

Project No. J-11/Task-43

# Health Impacts of Public Transportation

DRAFT FINAL REPORT

Prepared for  
Transit Cooperative Research Program  
Transportation Research Board  
of  
The National Academies of Sciences, Engineering, and Medicine

TRANSPORTATION RESEARCH BOARD  
OF THE NATIONAL ACADEMIES OF SCIENCES, ENGINEERING,  
AND MEDICINE  
PRIVILEGED DOCUMENT

This report, not released for publication, is furnished only for review to members of or participants in the work of the CRP. This report is to be regarded as fully privileged, and dissemination of the information included herein must be approved by the CRP.

Kate Bridges

Steer Davies & Gleave

December 2024

Permission to use any unoriginal material has been  
obtained from all copyright holders as needed.



Report

December 2024

# TCRP J-11 (043) Health Impacts of Public Transportation: Draft Final Report

---

Prepared by:

Steer  
800 Wilshire Blvd. Suite 1320  
Los Angeles, CA 90017

In partnership with  
Equitable Cities LLC and  
The Stellaire Group

1 213 425 0990  
[www.steergroup.com](http://www.steergroup.com)

Prepared for:

Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001

Client ref: TCRP J-11 (043)  
Our ref: 24308101

## Contents

<b>Executive Summary</b> .....	<b>i</b>
How to Use this Document .....	i
Key Insights .....	i
<b>1 Introduction</b> .....	<b>3</b>
Project Background .....	3
Research Objectives .....	3
Study Approach .....	4
How to Use this Document .....	6
<b>2 Defining Key Terms</b> .....	<b>7</b>
Why Words (and Definitions) Matter.....	7
Foundational Terms and Definitions .....	7
<b>3 Health Impacts of Public Transportation</b> .....	<b>12</b>
Health Impacts Associated with Public Transportation .....	12
Frameworks for Understanding Health Impacts .....	21
<b>4 Embedding Community Health in Decision-Making Processes</b> .....	<b>26</b>
How health can be embedded into transit agency decision-making .....	28
How transit agencies can make more strategic decisions to influence community health ...	34
Examples from Case Studies.....	38
<b>5 Measuring Health Impacts</b> .....	<b>45</b>
Physical Activity and Related Health Outcomes.....	46
Safety Impacts .....	47
Access to Destinations and Services.....	49
Economic Impacts .....	50
Environmental Impacts .....	51
<b>6 Communication Tools</b> .....	<b>52</b>
<b>7 Conclusions</b> .....	<b>56</b>

Public transportation contributes to diverse health benefits. .... 56

Transit agencies should promote health through goals and objectives. .... 57

Health impacts and methodologies should be fit-for-purpose. .... 57

Partnerships between transit agencies and health can help address gaps and build  
knowledge and support..... 58

**8 References .....59**

## Figures

Figure 1. Influence of transportation decisions on the leading causes of death in Oregon (from the Oregon State Population Health Indicators Report). ..... 21

Figure 2. Bus Rapid Transit (BRT) Scope Pathways Diagrams..... 23

Figure 3. Links between transportation and health ..... 24

Figure 4. Conceptual Framework Connecting the SDoE, Structural Tools, the SDoH, and Health and Quality-of-Life Outcomes ..... 25

## Tables

3.1: Summary of health impacts and relevance to transit agencies ..... 13

5.1: Types of Transit Investments and questions to explore related health considerations ..... 29

5.2: Health considerations during the project lifecycle..... 32

5.3: Health Impact Assessment Example: Using Strategic Goals and Objectives ..... 40

5.4: Health Impact Assessment Example: Evaluation Framework ..... 43

4.1: Methodologies to measure health impacts and related social determinants of health ..... 46

4.2: Methodologies to measure safety impacts ..... 48

4.3: Methodologies to measure access to destinations and services ..... 49

4.4: Methodologies to measure economic impacts ..... 50

4.5: Methodologies to measure environmental impacts ..... 51

A.1: Summary of Selection Criteria..... 2

## Appendices

### A Case Studies

- A Health Impact Assessment of Proposed Public Transportation Service Cuts and Fare Increases in Boston, Massachusetts
- Linx Blue Line Cross Sectional Studies in Charlotte, North Carolina
- South Central Neighborhoods Transit Health Impact Assessment
- Southern New Mexico Transportation Matters
- The Rails & Health Study in Portland, Oregon

## Executive Summary

Transportation and public health professionals increasingly cite the health benefits of public transportation as a rationale for increased strategic investments in public transportation networks and for associated improvements in the safety and design of transit-oriented communities. The concept of health – for individuals and communities – is expansive. Current public health discourse links mental and physical health to a wide range of factors that influence quality of life and well-being. Investments in public transportation bring both direct benefits to individuals and communities, and also work in complex ways to influence health indirectly through various levers or social determinants. These benefits can result in improved health outcomes in multiple dimensions: directly to individuals from increases in physical activity; indirectly to individuals through access to economic, educational, and social opportunities; as well as population-level reductions in negative environmental and safety impacts associated with automobiles.

