICYCLE

- + Primary mode of transportation.
- + More convenient or faster than other modes of transportation.
- + Recreation/pleasure.
- + Fitness.
- + An activity to do with family or friends.
- + Concern for the environment.
- + Less expensive than other modes of transportation.
- + Many trips are within easy bicycling distance: 40% of all trips nationwide are shorter than two miles, no more than a 10-minute bike ride.²⁵
- + Any combination of the above.

DESIRE AND SUPPORT FOR BICYCLING

In many parts of the country there are structural deficiencies in the environment that pose major obstacles to increasing the rate of bicycling and walking, such as sprawling development and highways that dissect communities. Fortunately, Cambridge is well-suited to support bicycling and walking as a compact city with many destinations in close proximity.

Even with Cambridge's great foundation for bicycling, two points ring true here as well as around the country:

1. **Most people would like to bicycle more than they do now. This is true across the US as well as in Cambridge, where 85% of people who biked in the past year want to bike more than they do now, as do 53% of people that did not bike in the past year.**
2. **The biggest barrier to bicycling is the lack of safe facilities. More and better bicycling facilities have dramatically increased bicycle share trips in cities without any tradition of cycling for daily travel.⁵⁵ 73% of people say they do not feel safe riding on some Cambridge Streets and that is a barrier to them biking more. Nearly half say that providing more or better bicycle facilities would help them bike more often.**

These findings came from the 2020 Bicycle Plan Update Community Needs Survey and the 2020 Resident and Telephone Online Survey. See Chapter 3 for additional survey responses.

People also consistently articulate their support for public spending on providing better facilities. In a 2020 survey of US voters, 60% wanted to see the level of federal funding for bicycling and walking facilities increased, up from 58% in 2016 and 47% in 2012.⁵⁶ In the 2020 survey, Cambridge residents listed bike issues as the 7th most important issue for the City to focus on.

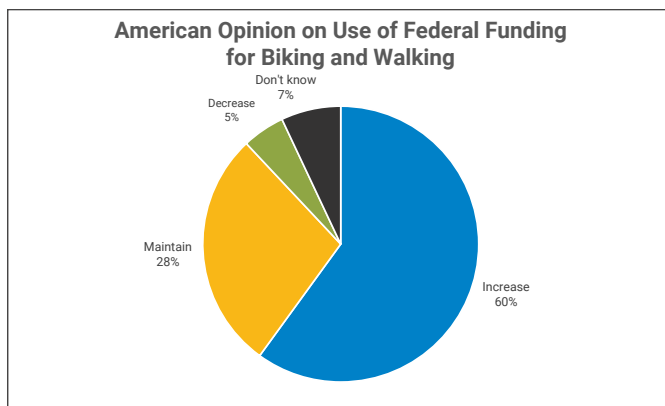


Figure 2.9: 88% of Americans polled want to maintain or increase federal funding for biking and walking.⁵⁶

HOW PEOPLE RELATE TO BICYCLING

In 2006, the City of Portland, Oregon’s Office of Transportation proposed that people differ in terms of their comfort riding a bicycle on different types of bikeways.⁵⁷ The hypothesis was that while some people are comfortable interacting with motor vehicle traffic while bicycling, most people are not and prefer off-road paths or quiet neighborhood streets. Because paths and neighborhood streets do not make complete connections to where people need to go, people do not bike as much as they might. This perspective was a significant shift compared to the decades-old Federal Highway Administration approach of classifying people based on skills and training.

Follow-up research in 2012⁵⁸ and 2016⁵⁹ surveyed nearly 4,000 people combined and confirmed that most people (88%) feel uncomfortable interacting with motor vehicle traffic while biking. The research found that more than half of people are both interested in biking more and uncomfortable biking on most streets. These perspectives were generally consistent across genders, income levels, education levels, and race. This population reported the highest level of comfort on separated paths and quiet residential streets, closely followed by riding in separated bike lanes on busy streets (30 to 40 mph), a dramatic improvement over the comfort level reported for striped bicycle lanes or riding in mixed traffic without a facility. The analysis indicated that reducing traffic speeds and increasing separation between bicycles and motor vehicles increases levels of comfort and bicycling rates.

