

Moving America Forward:

Health, Safety, and Economic Benefits
of Multimodal Transportation Systems

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**AMERICA IS
ALL IN**

HIGHLIGHTS

Highlights



- **FEDERAL FUNDING THROUGH THE INFRASTRUCTURE INVESTMENT AND JOBS ACT (IIJA)** provides an opportunity to modernize and enhance America's transportation systems while simultaneously making substantial improvements to public health, community safety, and economic resilience.
- **A FRESH APPROACH TO TRANSPORTATION DESIGN** is an important opportunity to help achieve national targets for greenhouse gas emissions reductions, as the transportation sector is the largest source of these emissions in the U.S.
- **IN DENSE URBAN AREAS, CLEAN MULTIMODAL SYSTEMS** should prioritize biking, walking, and mass transit, and rural areas will primarily be best served with EV use, safe street design to prevent traffic collisions, and on-demand shuttles for non-drivers.
- **HEALTH BENEFITS OF CLEAN MULTIMODAL SYSTEMS** include air quality improvement, noise pollution reduction, increased physical activity through active modes of transportation, less stressful commutes, and exposure to green spaces.
- **STREET DESIGN THAT SUPPORTS MULTIMODAL TRANSIT** is safer for pedestrians, bicyclists, and drivers alike.
- **EXPANDED ACCESS TO MULTIMODAL TRANSPORTATION** can increase economic mobility for the most vulnerable and make communities more productive, while EV use saves money relative to traditional gas-powered vehicles.
- **A COMPANION PAPER, "INVESTING IN CLIMATE-SMART TRANSPORTATION: AN ACTION GUIDE FOR AMERICA IS ALL IN MEMBERS,"** offers specific strategies and case studies for U.S. non-federal actors – states, tribal nations, cities, businesses, and civil society – seeking to realize these benefits for their communities.

ACKNOWLEDGEMENTS

This report was produced on behalf of America Is All In, and was made possible with funding from Bloomberg Philanthropies. This paper was led by World Resources Institute in consultation with RMI and the Center for Global Sustainability (CGS) at the University of Maryland. The authors wish to thank the many reviewers from World Resources Institute, RMI, CGS, and U.S. Climate Alliance. These included: Claudia Adiazola-Steil, Kyle Clark-Sutton, Vineet John, Leanne Kaplan, Shannon Kennedy, Dan Lashof, Leah Lazer, Devashree Saha, Mark Teschauer, and Benjamin Welle.

Suggested Citation: E. Bridgwater, S. Rajpurohit, and K. Kennedy. Moving America Forward: Health, Safety, and Economic Benefits of Multimodal Transportation Systems. America Is All In (2022).



Executive summary

EXECUTIVE SUMMARY



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THE INFRASTRUCTURE INVESTMENT AND JOBS ACT (IIJA) provides major federal funding to states, cities, municipal planning organizations, and other non-federal actors. IIJA includes \$110 billion for roads/bridges; \$39 billion to modernize transit; and \$7.5 billion to build out a national network of EV chargers (The White House 2021). This historic infrastructure funding provides an opportunity to modernize and enhance America's transportation systems while making substantial improvements to public health, community safety, and economic resilience.

A fresh approach to transportation design in the United States that emphasizes clean multimodal systems based around biking, walking, and mass transit in denser urban settings, and safer roads, electrified vehicles, and enhanced mobility for non-drivers in rural areas can pay dividends for climate, health, safety, and the economy. Outdated car-dependent transportation systems in the United States create climate, health, safety,

and economic issues that a new approach to transportation design focused on the overall wellbeing of a community can help alleviate.

Clean transportation systems offer significant climate and health benefits. The transportation sector is currently the largest source of greenhouse gas emissions in the United States, contributing 29% of total U.S. emissions (EPA 2021). Air pollution is the greatest environmental health risk factor in the United States (Thakrar et al. 2020), causing acute and chronic physical health issues. Electrifying cars, buses, and rail can avoid greenhouse gas emissions while addressing America's air quality crisis. Cars and trucks are major contributors to air pollution and perpetuate existing health and economic inequalities. Expanding safe and comfortable spaces to walk and bike offers low-carbon transportation and this increased activity can improve physical and mental health.

EXECUTIVE SUMMARY

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“Smart design allows neighborhoods to provide most basic needs within a short, safe, and comfortable walk or bike ride, with public transit connecting residents to further away destinations.”

Transportation planning has often focused on the needs of drivers rather than the needs and movement of everyone in a community, prioritizing vehicle traffic flow over multimodal access. The resulting transportation system fails to meet the needs of vulnerable and marginalized groups such as children, the elderly, low-income people, people of color and Black Americans, women and gender minorities, and people with certain disabilities. Transportation modes like walking and biking, critical for people who cannot drive, are currently under-invested and therefore unsafe. A tragic result is the significant avoidable traffic fatalities that are faced by pedestrians and bicyclists—as well as drivers. Shifting to use of walking, biking, and mass transit to meet many basic needs can reduce these preventable deaths. Where car use is still needed because other modes are less viable—which will especially be the case in rural places—strategies such as Complete Streets and the Safe Systems Approach can make roads safe for all.

Neighborhood design plays a critical role in making a multimodal transportation system a reality. Smart design allows neighborhoods to provide most basic needs within a short, safe, and comfortable walk or bike ride, with public transit connecting residents to further away destinations. Allowing people to meet their basic needs and access jobs through affordable transportation

options has beneficial economic outcomes. Expanded access to transportation enables economic mobility and connects employers with the labor force, particularly benefiting low-income populations. Zoning policies supporting housing densification can also drive economic productivity, growth, and innovation. Electric vehicle adoption saves individuals and fleet owners thousands of dollars over the lifetime of vehicle ownership, and equitable investment in charging infrastructure will help realize air quality benefits and savings for rural and urban environments alike.

This paper reviews the connections between transportation, air quality, health, road safety, and economic and social well-being. It also examines best practices and key considerations for equitable transportation system design. A companion paper, “Investing in Climate-Smart Transportation: An Action Guide for *America Is All In* Members,” offers specific strategies and case studies for U.S. non-federal actors seeking to realize these benefits for their communities. States, tribes, cities, towns, universities, businesses, and civil society actors can implement these tactics and coordinate action to create positive feedback loops.



Introduction: Moving America Forward

INTRODUCTION: MAKING THE MOST OF THE MOMENT

**IN THE NEXT FEW YEARS, COMMUNITIES ACROSS THE UNITED STATES**

can make transportation investments that deliver health benefits, safe streets, expanded access to economic opportunity, and more equitable communities all while reducing carbon pollution. The transportation sector is currently the largest source of greenhouse gas emissions in the United States, emitting 29% of total U.S. emissions (EPA 2021). Meeting the country's 2030 target of reducing GHG emissions by 50-52% from 2005 levels will require significant reductions from the transportation sector. Recent modeling from America Is All In shows that ambitious action can reduce transportation sector emissions by more than one-third by 2030 (Zhao et al. 2022). While switching to electric vehicles (EVs) will be a necessary part of decarbonization, EVs alone are not enough to reach climate goals. Significant reductions in the number of miles driven in the United States is an important component of limiting warming to 1.5 C, even under ambitious EV adoption scenarios (Yudkin et al. 2021). Fortunately, non-driving modes of transportation are also able to contribute significantly to decarbonization, with

shifting to public transportation being similar to the net greenhouse gas emission reduction potential of electric light duty vehicles (IPCC 2022).