### How to Use this Document

This study explores the myriad health impacts linked to public transportation and different models for understanding how public transportation influences health outcomes available in academic and policy literature, with a focus on five case studies.

The research was synthesized into the following resource to satisfy research objectives and designed to help transit agencies and partners:

- Understand key terms and concepts related to public health, public transportation, and equity that underpin current discourse in these fields and inform the research (**Chapter 2**);
- Summarize the research linking health impacts and public transportation and the pathways by which public transportation can directly and influence health outcomes (**Chapter 3**);
- Embed health benefits and impacts of public transportation into effective transportation decision-making processes at different phases of project planning (**Chapter 4**);
- Explore potential approaches to quantifying and measuring different health impacts (**Chapter 5**); and
- Communicate the health benefits of public transportation to decision-makers, strategic partners, and the public (**Chapter 6**).

### Key Insights

The following conclusions emerged through the course of this research:

*Public transportation contributes to diverse health benefits.*

The health benefits of public transportation accrue to both individual transit users and the broader community. The physical and mental health benefits associated with increased physical activity and cost savings associated with lower car ownership and use are well-documented in the literature. But benefits can also be realized by people who do not use transit, for example, the environmental and safety impacts of reduced automobile use. Benefits related to access to opportunities and resources that ultimately contribute to improved health outcomes are less studied and less-well understood, but no less important in the planning and provision of public transportation.

It is important to recognize that the provision of public transportation does not guarantee a change in travel behavior. Reduced fares, investments in more frequent and connective service, integration with other modes, and transit-oriented development augment and improve the customer experience and encourage actual mode shift helping to realize these health benefits. Deliberate and intentional strategic maintenance, investment, and on-going evaluation of existing public transportation system is required, or benefits may not materialize.

*Transit agencies should promote health through goals and objectives.*

Public transportation agencies provide vital services to people and communities, particularly those who have and continue to experience structural oppression, poverty, and other barriers to opportunity that create health inequities. Public transportation is a social determinant of health that connects people to essential aspects of life, including schools, jobs, homes, and recreation areas. Frequent, reliable, and affordable public transportation is therefore essential to the health of individuals and communities. Transit agencies should acknowledge their role in advancing and realizing better community health outcome by promoting specific health-related goals and objectives throughout the project life cycle and for a range of different transit investments.

The process of building a strategic case for public transportation investments itself can be a community and stakeholder engagement tool to increase support among decision-makers and the public. Stakeholder engagement is often a requirement or mandate for state and federal funding, but public transportation agencies should recognize that community-driven processes can provide opportunities to validate evidence, educate and inform, and build partnership and coalitions.

*Health impacts and methodologies should be fit-for-purpose.*

Health benefits are complex. Factors that influence health, especially those related to community wellbeing, stability, and access to social and cultural resources, may be more complex to quantify, but are no less important. The challenges in quantifying health benefits arise for a variety of reasons including limited availability and reliability of personal data related to health, challenges conducting research over long periods and document long-term outcomes, and difficulty in removing or narrowing study focus to remove external factors.

Public transportation agencies likely don't have the resources to identify, quantify, and measure every health impact associated with a proposed public transportation investment. The more actionable approach involves identifying specific health impacts and outcomes that are most relevant to the local and regional context and developing a study or case for investment that provides the best estimation of benefits for that purpose. This requires understanding local health issues and the priorities of community members, local public health professionals, and key decision-makers (e.g., elected officials).

*Partnerships between transit agencies and health organizations can help address gaps and build knowledge and support.*

Transit agencies can and should collaborate with a variety of partners that can help them study, assess, and communicate the individual and community health benefits of public transportation investments. These include, but are not limited to, public health agencies, universities and other research institutions, and non-profit organizations.

# 1 Introduction

---

This chapter introduces the background and purpose of the study and describes how transportation agencies can navigate and use this document to understand and incorporate a holistic view of health into their planning and decision-making processes.