I ride on the sidewalk because it is safe and I don’t feel comfortable biking on roads without paths. I only feel safe on Western Ave.

—Cambridge Bicycle Conversations Participant

In the same studies, women and the elderly were underrepresented among the more confident adults and those who currently ride bicycles for transportation. Particularly telling was the finding that survey respondents who said they are not interested in biking – approximately one third of the total population – reported that they would feel “comfortable or very comfortable” with a separated bicycle facility. Therefore, providing additional bikeways with separation from motor vehicle traffic presents a significant opportunity for increasing bicycling for transportation.



Further explorations of population attitudes revealed variability in how groups feel about bicycling. One 2020 study specifically targeted areas of the US where bicycling was less prevalent (Alabama and Tennessee). There, the research authors found that people with higher income and younger people perceive bicycling as safer and more comfortable, and are more willing to bike, than people with lower income and older people who did not bike. Additionally, females and people who are Black were found to be less willing to try bicycling than males and people of other races, respectively. The research does not explain why some people are less willing, but the authors recommended developing targeted educational, outreach, safety, and promotional programs along with infrastructure improvements to improve perceptions among or to investigate the needs of these populations.⁶⁰

A different 2016 study performed on a national level revealed that people who identified as White (non-Hispanic) were actually the most likely to fall into a category of not being interested in bicycling; people who identified as African-American, Asian, Multiracial, Hispanic-Mexican or “Other” were more likely to be interested in bicycling while remaining concerned about issues like traffic safety.⁵⁹

A separate nationwide survey found that the key factors that encourage adults age 50 and older to continue bicycling are safety, good infrastructure conditions, and separation from motor vehicle traffic.⁶¹

These studies together do show overall that most of the people in the US would like to bicycle more, but that barriers exist and must be addressed if we are to truly make bicycling accessible to all.

THE EXPERIENCE IN CAMBRIDGE

People in Cambridge have reported similar experiences and perspectives on comfort while bicycling. In the Community Needs Survey, over half of the responses to a question about barriers indicated that the most significant barrier to bicycling was not feeling safe riding on Cambridge streets. Women were more likely to select this barrier than male respondents (78% of women compared to 68% of men). Going deeper, the survey revealed that the reason most people don't feel safe riding on Cambridge streets is due to feeling unsafe around motor vehicles, which are perceived to be driven too fast and not safely. Lack of adequate lighting at night was also identified as a significant barrier. See Chapter 3 for additional survey results.

Cambridge Bicycle Conversations, which prioritized engaging with and learning from people of color, revealed that most participants who bike frequently cited dangerous and inconsiderate drivers as the biggest source of stress. Barriers to biking include fear of dangerous driving, self-perceptions of their lack of physical ability or a sense that biking is not something commonly done in their culture or community. Lack of access to high-comfort bicycle facilities is also a barrier for some, and many seniors reflected a self-perception that they cannot bike due to age and ability.



WHAT IS NEEDED TO SUPPORT PEOPLE OF ALL AGES, ABILITIES AND IDENTITIES?

Since Cambridge began planning for bicycle transportation in earnest in the 1990s, we have consistently seen that the greatest impact comes from creating facilities: people ride where there are places for them to ride.

Many studies conducted locally and across the country—such as those described earlier in this chapter—have clearly demonstrated that the most significant increases in bicycling rates happen when people are provided with safe, direct, low-stress facilities. These include separated bike lanes, multi-use paths, quiet streets with low-speed traffic, and streets with good lighting to help people feel safe and comfortable.

While facilities are a necessary condition for enabling people to bicycle, studies have also shown the importance of providing supporting programs that help build a bicycle culture, encourage more people to try biking, and increase people's access to affordable bikes. These programs are especially important for increasing the diversity of bicyclists in a community in terms of gender, race, and other identities.