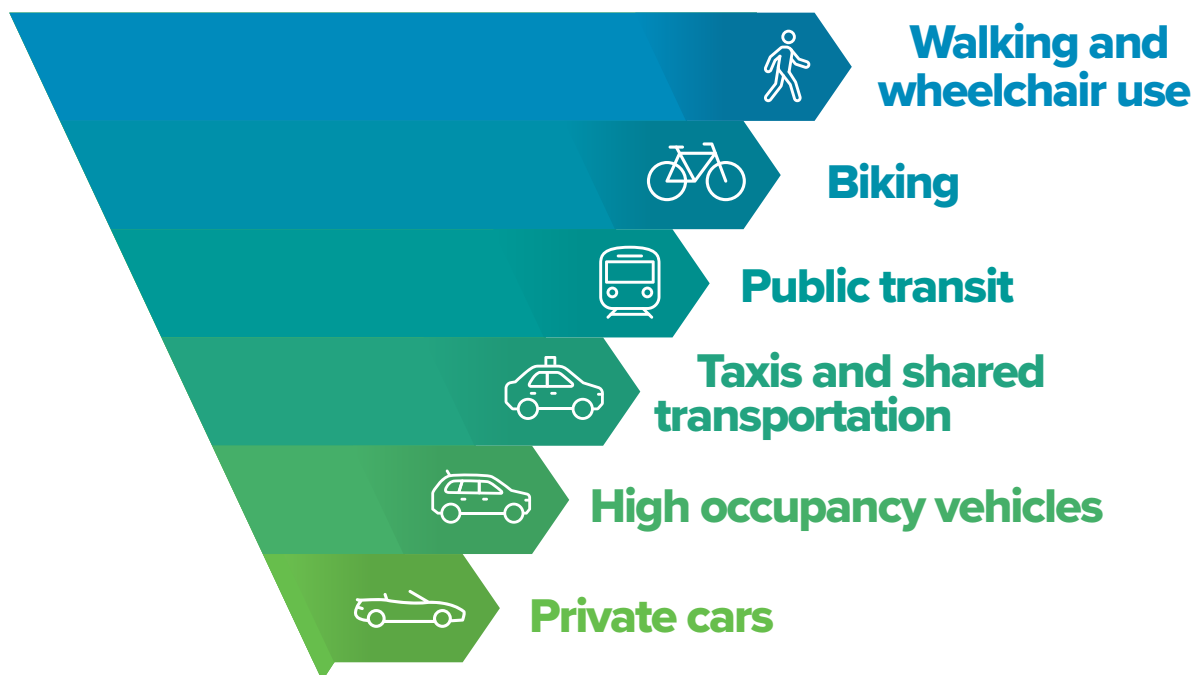
Achieving greenhouse gas reductions will take bold, coordinated action by non-federal and federal leaders alike. The new Infrastructure Investment and Jobs Act (IIJA) provides a large amount of federal funding available to states, cities, and other non-federal actors, including \$110 billion for roads/bridges with a program to reduce traffic fatalities; \$39 billion to modernize transit; and \$7.5 billion to build out a national network of EV chargers (The White House 2021). This funding can help steer America's transportation systems towards equitable and clean multimodal systems that expand walking, biking, and public transit; alternatively, it could further entrench inequitable and harmful car-dependency through activities like highway expansion (Plumer 2022). By leveraging these funding opportunities to create clean multimodal transportation systems, states, tribes, cities, towns, municipal planning organizations, universities, and businesses can achieve a range of benefits beyond and in addition to climate benefits.

INTRODUCTION: MAKING THE MOST OF THE MOMENT

Multimodal transportation systems favoring cleaner and safer modes of transit will maximize health, safety, economic, and equity benefits. Wherever possible, the most sustainable and equitable modes of transportation—namely, walking, biking, and mass transit—should be given preference in planning and policy decisions (Figure 1), though rural areas with dispersed locations will need to continue reliance on cars. Where cars are still used in urban areas, shared vehicles are a more sustainable and efficient use of resources than personal vehicles. In particular, focusing on electrifying intensively used vehicles, such as cars used on ride-hailing apps like Lyft and Uber, can accelerate the greenhouse gas reduction impact that EVs can have (Lazer et al. 2021).

In the decades since 1940 most U.S. transportation planning has favored cars, making the freedom to travel safely, conveniently, and comfortably dependent on access to a vehicle (Litman 2021; Martínez 2015; Buehler 2014; Stromberg 2015; Toth 2009). While cars themselves offer many benefits to their users, car *dependency* in a community results in harm to essentially every member of the community through needlessly unsafe roads, increased air pollution, degraded physical and mental health, reduced economic access, wasted land use opportunity from excessive parking lots, and aggravated climate impacts.

Figure 1. Sustainable Transportation Hierarchy. Figure is adapted from Todd Litman of the Victoria Transport Policy Institute. Source: (Litman 2015).



INTRODUCTION: MAKING THE MOST OF THE MOMENT

A multimodal transportation system in which travelers are not dependent on access to a vehicle makes a community more equitable. Car dependency limits the mobility of a significant portion of the United States. In a typical community 20-40% of the population cannot drive due to economic constraints, age constraints, disability, and vehicle failure (Litman 2021). While women make up a higher proportion of car buyers than men, they also have less access to household vehicles (Tiikkaja and Liimatainen 2021). Meanwhile, 18% of Black households did not have access to an automobile in 2019 (PolicyLink and the USC Equity Research Institute 2020). School-aged children in the United States can face restrictions in their ability to attend school or extracurricular activities if a parent is not available or able to drive them to a car-focused location.

Car dependency also degrades community health and does so inequitably. Air pollution is the greatest environmental health risk factor in the United States (Thakrar et al. 2020), and internal combustion vehicles are a major source of it. Research links air pollution to a host of physical and mental health issues, such as brain damage, chronic illnesses, serious birth defects, many types of cancer, and diabetes. Noise pollution from cars and loud roads is also prevalent throughout U.S. communities. While often overlooked, noise pollution impacts health and well-being in significant ways such as through hearing loss, stress-related illnesses, and cardiovascular disease.

The World Health Organization estimates that 99% of the global population breathes unhealthy air, but air pollution exposure and

impacts are not equally distributed. In the United States, lower-income and minority people are disproportionately exposed to traffic and air pollution and face higher risk of adverse health outcomes (Pratt et al. 2015). Historic transportation planning has fostered these disparities. For example, exposure to traffic emissions is highest near highways and major roadways, and historic interstate planning routed highways through Black and brown communities, at times purposefully (Padula et al. 2014; King 2021). Additionally, people who walk, bike, or take transit experience higher household exposure and risks from traffic and air pollution (Pratt et al. 2015). Lastly, children are harmed more by air pollution than adults, as their lungs are still developing and they inhale more polluted outdoor air than a typical adult (American Lung Association 2020).