---

## Project Background

Transportation and public health professionals increasingly cite the health benefits of public transportation as a rationale for increased strategic investments in public transportation networks and for associated improvements in the safety and design of transit-oriented communities. Although automobiles provide day-to-day mobility for many people, reliance on gasoline and diesel-powered automobile has caused negative impacts to air quality and distorted urban form in a way that is an impediment to other modes of travel.

Investments in public transportation bring an array of benefits to individuals, including more reliable transportation options and reduced dependency on automobiles. These benefits can also result in improved health outcomes for individuals and communities: directly from increases in physical activity, and indirectly through access to economic, educational, and social opportunities, as well as reductions in environmental and safety downsides associated with automobile reliance.

## Research Objectives

The objective of this research is to develop a practical, evidence-led resource for public transportation agencies and their partners that focuses on the health benefits of public transportation.

The resource is intended to:

- Present best available research on the health benefits of public transportation in urban, suburban, and rural areas including, but not limited to, the physical and mental health of transit passengers, air and noise quality of communities, access to destinations that address the social determinants of health (such as work, grocery stores, healthcare, education, and green space), and improved safety.
- Address equity considerations and barriers regarding the health benefits of public transportation for all communities and for current and potential transit riders.
- Identify improvements that public transportation agencies and their partners can implement to further increase health benefits and mitigate the adverse health effects of public transportation.

- Identify data, methods, and potential metrics that can be used to measure and track the health benefits of public transportation.
- Provide actionable communication tools for use by public transportation agencies and their partners in a format that can easily be conveyed to the public, transportation planners, and decision-makers (including policymakers and funders) on the health benefits of public transportation.

## Study Approach

The analysis included in this report is based on a review of literature and case study research intended to provide a summary of research on health impacts of public transportation to date as well as its application in real-world examples across different contexts in the United States.

### Key Definitions

Preliminary research included the collation and synthesis of industry definitions for ‘public transportation’, ‘health’ and ‘equity’, and related terms to help create a shared understanding of terms that underpin the study findings. In most cases, these definitions were based on those used by federal health and transportation agencies. In some cases, the definitions were refined with additional nuance and input from the panel to emphasize clarity, provide context and specificity, and generate belonging and inclusivity.

### Review of Academic and Policy Literature

The academic and policy literature review was central to analysis contained in this report. The literature review focused on peer-reviewed studies that examined the health benefits and impacts of public transportation. Upon employing an initial keyword search that involved “health” and “public transportation” or “equity,” with additional variants there were more than 5,000 potential references. However, for the purposes of this study, it was important to narrow the search criteria to articles that focused on public transportation and the interactions with health outcomes and equity.

Given the applied nature of this study, we were specifically interested in review articles that summarized to date about health impacts. We therefore adjusted our search parameters to include combinations of key words such as “Public transportation + Public Health NOT COVID-19” and “Public transportation + health equity” within the United States in the last 20 years.

Once these necessary search parameters were applied, we found approximately 16 review sources and 45 additional unique studies that met our criteria and were appropriate for inclusion in the study. These evidentiary sources included academic studies and policy literature. The section, “Health Impacts of Transportation,” provides a summary of the evidence gleaned from the literature review that links health impacts to public transportation in ways that reflect our focus on public transportation, health and equity in the United States over the last 20 years.

### Real-World Examples

To complement the literature review, five case studies were developed for this report to illustrate how methods for measuring various health impacts of public transportation have been applied within the United States in different geographies (urban, rural and suburban) and to different transit modes.

- A Health Impact Assessment of Proposed Public Transportation Service Cuts and Fare Increases in Boston, Massachusetts
- Linx Blue Line Cross Sectional Studies in Charlotte, North Carolina
- South Central Neighborhoods Transit Health Impact Assessment, Phoenix Arizona
- Southern New Mexico Transportation Matters
- The Rails & Health Study in Portland, Oregon

To identify this set of case studies, the research team reviewed more than 20 studies linking health impacts to public transportation. These studies were identified by members of the research team, an internet search, and suggestions from the project panel. Potential case studies were reviewed against five criteria related to the stated objectives of this study: describe key health benefits, address equity considerations, identify added health benefits, incorporate quantitative methods and performance metrics, and provide examples of useful communication tools.

The case studies provide information that is synthesized throughout this report. Full case study summaries providing helpful real-world applications of this material are included in **Appendix A** of this report.

### **Acknowledging Limitations**

The research team acknowledges that the information presented herein, focused on the results of the academic and policy literature review, contains limitations as a result of a “streetlight effect” in the research to date. The “streetlight effect” refers to the tendency among scientists and researchers to focus on particular questions for reasons of convenience (such as data availability) and show preference for using established frameworks and methodologies (Freedman 2010).