We have seen the importance of providing supporting programs in Cambridge such as Bluebikes bike share, including a reduced fee membership option, which allows more people access to bikes, and Safe Routes to School, which has demonstrably increased the number of students biking and walking to school. See Chapter 6, 7, and 8 for more information on bicycle programs in Cambridge.

SAFETY IN NUMBERS

In addition to all of the quality of life, environmental, health, and economic benefits for supporting people of all ages, abilities and identities to bicycle more (as described in this chapter), more people bicycling improves safety for everyone.

- + **People perceive a safety-in-numbers effect. Potential bicyclists feel that a higher density of people bicycling would increase safety because drivers would be conditioned to expect cyclists.⁶⁰ They also feel that this would reduce harassment.**
- + **The safety-in-numbers phenomenon is not only a perception though – it's an actual effect. The phenomenon was first published in a study by Jacobsen in 2003, where the author found that the likelihood of a person bicycling to be struck by a motorist varies inversely with the amount of people bicycling (i.e., the more people bicycling, the less likely they are to be struck by a motorist). The pattern was consistent across communities of varying size, from specific intersections to cities and countries, and across time periods.⁶²**
- + **A 2019 meta-analysis of safety-in-numbers studies confirmed this effect for bicyclists when looking at the relationship between traffic volume and number of crashes, particularly at the macro level (e.g., a city).⁶³**

INCREASE SAFETY, COMFORT AND SEPARATION

Not all bicycle facilities are created equally. To support people of all ages, abilities, and identities, bicycle facilities need to be “high comfort.” This is more fully defined in Chapter 5, but in short, high comfort bike facilities feel safe for everyone and reduce interactions with motor vehicle traffic. The following outlines key strategies for creating a high comfort system.

BUILD SEPARATED BIKE LANES

Major streets (arterials and major collector streets) often provide direct connections and access to destinations. On these streets, the ideal facility type is a “separated bike lane” (also known as “protected bike lanes” and “cycle tracks”).

Separated bike lanes provide an exclusive space for people to ride that is separated from motor vehicle and pedestrian traffic by a vertical element, which can include plastic flexposts, parked cars, curbs, grade separation, and/or landscaping.



Standard bicycle lane, Hampshire Street

Transitive benefit: more separated facilities > more riders > greater safety



Separated bicycle lane, Western Ave

The rationale for and safety benefits of separated bicycle facilities are extensive:⁵⁸

- + **Barrier- or buffer-separated bicycle facilities are most comfortable and the preferred facility type on major roads for bicyclists and potential bicyclists.**
- + **The degree of separation for bicycle lanes matters more to bicyclists and potential bicyclists than the number of vehicle lanes on the roadway.⁶⁰**
- + **Curbside parked cars, the dangers of opening doors and drivers parking or leaving the curb, are the most consistent concerns noted among bicyclists and potential bicyclists.⁶⁰ Buffered and separated bicycle lanes with a physical barrier such as bollards or planters are viewed as substantially improving comfort for bicyclists.**
- + **Where separated bicycle facilities have been established, marked increases in the number of people riding has been demonstrated.**
- + **Where separated bicycle facilities have been established, there is a dramatic decrease in sidewalk bicycling, thereby improving pedestrian comfort.⁶⁴**

In a survey of people who travel on a major commercial street, streets with barrier-separation between moving non-motorized and motorized traffic were consistently found to be the most comfortable for not only for those on bicycle, but for those driving as well. The survey also indicates that the risk of being hit by a car door is a consistent worry for everyone who biked, many of whom have been hit or almost hit in this situation. As parking-related crashes are a substantial portion of crashes in Cambridge (see Chapter 3), this is a significant issue here as well.⁶⁵

Another study found that the presence of buses along a route decreases bicycling satisfaction levels for all genders. The same study found that one of the most significant factors for increasing satisfaction was the presence of fully-separated paths for bicycling.⁶⁶

When Paris installed pop-up separated bike lanes during a transit strike, a report found that approximately 60% of users were new to bicycling. Women represented a significant portion of these new bicyclists, increasing women's representation amongst Parisian bicyclists from 36% before the pop-up lanes to 41% after installation.⁶⁷

Studies of the effects of separated bicycle facilities on Cambridge Street and Brattle Street, installed in the summer of 2017, align with these national trends. Bicycle ridership increased dramatically on both streets post-construction, while the clear majority of people walking, biking, or taking transit surveyed stated they were satisfied or very satisfied with the new design. These studies are discussed in greater detail in Chapter 3, with the full studies available on the City's website.