Car-focused roads are also needlessly unsafe. Traffic fatalities have been growing in the United States, despite falling in other developed countries in Europe (Eurostat 2022; U.S. Department of Transportation 2022). 2020 alone saw 23,000+ deaths to occupants of cars, 6,000+ pedestrian deaths, and nearly 900 bicyclist deaths in the United States (National Highway Traffic Safety Administration 2021a). Traffic deaths surged during the pandemic, with links to more aggressive driving and erratic behavior (Leonhardt 2022). And, traffic deaths are not distributed equitably; traffic deaths of non-Hispanic Black people were uniquely high in 2020, up 23% (National Highway Traffic Safety Administration 2021a).

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“A multimodal transportation system with safe and accessible walking, biking, public transit, and EV use can alleviate the current harms that stem from car-dependency in the United States.”

Reducing car-dependency offers communities a number of economic benefits, and the costs of owning a car are inequitable and expensive. Car dependency makes it challenging for some workers to access jobs, in turn restricting their economic access and upward mobility. In car-dependent communities, businesses miss out on economic opportunity through a reduced labor pool, reduced employee productivity, higher business-related transportation costs, and a missed opportunity for increased economic productivity stemming from densification and walkability/bikability. Zoning practices like requirements for developers to build a certain amount of parking also make it more expensive to build housing and steers land use away from more economically beneficial uses. Additionally, the costs of buying a gas-powered car is expensive and the costs are not experienced equitably: Black buyers are charged higher markups on auto loans than White buyers, and African-American neighborhoods pay higher auto insurance premiums (Cohen 2012; Feltner and Heller 2015). EVs offer significant savings over

the lifetime of the vehicle, and in most states EVs are now cheaper to own than gas-powered counterparts on a monthly basis as soon as being driven off the lot (Orvis 2022).

A multimodal transportation system with safe and accessible walking, biking, public transit, and EV use can alleviate the current harms that stem from car-dependency in the United States. Embracing this shift presents a powerful opportunity for local governments, businesses, universities, and community-based organizations to advance well-being by improving health, safety, the economy, and equity, all while mitigating the climate crisis. In the following sections we present the diverse range of benefits that clean multimodal transportation systems can confer to cities, so that decision makers can move America forward and use current federal funding opportunities to improve America’s transportation systems.



Land Use Patterns and Transportation Needs

LAND USE PATTERNS AND TRANSPORTATION NEEDS



TRANSPORTATION NEEDS VARY ACROSS RURAL, SUBURBAN, AND URBAN AREAS IN THE UNITED STATES

because of differences in land use patterns. We discuss here the two extremes of land use patterns in U.S. communities: urban and rural spaces. While not discussed directly, large towns and small cities have land use patterns that fall in between these extremes and can use hybrid elements of both approaches.

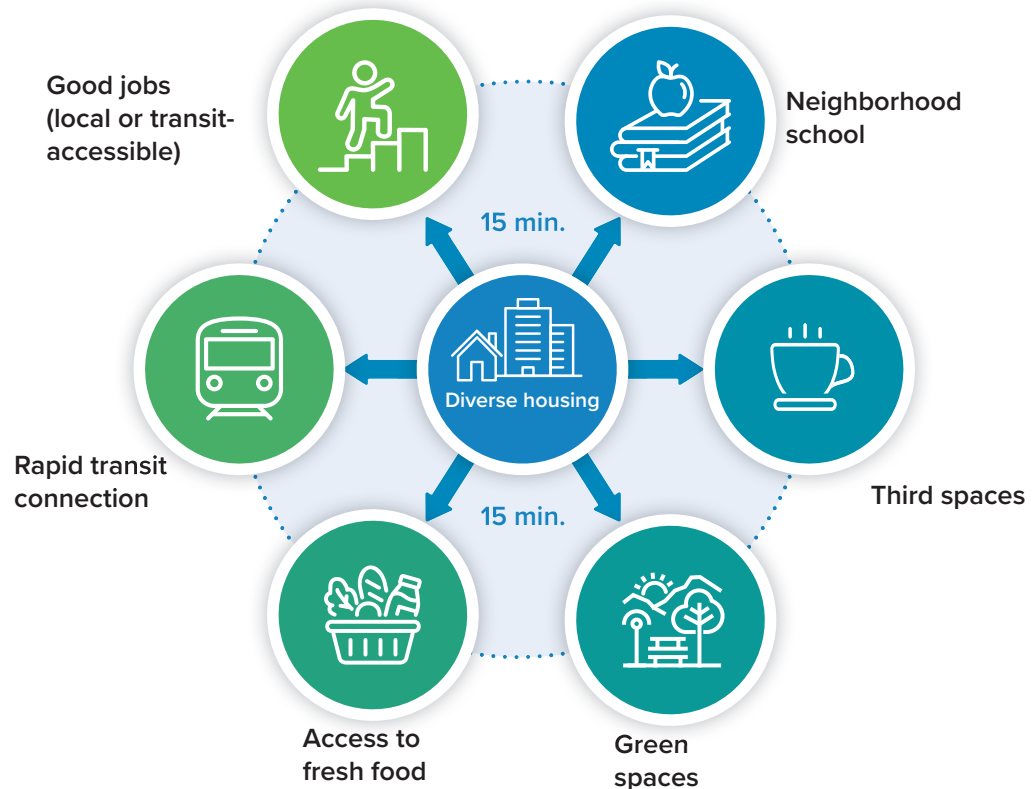
Mass transit, biking, micro-mobility, and walking can confer significant benefits relative to personal vehicle use in densely populated urban areas where final destinations are close. A core principle underlying efficient multimodal urban transportation systems is the concept of a “15-minute community” (see figure 2). This term generally refers to neighborhoods where all residents live within a 15-minute walk or bike ride of basic needs, such as rapid transit, a place to buy fresh food, quality schools and jobs, a park, and

“third spaces” like bookstores or libraries, coffee shops, and public plazas that support gathering and interaction. Destinations further away can then be reached via high-frequency public transit routes.

An urban community does not guarantee basic needs can be easily met without a vehicle. In many cases urban sprawl contributes to car-dependency, making it difficult for residents to reach basic needs. Sprawl also makes inefficient use of land for the most valuable activities in a community. Prioritizing cleaner and more efficient modes such as walking, biking, and public transit is key to maximizing long-term and sustained health benefits. As such, it is vital that cities adjust existing land use patterns and consider the model of the 15-minute community when planning new development, for example by facilitating infill housing and loosening zoning restrictions that prevent mixed-use development.

Figure 2.
The Components
of 15-minute
Communities.

Every basic community need is a 15–minute walk or bike ride away



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“Planning rural communities so that people can meet their basic needs within as short a trip as possible would benefit both drivers and non-drivers.”