Some relationships are studied more than others for a variety of reasons, including the ease of finding data to explore specific relationships, the existence of political support for certain kinds of research, and the availability of funding is available for certain areas of inquiry. Relationships between phenomena are studied – or not studied – for a variety of reasons. However, just because a study exploring a relationship between phenomena doesn’t exist or cannot be located, it does not mean the relationship does not exist. This simply indicates a gap in the research.

Similarly for this study, it is important to acknowledge that the literature review conducted is limited by the studies that have been conducted or located. However, this is not an indication that other kinds of relationships between health impacts and public transportation do not exist. It simply means that, more than likely, they are simply underexplored. As with much in transportation-related research (particularly when it comes to exploring links between transportation and health), there are many gaps and potential relationships that as of today have yet to be investigated or published in the peer-review or grey literature.

As will be explored in this report, some linkages between public transportation are easier to quantify and measure and therefore may be more prevalent in the literature than other, less understood relationships. This does not mean that health impacts and methodologies that appear less frequently in the literature are less meaningful to issues of public transportation and health.

## How to Use this Document

This report is organized into six chapters to response to the research objectives and provides public transportation agencies and their partners with an understanding of the range of health benefits and impacts associated with public transportation, the tools and methods that can be used to measure them, and ways that this information can be applied to decision-making processes.

1. **Introduction** – provides an overview of the purpose of this study, the study methodology and the contents of the report.
2. **Defining Key Terms** – provides foundational definitions for equity, health, and public transportation, as well as important related terms used by practitioners and researchers.
3. **Health Impacts of Public Transportation** – summarizes the range of health impacts linked to public transportation and how they influence individual and community health.
4. **Embedding Community Health in Decision-Making Processes** – explores how transportation agencies can apply this information when making strategic investments in transit and build support for transportation investments.
5. **Measuring Health Impacts** – explores approaches to quantifying and measuring health impacts and the most relevant themes for public transportation agencies.
6. **Communication Tools** one-page resources that can be adapted to different audiences to communicate health information to decision makers, key partners, and the public.
7. **Conclusions** – provides key insights from the research and areas for future study.

In addition, **the Case Study Summaries** (Appendix A) demonstrate how health impacts can be used to support transit investments and provide valuable insights pre- and post-project.

## 2 Defining Key Terms

The following chapter establishes definitions for several key terms and related concepts used throughout this report and explains why a clear understanding of health, public transportation and equity and related concepts matter during the planning process. These definitions are intended help transit agencies communicate within their organizations, their partners, and the public.

### Why Words (and Definitions) Matter

Defining key terms is critical to create clear parameters for the research activities associated with this study and to ensure there is a shared understanding of terms that underpin the study findings in this report. For example, public health – an essential lens through which this report was developed – utilizes a holistic definition of “health” to fully encompass broader determinants of health (i.e., policies, systems, and environments). This more holistic definition can reveal highly impactful, population-level opportunities and investments that can ultimately improve health that go beyond individualized health outcomes.

It is important to remember that words matter. Specifically, the ways that research – and researchers – define key terms are important to ensure clarity, provide context and specificity, and generate belonging and inclusivity. Defining terms sets parameters (i.e., what we mean and what we don’t) and informs what we intend to measure, how, and for whom.

But more importantly for the purposes of this study, words and definitions convey *values* that can guide public transportation project outcomes and provide compelling, cogent, and socially just reasons for investing in public transportation. By using public health, health equity, and transportation equity lenses to articulate terms such as “public transportation” and “health,” we can work to ensure that the research included in this report is robust, inclusive, and encompasses the full range of impacts and benefits afforded by public transportation on the health of diverse communities and individuals.

### Foundational Terms and Definitions

Several specific terms and definitions were used to ground the report and guide its focus, structure, and scope, many of which are based on definitions used by government agencies such as the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO). In some cases, these definitions have been amended (and often expanded) to better reflect: an evolution and expansion in how we characterize “health” (especially in the years since

the CDC and WHO definitions were published), new understandings and conceptualizations of terms related to health and transportation, and the goals of this report and their application to community and transportation planning.

## Health

Complete physical, mental, emotional, and social well-being. Health is more than the absence of disease or sickness; it allows people to meet their needs, realize aspirations, cope with the environment, prosper and live full, fruitful lives. Health has traditionally been viewed from a personal perspective, focusing on health outcomes of individuals. However, as discussed below, it is also important to consider health at a community level.