Separated bicycle lanes enhance the comfort and safety of bicycling on urban streets and encourage people of all ages and abilities to ride.

In a study conducted in Portland, OR, air quality was found to be 8% to 38% better in a separated bike lane than a standard bicycle lane. Researchers also found that the highest differences between the two facilities corresponded with higher traffic volumes, supporting the conclusion that the distance created by a physical barrier between a bicycle facility and moving traffic affects air quality and exposure to ultrafine pollutant particles for people on bicycles.⁶⁸

CREATE BICYCLE PRIORITY STREETS

Some streets can be comfortable places for bicycling without separated bike lanes. Many streets, like quiet neighborhood streets, are great for riding without any added facilities. Other streets may be on the threshold of comfort but cannot have separated bike lanes added for various reasons. These streets are opportunities to create bicycle priority streets.

Bicycle priority streets have low motorized traffic volumes and speeds and are designated and designed to give bicycle travel priority. To achieve and maintain high-comfort bicycle priority streets, bicycle priority streets may involve physical treatments to manage motor vehicle speeds and volumes and/or designated space (e.g., bike lanes). These treatments have positive side-effects, like making the street more comfortable for walking and reducing speeding.

Bicycle priority streets are referred to by a variety of names in other communities, such as neighborways and bicycle boulevards. The benefits of these types of streets are numerous and include:

- + **Increasing safety by reducing motor vehicle speeds and cut-through traffic on residential streets.**
- + **Improving livability by preserving neighborhoods and reducing traffic noise.**
- + **Enhancing the environment by reducing motor vehicle emissions.**
- + **Supporting healthy lifestyles by making it easier to engage in physical activity.**
- + **Increasing access by providing connections that are safe and comfortable.**

A study of the SE Salmon Street bicycle boulevard in Portland, Oregon, found that residents along the street saw positive impacts on convenience for bicyclists, sense of community, quality of life, home value, air quality, and noise after the implementation of the bicycle boulevard.⁶⁹

Research in Palo Alto, California, found that while motor vehicle volumes remained constant and property access was maintained, bicyclist volumes increased significantly after the City installed a bicycle boulevard on Bryant Street.



PROVIDE ADEQUATE LIGHTING

Lighting is important for encouraging people to bicycle, by increasing traffic safety and personal security through increased visibility. A study of crashes in Cambridge found that crashes involving people biking and walking disproportionately occur at areas without adequate street lighting. The risk is greatest at dusk and dawn, when crashes are 21% and 35% more likely to occur at unlit locations, respectively.⁷⁰ Other research indicates that better lighting can promote bicycling after dark, both on street and on shared use paths.⁷¹



SUPPORTIVE PROGRAMS

As mentioned, while establishing a safe, comfortable, and inviting environment for riding is a fundamental condition to making bicycling available to all, other elements are important as well. These are further described in Chapters 6-9.



The Safe routes to school program includes a variety of activities, including on-the-bike practice for children.