Small towns and cities in rural areas can reduce vehicle trips through improved walking, bicycling, and targeted transit systems. In addition, encouraging more compact community planning can reduce overall miles travelled and confer some of the economic benefits of densification. However, because mass transit cannot reasonably offer the same frequency of service to the many dispersed destinations in rural areas as it can for urban areas, personal vehicles will still be needed. However, it must be kept in mind that car use poses significant safety threats to pedestrians, bicyclists, and drivers. This concern is particularly salient in rural communities, as nation-wide the rural roadway fatality rate is approximately two times higher than the urban fatality rate (U.S. Department of Transportation 2022). All road users can be kept safe through a “complete streets” approach and adoption of the Safe System Approach (these approaches are discussed in the Safety section of the Benefits section).

Replacing internal combustion engine vehicles with electric vehicles will be critical to reduce greenhouse gas emissions. Investments in electric vehicle infrastructure in rural areas can emphasize equity to promote wider adoption. Because a portion of people in rural areas are either unable to drive or cannot own a vehicle because of age, ability, or income, additional efforts to expand mobility for non-drivers are needed. For example, on-demand paratransit shuttles can increase mobility for non-drivers. Planning rural communities so that people can meet their basic needs within as short a trip as possible would benefit both drivers and non-drivers—even if these trips take longer than the 15-minute threshold discussed above.

Specific strategies for shifting to clean multimodal transportation are discussed in the partner paper to this publication, “Investing in Climate-Smart Transportation: An Action Guide for *America Is All In* Members.”



The Benefits of Clean Multimodal Transportation Systems: Health, Safety, and the Economy

Health

Air quality improvements save lives, relieve physical health burdens, improve cognitive function, protect the most vulnerable and redress historic injustices

America has an air quality crisis. Shifting towards a multi-modal and zero emissions transportation system is an essential part of addressing this crisis. Over 40% of Americans— more than 137 million people— breathe unhealthy levels of air pollution (American Lung Association 2020). Air pollution is associated with 100,000–200,000 excess deaths annually in the U.S., exceeding the number of deaths from murders and car crashes combined (Thakrar et al. 2020). The transportation sector accounts for 37% of national CO₂ emissions, 30% of NO_x emissions, and 6% of PM_{2.5} emissions, and it is a source of air toxics like benzene, formaldehyde, and diesel particulate matter that are known or suspected to cause cancer or other serious health effects (Environmental Protection Agency 2021; 2015). Lower-income people, minority people, and children are all disproportionately impacted by this poor air quality in the United States (Pratt 2015, American Lung Association 2020).

Air pollution manifests in acute physical health risks as well as chronic harm from toxins absorbed into the body, potentially affecting every organ and causing greater harm in people with heavy exposure and existing illnesses (Schraufnagel, Balmes, Cowl, et al. 2019). Air pollution is linked with higher rates of heart disease, strokes, many cancers, diabetes, and accelerated degeneration of eyesight (Gardiner 2019; Chua 2022). Premature births, stillbirths, low birthweights, and heart malformations increase in line with air pollution levels (Miller and Ruiz-Tagle 2018; Y. Liu et al. 2019; Agay-Shay et al. 2013). Extremely premature births

are 80% more likely when mothers live in areas of heavy traffic (Wallace-Wells 2021). Traffic-related air pollution and prematurity particularly affect parents living in low-socioeconomic status neighborhoods (Padula et al. 2014).

Equally concerning is evidence of the link between air pollution and profound changes to the brain. Air pollution is implicated in depression, Alzheimer's, Parkinson's and other sorts of dementia (Li et al. 2021; Wallace-Wells 2021; Ali and Khoja 2019). Small increases in local pollution can raise the need for psychiatric treatment by a third and for hospitalization by a fifth (Bernardini et al. 2020). Those who breathe dirtier air in childhood show higher rates of self-harm in adulthood (Mok et al 2021). Air pollution has been linked to ADHD, and risk of autism increases with exposure to fine particulate matter during prenatal periods and early childhood (Thygesen et al. 2020; Lin et al. 2021). Poor air quality impedes cognitive performance, worsening performance on verbal and math tests, and inhibiting memory, attention, and vocabulary (Zhang, Chen, and Zhang 2018; Wallace-Wells 2021).

Reducing air pollution provides significant improvements. While switching to personal electric vehicles is one option to prevent air pollution, electric mass transit is also beneficial for air quality, and walking and biking are clean ways to travel without creating any air pollution. Research shows a transition to zero emissions vehicles coupled with shifts in electricity supply could avoid up to 110,000 premature deaths, 3 million asthma attacks and over 13 million workdays lost due to polluted air by 2050 (American Lung Association 2020).

THE BENEFITS OF CLEAN MULTIMODAL TRANSPORTATION SYSTEMS: HEALTH, SAFETY, AND THE ECONOMY

When diesel school buses are retrofitted to reduce emissions there are positive effects on both respiratory health and test scores, particularly English test scores (Austin, Heutel, and Kreisman 2019). When New Jersey and Pennsylvania introduced E-ZPass to reduce traffic congestion, reduced exhaust from idling traffic resulted in premature birth rates dropping 10.8% and low birth weights dropping 11.8% for pregnant women within a 1.25 mile radius of the E-ZPass booths (Currie and Walker 2011). Within only a few weeks of air pollution improvements, respiratory and irritation symptoms like shortness of breath, cough, phlegm, and sore throat are alleviated, along with significant decreases in school absenteeism, clinic visits, hospitalizations, premature births, cardiovascular illness, and all-cause mortality (Schraufnagel, Balmes, De Matteis, et al. 2019). Studies have also suggested that improving air quality reduces the risk of dementia and Alzheimer's disease (Alzheimer's Association International Conference 2021).

Air pollution is also exacerbated in indirect ways by America's continued reliance on gas-powered cars. Greenhouse gas emissions from cars contribute to a warming climate with profound impacts across the United States. Wildfires contributed almost half of the PM_{2.5} pollution in

the western United States in 2020, indicating more particulate matter from burning forests entered the lungs of Americans living in western states than from any other human source (Y. Li et al. 2021). Wildfires are expected to at least double in extent by mid-century, compared to 2012, and the worst air quality in the country is now routinely registered in places like California's San Joaquin Valley, a farming region (Morton et al. 2012; American Lung Association 2022; Wallace-Wells 2021). Smoke from last year's fires is already responsible for five thousand additional pre-term births in California (Wallace-Wells 2021).

Finally, while vehicle electrification can significantly reduce greenhouse gas emissions and unhealthy air pollutants from tailpipes, electric vehicles still contribute to non-exhaust air pollution. Particulate matter arising from the wear of brakes, tires, and road surfaces are generated and resuspended by all vehicles including electric vehicles. Non-exhaust emissions substantially contribute to traffic emissions and the related adverse health impacts (Charron et al. 2019), so simply switching from combustion engines to electric vehicles would not eliminate all car-related health impacts from particulate matter.

Mode shifts provide opportunities for increased physical activity, which reduces risks of chronic disease and supports mental health, while also improving health through exposure to green spaces and less stressful commutes

Mode shifts toward active modes of transportation offer physical and mental health benefits through increased physical activity levels, whether as independent trips or as part of travel to a transit hub. For example, in one study, transit walkers in large urban areas with a rail system were 72% more likely to walk 30 minutes or more per day than were those without a rail system (Freeland et al. 2013).

Increasing exercise through active modes of transportation can support better physical health outcomes. Half of U.S. adults live with a chronic disease like cancer, diabetes, or heart disease, with higher rates among low-income and disabled populations and racial minorities being 1.5-2 times more likely to live with certain chronic diseases (Price et al. 2013, Carroll et al. 2014, Office of the Surgeon General 2015). Fortunately, increased physical activity reduces risk of chronic diseases and improves the health of people already living with them (Office of the Surgeon General 2015). Furthermore, active transportation is associated with a 12% reduction in mortality and a 11% reduction in risk of cardiovascular disease (U.S. Department of Transportation 2015). While there is strong evidence of the health benefits of physical activity, only half of U.S. adults meet the guideline for recommended aerobic physical activity, and that group is disproportionately male, younger, well-educated, and White or Asian (Office of the Surgeon General 2015).

Increased physical activity is associated with improved mental health, and as such, active modes of transportation can support improvements in mental health. Mental health issues are common in the United States, with one in five Americans living with a mental illness (National Institute of Mental Health 2022). Adults of all ages with low socioeconomic status in the United States have experienced increased distress and declines in well-being since the 1990s (Goldman, Gleib, and Weinstein 2018). Compared to adults without disabilities, adults with disabilities experience mental distress five times more frequently (Cree 2020). Mental health disparities exist for racial and ethnic minorities related to access and use of mental health services, diagnosis, and outcomes (American Psychological Association 2022). The reported prevalence of any mental illness or serious mental illness is highest among female people and younger adults (National Institute of Mental Health 2022).

Children's academic performance improves when schools encourage physical activity, and anxiety and depression levels drop (Office of the Surgeon General 2015). Improved quality of life, emotional well-being, and positive mental health are associated with physical activity in adults, and regular exercise assists healthy aging and may delay cognitive decline in older people (Office of the Surgeon General 2015). Numerous studies have found that exercise is comparable to antidepressants and psychotherapy for treating depression (Kvam et al. 2016). Research also suggests that physical activity protects against anxiety symptoms and disorders (McDowell et al. 2019). Growing research suggests that exercise can provide holistic benefits for people with schizophrenia or psychosis (Mittal et al. 2017).

In certain contexts, cities can be made quieter with vehicle electrification and modernized street design, relieving mental and physical health burdens stemming from noise pollution

Some World Health Organization findings indicate that noise pollution is the second largest environmental cause of health problems, second only to the harm of air pollution (European Environmental Agency 2021). Much of pervasive noise pollution comes from transportation, including highways and rail (Goines and Hagler 2007; American Association of State Highway and Transportation Officials 2022). A 2014 study found that 104 million Americans were exposed to continuous noise pollution above the EPA's recommended level to avoid hearing loss, with tens of millions more Americans potentially at risk for heart disease and other noise-related health effects (Hammer, Swinburn, and Neitzel 2014). Noise pollution is related to stress-related illnesses, cardiovascular disease, endocrine effects, increased incidence of diabetes, speech interference, sleep disruption, loss of productivity, and annoyance, yet very few communities consider it when making policy (Hammer, Swinburn, and Neitzel 2014).

Depending on the way in which transportation investments are planned and implemented, clean multimodal transportation systems can be an opportunity to avoid the harms of noise pollution. Some of these benefits can stem from electrified transportation: Electric high-speed trains are expected to be quieter compared to conventional passenger and freight rail services (California High-Speed Rail Authority 2018), and EVs almost entirely eliminate engine noise, the dominant source of noise at low speeds. As such, roads with speeds below 25 mph, which are often located in residential areas, will get quieter with EV use— but highways are not expected to become quieter through EV use (Barnard 2016).

Communities can also reap the benefits of quieter transportation systems if improved road design and traffic management practices that

consider the needs of multi-modal travelers are taken up. Reducing congestion, speed, and vehicle size can make roads quieter, as well as safer for pedestrians and bicyclists (American Association of State Highway and Transportation Officials 2022). Planting trees and increasing distances between highways and people also reduces noise pollution; reducing car-dependency could free up more land for such initiatives (American Association of State Highway and Transportation Officials 2022). Quieter pavements, noise barriers, and noise level thresholds can also help (Federal Highway Administration 2005).

Exposure to green spaces can improve health outcomes

Increased walking and biking, either independently or when traveling to or from public transit, can also improve mental health if green space is available along a travel route. Shifting away from car-dependency frees up land previously used for parking lots and roads, allowing more land to be used for green spaces that help create a more vibrant community. For adults, contact with green space is associated with healthier cortisol levels, independent of income levels (Roe et al. 2013). For children, exposure to green space reduces the risk for developing an array of psychiatric disorders during adolescence and adulthood, and is comparable to family history when predicting mental health outcomes - only socioeconomic status was a slightly stronger indicator (Engemann et al. 2019).

Improved commutes can reduce stress

Finally, the stress of commuting has serious public health and social implications. Driving is more stressful for commuting than walking or taking mass transit (Legrain, Eluru, and El-Geneidy 2015). As such, shifting away from car dependency and towards multimodal transportation systems can reduce the stress of commuting.

Safety

Street design that supports multimodal transit is safer for pedestrians, bicyclists, and drivers alike

The safety of pedestrians, bicyclists, and drivers can be improved by shifting towards multimodal transportation design that supports safe use of public space by all road users. A study of 37 U.S. Complete Streets projects (see Figure 3) found that the projects pay for themselves in less than eight years by avoiding substantial collision and injury costs (Smart Growth America 2015). The Complete Streets model ensures safe and sufficient accommodation of all travelers on a street, including pedestrians, bicyclists, public transportation users, drivers, and freight vehicles, as well as children, older people, and people with disabilities (Federal Highway Administration 2022). Similarly, a study of 53 countries found that a “Safe System” approach achieves the lowest rates of road death fatalities. The Safe System approach considers how design, infrastructure, and systemic issues influence road safety, instead of assuming that traffic safety stems solely from the behaviors of road users (Welle et al. 2018). The U.S. Department of Transportation recently released a landmark National Roadway Safety Strategy to leverage IIJA funding for the advancement of a Safe System approach in the United States (U.S. Department of Transportation 2022).

A significant number of pedestrians and bicyclists die from collisions with vehicles every year in the United States, with significant inequity in who

experiences serious injury or death. As such, making biking and walking safe and comfortable activities can both reduce unnecessary deaths and improve the equity of a community. In the United States, a pedestrian is killed on average every 85 minutes. Pedestrian deaths accounted for 17% of traffic fatalities in 2019 (National Highway Traffic Safety Administration 2021b). Even after controlling for differences in walking rates, older adults, people of color, and pedestrians in low-income communities are more likely to be killed while walking (Smart Growth America 2021). Racial inequities in access to healthcare exacerbate the unequal impacts of traffic violence (Dieleman et al. 2021). Vehicle crashes are also a leading cause of death for children, and an AARP survey found that 47% of people older than 50 cannot safely cross the main roads in their community (AARP 2009; Smart Growth America 2014).