ENDNOTES

- 1 U.S. Department of Transportation, "Table A-2 - Mean Number of Drivers, Vehicles, and Bicycles per Household," U.S. DOT Bureau of Transportation Statistics, 2001, https://www.bts.gov/archive/publications/highlights_of_the_2001_national_household_travel_survey/table_a02
- 2 Andrew J. Hawkins, "How to keep the bike boom from fizzling out," *The Verge*, 2020. <https://www.theverge.com/22178543/bike-bicycle-boom-covid-pandemic-2020-sales-cities-infrastructure>
- 3 Outdoor Industry Association, "The Outdoor Recreation Economy," Outdoor Industry Association, 2017, https://outdoorindustry.org/wp-content/uploads/2017/04/OIA_RecEconomy_FINAL_Single.pdf
- 4 Adventure Cycling Association, "Economic Impact," Adventure Cycling Association, <https://www.adventurecycling.org/advocacy/building-bike-tourism/economic-impact/#:~:text=The%20Outdoor%20Industry%20Association%20released,the%20creation%20of%20848%2C000%20jobs>
- 5 Tom Murphy, "Do the Math: MPG of a Human," *Do the Math*, 2011, <http://physics.ucsd.edu/do-the-math/2011/11/mpg-of-a-human/>
- 6 US Census, "American Community Survey," US Census, 2019.
- 7 David Banister, "Sustainable Transport and Public Policy," Global Communications Institute, 2011, <http://www.gci.org.uk/Documents/E6-40-04-021.pdf>
- 8 Photo by City of Münster, Germany. Accessed via <https://www.flickr.com/photos/carltonreid/7999178447/>
- 9 People for Bikes, "Statistics Library/Environmental Statistics: Bicycling + the Environment," People for Bikes, 2013, <https://www.peopleforbikes.org/statistics/environmental>
- 10 Seyed Amir H. Zahabi, Annie Chang, Luis F. Miranda-Moreno, Zachary Patterson, Exploring the link between the neighborhood typologies, bicycle infrastructure and commuting cycling over time and the potential impact on commuter GHG emissions, *Transportation Research Part D: Transport and Environment*, Volume 47, 2016, Pages 89-103, ISSN 1361-9209, <https://doi.org/10.1016/j.trd.2016.05.008>
- 11 MassTrails, "Impacts of Shared Use Paths," MassTrails, 2021, <https://www.mass.gov/doc/masstrails-shared-use-path-impacts-study/download>
- 12 People for Bikes, "Statistics Library/Economic Statistics," People for Bikes, 2018, <https://www.peopleforbikes.org/statistics/economic>
- 13 European Cyclists' Federation, "How much CO2 does Cycling really Save?," European Cyclists Federation, 2013, <https://ecf.com/news-and-events/news/how-much-co2-does-cycling-really-save>
- 14 Traffic-Related Air Pollution: A Critical review of the Literature on Emissions, Exposure, and Health Effects. (2010). Boston, MA: Health Effects Institute. <https://www.healtheffects.org/system/files/SR17Traffic%20Review.pdf>
- 15 Maizlish N, Woodcock J, Co S, Ostro B, Fanai A, Fairley D. Health cobenefits and transportation-related reductions in greenhouse gas emissions in the San Francisco Bay area. *Am J Public Health*. 2013 Apr;103(4):703-9. <https://pubmed.ncbi.nlm.nih.gov/23409903/>
- 16 Celis-Morales C A, Lyall D M, Welsh P, Anderson J, Steell L, Guo Y et al. Association between active commuting and incident cardiovascular disease, cancer, and mortality: prospective cohort study *BMJ* 2017; 357 :j1456 doi:10.1136/bmj.j1456
- 17 Gordon-Larsen P, Boone-Heinonen J, Sidney S, Sternfeld B, Jacobs DR, Lewis CE. Active Commuting and Cardiovascular Disease Risk: The CARDIA Study. *Arch Intern Med*. 2009;169(13):1216–1223. doi:10.1001/archinternmed.2009.163
- 18 Centers for Disease Control and Prevention, "National Center for Environmental Health," Centers for Disease Control and Prevention, 2021, https://www.cdc.gov/nceh/information/built_environment.htm
- 19 Duggal, NA, Pollock, RD, Lazarus, NR, Harridge, S, Lord, JM. Major features of immunosenescence, including reduced thymic output, are ameliorated by high levels of physical activity in adulthood. *Aging Cell*. 2018; 17:e12750. <https://doi.org/10.1111/ace1.12750>
- 20 Fiona Raje and Andrew Saffrey, "The Value of Cycling," Phil Jones Associates & University of Birmingham, 2016, <https://www.niagaraknowledgeexchange.com/wp-content/uploads/sites/2/2016/04/value-of-cycling.pdf>
- 21 Østergaard L, Grøntved A, Børrestad LA, Froberg K, Gravesen M, Andersen LB. Cycling to school is associated with lower BMI and lower odds of being overweight or obese in a large population-based study of Danish adolescents. *J Phys Act Health*. 2012 Jul;9(5):617-25. doi: 10.1123/jpah.9.5.617
- 22 Børrestad LAB, Østergaard L, Andersen LB, Bere E. Experiences from a randomised, controlled trial on cycling to school: Does cycling increase cardiorespiratory fitness? *Scandinavian Journal of Public Health*. 2012;40(3):245-252. doi:10.1177/1403494812443606