Making walking safer will help cities and people access the health and economic benefits of increased levels of walking. Most pedestrian deaths occur on arterial roads designed for cars and can be prevented by improving policy, design, practice, and regulations (Smart Growth America 2014). Shifting towards multimodal transportation systems is the most direct way to prevent these pedestrian deaths, but the choices that automakers, drivers, and urban planners make also influence how dangerous cars are. Multiple factors are at play when it comes to a pedestrian surviving a car collision such as the speed the vehicle was traveling, the weight of the vehicle, the height of the vehicle, and the driver’s visibility (Geman 2021; Davis 2021).

Automakers have a role to play in designing vehicles to be safer for non-passengers. Nearly half of all cars sold in the United States are SUVs, but the bigger size of pickup trucks and SUVs means these vehicles are two to three times more likely to kill people in a collision compared to smaller personal vehicles (Davis 2021; Cozzi and Petropoulos 2019). In addition to size, vehicle weight is also a safety consideration. While EVs offer significant climate benefits, they are also heavier than gas-powered counterparts, and as such are almost certain to pose additional risk to pedestrians (Wilson 2021). Most EVs are currently

smaller designs, and keeping designs smaller is an opportunity to mitigate the increased risk that comes from larger and heavier vehicles.

Another component of safer roads is slower speeds. When a person is hit by a passenger car traveling 20 mph, the fatality rate is 5%. The fatality rate rises to 85% when the car is driving 40 mph prior to collision (Davis 2021). An analysis with a small sample size found a 100% pedestrian fatality rate when an SUV was traveling at or above 40 mph (Insurance Institute for Highway Safety 2020). Slow speed zones could make driving a safer activity.

Figure 3. The Complete Streets Approach: Example Features for Safer and More Livable Streets. Figure is adapted from Wisconsin Bike Fed. Source: (Wisconsin Bike Fed 2022)



Bikes lanes and protective barriers provide safer and more comfortable experiences for bikers and micromobility users

Multiple visual safety cues, narrower lanes, and slower speed limits makes driving a safer activity for drivers and non-drivers alike

Shady trees, green spaces, benches, public art, and spaces for public gathering make streets comfortable and enjoyable places to travel and interact

Sidewalks with street lights, curb extensions, marked crosswalks, ramps for wheelchairs, and accessible pedestrian signals allow pedestrians and wheelchair users to safely travel alongside traffic and cross intersections

Designated space for buses makes bus service faster, while comfortable bus stops and access to first/last mile travel for bus riders improves the experience of riding the bus

THE BENEFITS OF CLEAN MULTIMODAL TRANSPORTATION SYSTEMS: HEALTH, SAFETY, AND THE ECONOMY



Updates to existing infrastructure and investments in new road safety measures - particularly on arterial roads that are designed for high traffic volumes and are the site of most pedestrian deaths - can make driving safer. (McAndrews et al. 2017; Smart Growth America 2014). To make walking a truly safe activity for Black walkers, there will need to be changes to policing; Black Americans disproportionately experience race-based hate crimes, overly aggressive police enforcement, and police brutality when walking (Brown 2021). For example, a study of five years of tickets given to pedestrians in Jacksonville, Florida found that the majority of tickets were given to Black pedestrians, despite less than one-third of the city's population identifying as Black (Brown 2021).

The effects of unsafe biking conditions or perceived safety concerns is not equitable across all people. Biking is a particularly important mode to consider when it comes to transportation patterns of people of color in the United States, as people of color are more likely to ride bicycles regularly, and are most likely to say protected bike

lanes would affect their riding habits (Andersen 2015). People across all income levels bike to work, but on average people from lower-income households are more likely to rely on biking to get to work (Cortright 2019). While most people will avoid bike use if they feel unsafe, women, children, and the elderly are especially likely to avoid biking when they feel unsafe (Adriazola-Steil et al. 2021).

Improving the safety of biking can help reap the health and economic benefits of biking. Adequate bike infrastructure is a significant way to help more people bike. People interested in biking have different stress tolerances when considering use of a bike network; bicyclists with low stress tolerance will not bike unless the perceived level of comfort is met such as having off-street or separated bicycle facilities, while bicyclists with high stress tolerance are willing to bike with traffic or bike without bike lanes (Adriazola-Steil et al. 2021). The majority of people interested in biking have low stress tolerance, so implementing adequate bike infrastructure can increase the number of people

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“Improving the safety of biking can help reap the health and economic benefits of biking.”

biking (Adriazola-Steil et al. 2021). Along with changes in physical infrastructure, setting safe speed limits for cars is vital for bicyclist safety; the severity of injury incurred in a bicycle-vehicle crash is significantly related to vehicle speed limit (Isaksson-Hellman 2012). Furthermore, for Black and brown communities to be able to safely bike, the common issue of over-policing Black and brown bicyclists must be addressed (Uyeda 2022). For example, in 2016 and 2017 the majority of bicyclist-related stops in Oakland, California involved Black cyclists, even though only one-fourth of the city’s population identified as Black (Brown 2021).

Driving is also unsafe for people inside cars. Shifting trips from automobiles to alternative modes improves the overall safety of the transportation network and reduces fatality risks, while strategies that make roads safer for bicyclists and pedestrians, such as complete street design, also makes roads safer for motorists (APTA 2018). Motor vehicle crashes are the second leading cause of death for teenagers in the United States (CDC 2021). In 2019, over 22,000 passenger vehicle occupants died in traffic crashes and 2,448,000 passenger vehicle occupants were injured (National Highway Traffic Safety Administration 2021b). Impaired driving

also continues to be a common safety issue in the United States. In 2019, drunk drivers accounted for 28% of U.S. vehicle traffic fatalities (National Highway Traffic Safety Administration 2020). The World Health Organization has found no evidence that traditional mass media campaigns to reduce drunk driving actually reduce the risk of alcohol related injuries and fatalities (Yadav and Kobayashi 2015). An alternative and powerful way to prevent impaired driving is to address the root of the problem by helping drunk and high people to not depend on driving.

Of note, driving is particularly unsafe for Black drivers, who in addition to the general safety issues of driving also face disproportionate safety issues from policing. Black drivers are 20 times more likely to be stopped by the police compared to White drivers, and when stopped are 1.5-2 times more frequently searched – though White drivers are more likely to be carrying drugs, guns, or illegal contraband (Pierson et al. 2020). A disproportionate share of the people who are shot and killed at traffic stops are Black (Patterson et al. 2020). This means that for roads to become a truly safe place for all members of a community, changes in policing will be needed in addition to shifts towards multimodal transportation systems.

Economy

Expanded access to multi-modal transportation can increase economic mobility for the most vulnerable and improve economic outcomes for businesses, land can be used for more valuable purposes through reduced need for large parking lots, and loosened zoning restrictions can maximize economic benefits from multimodal transportation systems

Expanded access to transportation is expanded access to economic opportunity. High-wage jobs are increasingly concentrated in hubs that promote knowledge sharing, and limited transportation options to these places can limit who can access these jobs (Moretti 2012; Glaeser 2010). Service industry jobs that are located outside of a city center and remain unconnected by public transit can also be very difficult to access, with rising housing costs that price low and middle-income groups out of urban housing markets increasing the spatial mismatch between where jobs are located and where workers live (Stacy 2020). Multimodal transportation systems address both challenges. Increasing low-cost, accessible transportation options connects people to jobs difficult to access without a car. Accessible transportation particularly benefits groups that spend higher shares of their income on transit, helping them connect to higher-earning opportunities. Prioritizing non-driving multimodal

transportation systems also reduces the need for highway expansions and parking development and increases the amount of land available for housing densification, in turn making it easier to co-locate housing with good jobs.

Bringing housing and jobs closer together can shorten commutes and shorter commute times are a significant predictor of upward economic mobility (Chetty et al. 2014). A 2012 study showed that among the nation's 100 largest metropolitan areas, a typical job was accessible to only about 27% of its metropolitan workforce by transit in 90 minutes or less (Tomer 2012). Better and shorter commutes can decrease stress, health complaints, and absenteeism from work due to sickness (Costa, Pickup, and Martino 1988).

Adjusted zoning restrictions can maximize economic benefits from multimodal transportation systems. Proximity to a thriving economy, limitations of housing stock, and access to good public transit can cause home values to increase relative to locations equal in other ways. Increasing the overall availability of public transit can help blunt the high variation in housing prices by creating more "good" neighborhoods with access to economic mobility throughout a city. The rise in housing prices can also be checked by pairing affordable housing development with transit development. Inclusionary zoning, requirements for affordable housing in joint development projects, collaboration with affordable housing developers and community-based organizations, as well as funding for affordable transit-oriented development are all key to ensuring the people currently living in a community are not displaced by transit improvements.

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“Persistent congestion in car-dependent communities imposes a geographic constraint on business markets, raises costs of logistics and business-related transportation, and limits firm productivity through reduced employee productivity.”

At present urban areas in the U.S. average between 3 and 8 off-street parking spots per registered vehicle, and freeing up land currently used for parking lots and road space can help keep housing costs down (Victoria Transport Policy Institute 2020). Easing expensive zoning restrictions can also make housing more affordable; Recent evidence points to a “zoning tax” in large coastal housing markets, with restrictive zoning regulations driving up home prices by anywhere from \$50,000 in Boston to \$400,000 in the San Francisco metro (Gyourko and Krimmel 2021). Minimum parking requirements for developers inflate the cost of new developments by requiring larger lot sizes, contribute to urban sprawl, and further entrench car dependency while wasting valuable space to build excessive parking used just a fraction of the time (Bream and Chilton 2017; Shoup 1997). Removing minimum parking requirements, upzoning communities for infill housing, developing transportation-oriented housing, and general efforts at densification are a key pathway by which transportation improvements can deliver economic benefits.

In addition to improving economic access for workers, multimodal transportation systems can improve outcomes for businesses.

Persistent congestion in car-dependent communities imposes a geographic constraint on business markets, raises costs of logistics and business-related transportation, and limits firm productivity through reduced employee productivity (Weisbrod, Vary, and Treyz 2003). Multimodal transportation options expand the labor force available to businesses, and public transport improvements may increase economic productivity if they enable the growth and densification of cities, downtowns, or industrial clusters (Chatman and Noland 2014). Denser areas also offer economic benefits to local businesses - a café in a dense, walkable or bikeable area can serve more customers than the same café where the number of customers is capped by the number of parking spots available. Although local businesses are often concerned that adjustments to make streets more walkable and bikeable will harm revenue by removing parking, a study of six U.S. cities found that walking and bicycling street improvements had either a positive or non-significant impact on retail and food service sales (J. Liu 2019).

Electric vehicles offer savings due to lower fuel and maintenance costs, and at this point investments in EV infrastructure promote adoption twice as well as direct subsidies

Relative to traditional gas-powered cars, EVs can offer significant cost savings over the life of the vehicle for both public fleet owners and individual owners. EVs require 50% less maintenance than traditional combustion vehicles, and can lower fuel costs by \$4,700 or more over the first seven years of ownership, resulting in an overall lower total cost of ownership throughout the lifetime of the vehicle despite a higher upfront cost (Harto 2020). In addition to the many studies that find lower total costs of ownership for EVs, new research has also shown that with the existing federal EV tax credit, many new EVs are now cheaper to own than traditional gas cars on a monthly basis as soon as being driven off the lot (Orvis 2022). While not everyone can afford to buy a new EV, 85% of Americans finance their cars and this study focuses on the monthly costs for financing and owning an EV (Orvis 2022). As recent gasoline price spikes have made clear, there is also a benefit to the reduced volatility of fuel prices. While there is much to be gained in the transition to electric

vehicles, it will also be important to address the manufacturing, repair, and retail workers who will be displaced by the shift away from internal combustion engines, and more work is needed on how to support a just transition.

Broad-based adoption of this emerging technology requires equitable access to charging infrastructure. An estimated 80% of EV charging takes place at home (Blonsky, Munankarmi, and Balamurugan 2021), and renters cannot always ensure home charging access. Investments in public EV charging infrastructure like pole-mounted chargers can help lower barriers to adoption for renters and low-income residents (Werthmann and Kothari 2021). At present public EV charging infrastructure is disproportionately located in high-income areas and investments to expand access have inconsistently accounted for equity concerns (Huether 2021; Hsu and Fingerma 2021).

EV infrastructure investments are particularly important for rural communities that cannot be served as well by mass transit. Transportation electrification is key to realizing health and savings benefits in these contexts, and research shows that given the current stage of U.S. technology adoption, a dollar spent on charging infrastructure is about twice as effective at promoting EV uptake as a dollar spent on EV tax credits (Cole et al. 2021; S. Li et al. 2017; Springel 2021). Targeting federal dollars to these critical investments can advance transportation electrification.



Designing for Equity

DESIGNING FOR EQUITY



CLEAN MULTIMODAL TRANSPORTATION OPTIONS OFFER NUMEROUS BENEFITS that bridge physical and mental health, safety, and the economy, but investments into multimodal transportation systems must be intentionally designed to have equitable outcomes. With thoughtful policy design, non-federal actors can unlock benefits for disinvested communities and marginalized groups.

Community Engagement

Community-engaged and community-led transportation planning enables residents to choose their own goals, strategies and projects. As transportation decisions impact neighborhoods and the daily lives of people who live in them, ensuring that projects grow from resident-identified needs gives community members ownership over changes taking place in their own neighborhoods. Collaborative governance structures that tie together local government, community-based

organizations and residents can be effective in identifying and addressing local needs and priorities (Wang and Lu 2021).

Attention to First and Last-Mile Considerations

For an expansion of mass transit to maximize its impact, the transit rider experience must be safe, comfortable, and accessible from start to end. Benefits are optimized by ensuring a safe and comfortable “first-and-last-mile” journey, which is the distance traveled between a start or end destination and a mass transit hub. Ensuring a safe first-and-last mile journey can be addressed through investments in infrastructure and safety, like sidewalks and lighting. Micro-mobility options like scooters and electric bikes can be integrated with mass transit to ensure first-and-last mile connectivity and access for those across ability and age groups.