- 23 Willis, D., Manaugh, K., & El-Geneidy, A. (2013). Uniquely satisfied: Exploring cyclists trip satisfaction. *Transportation Research Part F: Traffic Psychology and Behaviour*, 18, 136-147.
- 24 Mark Appleton, "Cycle-commuting the secret* to a happy life says New Economic Foundation report," road.cc, 2011, <https://road.cc/content/news/31477-cycle-commuting-secret-happy-life-says-new-economic-foundation-report>
- 25 Echiburú, T., Hurtubia, R., & Muñoz, J. C. (2021). The role of perceived satisfaction and the built environment on the frequency of cycle-commuting. *Journal of Transport and Land Use*, 14(1), 171–196. <https://doi.org/10.5198/jtlu.2021.1826>
- 26 Oliver Smith, Commute well-being differences by mode: Evidence from Portland, Oregon, USA, *Journal of Transport and Health*, 2013, http://bikeportland.org/wp-content/uploads/2013/01/TRB_Osmith_55x44.pdf
- 27 Lars Bo Anderson, et al., "All-Cause Mortality Associated With Physical Activity During Leisure Time, Work, Sports, and Cycling to Work," *Arch Intern Med* (2000): Pp. 160, 1621-1628.
- 28 Rojas-Rueda D, de Nazelle A, Tainio M, Nieuwenhuijsen M J. The health risks and benefits of cycling in urban environments compared with car use: health impact assessment study *BMJ* 2011; 343 :d4521 doi:10.1136/bmj.d4521
- 29 Chertok, Michael & Voukelatos, Alexander & Sheppard, Vicky & Rissel, Chris. (2004). Comparison of air pollution exposure for five commuting modes in Sydney - car, train, bus, bicycle and walking. *Health promotion journal of Australia: official journal of Australian Association of Health Promotion Professionals*. 15. 63. 10.1071/HE04063
- 30 Julian D. Marshall and Eduardo Behrentz, "Vehicle Self-Pollution Intake Fraction: Children's Exposure to School Bus Emissions," *Environmental Science & Technology* 2005 39 (8), 2559-2563 DOI: 10.1021/es040377v
- 31 S. Kaur, R.D.R. Clark, P.T. Walsh, S.J. Arnold, R.N. Colvile, M.J. Nieuwenhuijsen, Exposure visualisation of ultrafine particle counts in a transport microenvironment, *Atmospheric Environment*, Volume 40, Issue 2, 2006, Pages 386-398, ISSN 1352-2310, <https://doi.org/10.1016/j.atmosenv.2005.09.047>
- 32 Executive Office of Energy and Environmental Affairs, GHG Emissions and Mitigation Policies, Commonwealth of Massachusetts, <https://www.mass.gov/info-details/ghg-emissions-and-mitigation-policies>
- 33 Victoria Transport Policy Institute, "Transportation Cost and Benefit Analysis II – Vehicle Costs," Victoria Transport Policy Institute, 2009, <http://www.vtpi.org/tca/tca0501.pdf>