DESIGNING FOR EQUITY

Interoperability and Access for the Unbanked

About 15% of U.S. adults do not have access to a smartphone. 14% of Black households were unbanked in 2019, meaning they did not have a checking or savings account at an FDIC-insured institution. 30% of Black households were underbanked in 2017, meaning they had a checking or savings account with an FDIC-insured institution but regularly used alternative financial services such as money orders, refund-anticipation loans, or payday loans (Atske and Perrin 2021; Federal Deposit Insurance Corporation 2017; 2019). All of these realities can make it challenging to access app-based mobility services. Integrating payment systems for micro-mobility options with existing public transit payment systems would help ensure access to micro-mobility options. For example, any traveler, regardless of having a smartphone or bank, could use a single payment card that can be pre-loaded with state funds rather than linked to a bank account.

Modality Considerations

Every mode of transportation offers specific advantages relative to other modes, and these advantages should be considered when designing transportation investments or policies. For example, buses are better for serving areas with dispersed destinations and lower demand, but rail is best at serving commercial and urban centers with concentrated destinations and ridership (Kuby, Barranda and Upchurch 2004). Buses in particular support mobility of transit-dependent and low-income populations. With flexible routes, low infrastructure and capital costs, and wide range, bus service improvements can often offer greater equity benefits than expansions of rail (Litman 2022). Existing roads can also be converted into bus-only lanes, or lanes for buses, emergency vehicles, and commercial delivery trucks. Alternatively, rail projects can be more popular and drive updates to zoning rules. Both rail and bus projects can advance equity if targeted at corridors where they can meet demands of low-income, transit dependent households and reduce disparities of access. Considering the location and needs of

specific vulnerable communities can be helpful in identifying the best modality for a given project.

Progressive Fare Design

Progressive fare-design prioritizes access for low-income community members who need mass transit the most. Mass transit providers frequently offer a monthly pass that is cheaper than buying a fare every day for a month. This payment structure can result in low-income riders with less discretionary income and access to savings paying more for transit than wealthier riders who can afford a monthly pass. “Fare-capping” ensures no rider pays more in a month than the cost of the monthly pass, and can be taken up by mobility service providers across modes and fare structures. Additionally, discounts should focus on people who have the most need, such as low-income children.

Multiple U.S. cities are piloting and implementing fare-free public transit and finding that it benefits both the city and riders. For example, in Olympia, Washington, planners were faced with the issue of fare collection options costing more to collect and process than the actual amount of fare that was collected. After just one month of providing fare-free bus service, the city saw ridership go up by 20% (Hess 2020).

Accessible and Safe Mass Transit Design

Design decisions in mass transit infrastructure can increase ridership by making mass transit safer and more comfortable to use. For example, good lighting can reduce the threat of gendered violence at dark transit stops. The threat of gendered violence can also be avoided by increasing the frequency and reliability of transit service, as these actions can increase ridership and avoid isolated situations. Ensuring that the routes to transit stations and transit stations are designed with elevators or ramps for the mobility impaired can foster more equitable access to public transit. Public transit fare enforcement occurs more frequently in Black communities, and shifting funding from enforcement towards safe and accessible public transit infrastructure would benefit Black communities (Patterson et al. 2020).

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“Special attention needs to be paid to the challenges faced by disadvantaged groups as they navigate transportation environments.”

Accounting for Identity

Special attention needs to be paid to the challenges faced by disadvantaged groups as they navigate transportation environments. For example, disadvantaged racial groups face unique difficulties while navigating transportation environments. Evidence that Black pedestrians experience longer wait times to cross streets and are afforded less space by drivers when crossing the road compared to White pedestrians in identical circumstances suggests that subconscious, implicit biases are influencing driver’s treatment of pedestrians. Transportation planners have a role to play in mitigating the role that implicit bias can have in a driver’s treatment of pedestrians, such as installing clearly marked crosswalks where stopping is perceived by drivers as mandatory instead of discretionary (Kahn 2017). A study in Chicago found that tickets to bicyclists were issued eight times more often per capita in majority Black tracts and three times more often per capita in majority Latino tracts compared to majority White tracts; however, 85% fewer tickets were issued when bike facilities were available, which were less prevalent in Black and Latino neighborhoods (Barajas 2021). This suggests that the presence of bike facilities could help reduce inequitable bicycle citations. As autonomous vehicle usage grows, their algorithms must be trained with balanced datasets to ensure an ability to recognize people of all skin tones (Patterson et al. 2020).

Concerns about safety are especially salient and legitimate for women, particularly low-income and minority women who are more likely to live in high-crime areas, come home from work at off-peak hours, and have more limited transportation

options than affluent women (Loukaitou-Sideris et al. 2009). A survey of Metro riders in Washington DC found that women are nearly twice as likely as men to experience harassment on public transportation (Washington Metropolitan Area Transit Authority 2018). Women take fewer trips, and avoid certain modes of transportation (e.g., walking alone at night) due to these concerns (Ro 2017; Loukaitou-Sideris et al. 2009). Travel to and from transit stations and waiting at these locations, particularly in desolate or poorly lit areas, is the general concern - as opposed to being fearful while on a bus or train - though overcrowded transit vehicles also register fear. Incorporating these perspectives and experiences into design and planning of transit environments is important (Loukaitou-Sideris et al. 2009).

Filling in Data Gaps

Decision makers should be vigilant of data gaps about the travel patterns and needs of different groups, particularly for marginalized groups. For example, although women make up the majority of public transit users, there are significant data gaps regarding their travel patterns (Goodyear 2015; Badstuber 2019). There is ample data available about travel patterns for there-and-back commutes to jobs, but women are still disproportionately responsible for care-taking tasks that often require “trip-chaining,” or complex travel patterns that involve picking up children or running errands in addition to traveling to work. More can be done to gather information on these patterns and incorporate them into transportation planning (Badstuber 2019).



Conclusion

CONCLUSION



C

COMMUNITIES ACROSS THE UNITED STATES CAN LEVERAGE IIJA FUNDING to modernize their transportation systems by expanding options for walking, biking, public transit, and EV use. Such investments can improve physical and mental health, deliver safe streets, increase economic opportunity, and deliver more equitable communities while reducing carbon pollution. Achieving these benefits will require both federal and non-federal leaders to take bold, coordinated action.

A greater emphasis on walking, biking, mass transit, and EV use can significantly reduce local air pollution, which represents the greatest environmental health risk in the United States, while simultaneously providing an opportunity for increased physical activity and the benefits associated with exercise. Improved street design can prevent the all-too-common tragedy of

avoidable road fatalities in the U.S. Multimodal transportation and improved zoning and land use planning can also expand mobility and economic access, making safe, convenient, and comfortable travel less dependent on access to a vehicle. Rural areas with lower population density can benefit from investments that support zero emissions vehicles, which help improve air quality and offer cost savings over the life of the vehicles, while improved road design would make driving a safer activity and on-demand shuttles would increase mobility for non-drivers in rural areas.

States, tribes, cities, towns, universities, and businesses across the United States can make use of IIJA funds to improve local transportation in ways that benefit all people in a community.

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