- 34 AAA, "2019 Your Drivign Costs: Spikes in Finance Costs Drives Increase," AAA, 2019, <https://newsroom.aaa.com/2019/09/your-driving-costs-spike-in-finance-costs-drives-increase/>
- 35 Eric Jaffe, "The Complete Business Case for Converting Street Parking Into Bike Lanes." CityLab, 2010, <http://www.citylab.com/cityfixer/2015/03/the-complete-business-case-for-converting-street-parking-into-bike-lanes/387595/>
- 36 Darren Flusche, "Bicycling Means Business: The Economic Benefits of Bicycle Infrastructure", *Advocacy Advance*, 2012, <https://www.advocacyadvance.org/the-economic-benefits-of-bicycle-infrastructure/>
- 37 Clifton, K et al, "Exploring the Relationship Between Consumer Behavior and Mode Choice", *TR News*, IN 280, Transportation Research Board, 2011, <https://trid.trb.org/view/1143628>
- 38 Jenny Liu, "Understanding Economic and Business Impacts of Street Improvements for Bicycle and Pedestrian Mobility", National Institute for Transportation and Communities, 2019, <https://nitc.trec.pdx.edu/research/project/1161>
- 39 Tania Lown-Hecht, "The Nantahala and Pisgah National Forests: An Economic Powerhouse for Western North Carolina," *Outdoor Alliance*, 2017, <https://www.outdooralliance.org/blog/2017/10/4/the-nantahala-and-pisgah-national-forests-an-economic-powerhouse-for-western-north-carolina-1>
- 40 Walton Family Foundation, "Bicycling Provides \$137 Million in Economic Benefits to Northwest Arkansas," Walton Family Foundation, 2018, <https://www.waltonfamilyfoundation.org/about-us/newsroom/bicycling-provides-137-million-in-economic-benefits-to-northwest-arkansas>
- 41 N.C. Department of Transportation, "Pathways to Prosperity," N.C. Department of Transportation, 2004, <https://www.americantrails.org/files/pdf/NCbikeinvest.pdf>
- 42 Delft Ministry of Transport, "Cities Make Room for Cyclists," *Public Works and Water Management*, 1995.
- 43 Sany Zein, et al., "Safety Benefits of Traffic Calming," *Transportation Research Board* (Paper No. 971326), 1997. <http://library.ite.org/pub/e2742f06-2354-d714-514e-de01e77d5505>
- 44 Peter Newman. Lecture presented at the Conservation Law Foundation. Boston, MA, January 9, 1997.
- 45 Chetty, Raj, Nathaniel Hendren, Patrick Kline, and Emmanuel Saez. 2014. "Where is the Land of Opportunity: The Geography of Intergenerational Mobility in the United States." *Quarterly Journal of Economics* 129 (4): 1553-1623. <https://scholar.harvard.edu/hendren/publications/economic-impacts-tax-expenditures-evidence-spatial-variation-across-us>
- 46 Garre FG et al., "The association between commuter cycling and sickness absence," 2010, *PubMed* (20580736), <http://www.ncbi.nlm.nih.gov/pubmed/20580736>

- 47 White MI, et al. Physical Activity and Exercise Interventions in the Workplace Impacting Work Outcomes: A Stakeholder-Centered Best Evidence Synthesis of Systematic Reviews. *Int J Occup Environ Med.* 2016 Apr;7(2):61-74. doi: 10.15171/ijoom.2016.739
- 48 Humphreys, David K et al. "Associations between active commuting and physical and mental wellbeing." *Preventive medicine* vol. 57,2 (2013): 135-9. doi:10.1016/j.ypmed.2013.04.008
- 49 United States Department of Transportation, Bureau of Transportation Statistics, Transportation Economic Statistics 2017 - Chapter 6 - Household Spending on Transportation, 2018, <https://www.bts.dot.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/transportation-economic-trends/224726/tet-2018-chapter-6.pdf>
- 50 Todd Litman, "Evaluating Active Transport Benefits and Costs," Victoria Transport Policy Institute, 2021, <https://www.vtpi.org/nmt-tdm.pdf>
- 51 6th Grade Bike Joys was an assignment through the Safe Routes to School program that asked students to tell about a memorable experience they had bicycling.
- 52 Appleyard, Donald et al., *Livable Streets*, University of California Press, 1982.
- 53 Outdoor Foundation. "2020 Outdoor Recreation Participation Report," Outdoor Foundation, 2020, <https://outdoorindustry.org/resource/2020-outdoor-participation-report/>
- 54 Brian McKenzie and Melanie Rapino, "Commuting in the United States: 2009," US Census, 2011, <https://www2.census.gov/library/publications/2011/acs/acs-15.pdf>
- 55 John Pucher et al., "Infrastructure, Programs, and Policies to Increase Bicycling," *Preventive Medicine* (2010): Vol. 50, S.1 pp. S106-S125
- 56 League of American Cyclists, "60% of Americans Support Increasing Federal Funding for Biking and Walking," League of American Bicyclists, 2020. <https://bikeleague.org/content/60-americans-support-increasing-federal-funding-biking-and-walking>
- 57 Roger Geller, "Four Types of Cyclists," Portland Office of Transportation, 2006.
- 58 Jenifer Dill and Nathan McNeil, "Four types of Cyclists? Examining a typology to better understand bicycling behavior and potential," Transportation Research Board, 92nd Annual Meeting, 2012.
- 59 Jenifer Dill and Nathan McNeil, "Revisiting the Four Types of Cyclists: Findings from a National Survey." *Transportation Research Record.* 2016;2587(1):90-99. doi:10.3141/2587-11
- 60 National Academies of Sciences, Engineering, and Medicine. 2020. *Bicyclist Facility Preferences and Effects on Increasing Bicycle Trips.* Washington, DC: The National Academies Press. <https://doi.org/10.17226/25792>
- 61 dbiTilde Collaborative, "50+ Cycling Survey," dbiTilde Collaborative, 2021, <https://drive.google.com/drive/u/0/folders/1aTb4KF7Rlq0gqJlkKPX3fIDP3ohNmf04>
- 62 Jacobsen, P. (2003). Safety in numbers: More walkers and bicyclists, safer walking and bicycling. *Injury prevention : journal of the International Society for Child and Adolescent Injury Prevention.* 9. 205-9. 10.1136/ip.9.3.205
- 63 Elvik, Rune & Goel, Rahul. (2019). Safety-in-numbers: An updated meta-analysis of estimates. *Accident Analysis & Prevention.* 129. 136-147. 10.1016/j.aap.2019.05.019
- 64 Michael Anderson, "Honolulu Installs Protected Bike Lane, Sees Massive Drop in Sidewalk Biking." *People for Bikes*, 2015, <https://brokensidewalk.com/2015/protected-bike-lanes-and-sidewalk-biking/>
- 65 Rebecca Sanders, "Examining the Cycle: How Perceived and Actual Bicycling Risk Influence Cycling Frequency, Roadway Design Preferences, and Support for Cycling Among Bay Area Residents," (PhD diss., University of California, Berkeley, 2013.), pp. 218
- 66 Echiburú, T., Hurtubia, R., & Muñoz, J. C. (2021). The role of perceived satisfaction and the built environment on the frequency of cycle-commuting. *Journal of Transport and Land Use*, 14(1), 171–196. <https://doi.org/10.5198/jtlu.2021.1826>
- 67 Simon MacMichael, "Six in ten users of pop-up bike lanes in Paris are new to cycling, says city's government," *Road.cc*, 2021, <https://road.cc/content/news/6-10-users-pop-bike-lanes-paris-new-cycling-280681>
- 68 C.M. Kendrick et al., "The impact of bicycle lane characteristics on bicyclists' exposure to traffic-related particulate matter," Transportation Research Board, 90th Annual Meeting, 2010, <https://trid.trb.org/view/1092828>
- 69 Mariah VanZerr, "Resident Perceptions of Bicycle Boulevards: A Portland, Oregon Case Study," Transportation Research Board, 2010, <https://trid.trb.org/view/911422>
- 70 Emily Rose Hennessy, P.E., M.S. & Chengbo Ai, Ph.D, "Roadway Lighting and Non-Motorist Crashes :A Spatial Comparison of Cambridge," UMass Amherst. MA. 2021.
- 71 Uttley J, Fotios S, Lovelace R (2020) Road lighting density and brightness linked with increased cycling rates after-dark. *PLoS ONE* 15(5): e0233105. <https://doi.org/10.1371/journal.pone.0233105>