This definition combines definitions from both the CDC and the WHO. These definitions speak to a state of being or an outcome. This research acknowledges that state of being has not yet been achieved and looks to better understand what barriers to health exist within public transportation and what benefits it provides to bring users closer to a state of health.

### *Community Health*

Common definitions of health often focus on the physical or emotional and social state of the individual. Public health research, however, emphasizes broader outcomes for populations and communities. This report will explore how public transportation influences social determinants of health and their influence on the health of communities.

This research uses a definition of ‘community health’ developed by Porter and Pamukcu (2025) with references to Jones (2014):

An expansive and inclusive conceptualization of health and well-being that focuses on communities broadly rather than solely on individuals alone. Community health requires addressing many drivers and root causes of health outcomes, which include the social determinants of health and the social determinants of equity. Community health is complex and multifaceted. It can be influenced by a wide variety of factors, including social, physical, and political environments; public and organizational policies; historical events and contexts; and levels of civic participation, political advocacy, and community power.

### *Social Determinants of Health*

The social determinants of health acknowledge that environments, systems, and cultures have a large influence on health that goes beyond individual behaviors and conditions.

The US Department of Health & Human Services, Office of Disease Prevention and Health Promotion (2023) defines the ‘social determinants of health’:

The conditions in the environments where people are born, live, learn, work, play, worship, and age affect a wide range of health, functioning, and quality-of-life outcomes and risks. Domains of the social determinants of health can include economic stability, education access and quality, health care access and quality, neighborhood and built environment, and social and community context.”

## Public Transportation / Public Transit

This following is an expansion of the definition provided in the Federal Infrastructure Investment and Jobs Act Plan (2021) to include modes that serve specific user's daily travel needs.

Regular, continuous shared-ride surface transportation services that are open to the general public or open to a segment of the general public. This includes modes that serve daily travel needs such as fixed-route bus, commuter rail, subway, light rail, or ferry; demand-response public transportation (dial-a-ride), traditional and deviated fixed route services (e.g., shuttles, circulators) or ADA complementary services: and vanpool or reimbursement programs provided that these programs are publicly funded.

This excludes intercity passenger rail and bus services serving recreational and tourism markets; charter bus service; school bus service; sightseeing service; courtesy shuttle service for patrons of one or more specific establishments; or intra-terminal or intra-facility shuttle services. For the purposes of this study and our focussed literature review, the definition also excludes active transportation and micromobility services – however these services may be publicly funded and could also provide known health benefits.

## Equity

Health impacts are not experienced equally or uniformly between people. Social determinants of health and social determinants of equity (Jones 2014) underscore the importance of access to and use of public transportation services. Therefore, by explicitly naming equity, this research can investigate the relationships between public transportation, health, and equity.

For the purposes of this report, 'equity' means:

The consistent, systematic, fair, and impartial treatment of all individuals; a state in which someone's race, background or identity do not predict their quality of life. Achieving equity requires removing social, economic, contextual, institutional, systemic, and structural barriers and addressing the ongoing or pervasive impacts these barriers have caused, providing everyone what they need to thrive. *Equity is not the same as equality.* Equality assumes that everyone is at the same starting point and has faced the same circumstances and challenges. Equity fundamentally requires treating some people differently and providing people with resources according to their needs. Ultimately, to treat all people equally – and to ensure they can reach universal goals of health and well-being for all – we must treat people equitably. Equity has three requirements: (1) valuing all individuals and populations equally, (2) recognizing and rectifying historical injustices, and (3) providing resources according to need. Equity-related efforts can and should be led by individuals, agencies, and institutions that have dominant power – particularly government agencies and staff – to create and memorialize policies, practices, and processes that prevent or undo exclusion and harm (Coalition of Communities of Color).

This definition includes and combines definitions from World Health Organization, US Department of Transportation Equity Action Plan (2024), Jones (2014), Coalition of Communities of Color, and Porter and Pamukcu (2025).

### *Health Equity*

This definition is used by CityHealth (2021) and again emphasizes the structural barriers to Health Equity.

Health equity means all people, regardless of race, background, identity, or ability, have a fair and just opportunity to live their healthiest possible lives – in body, mind, and community. Achieving health equity requires eliminating health and health care disparities, removing social, economic, contextual, institutional, systemic, and structural barriers to health, and a commitment to prioritize those affected by historical and contemporary harms.

### *Transportation Equity*

This definition is adapted from USDOT resources on Equity in Transportation (2023).

Equity in transportation seeks fairness in mobility and accessibility to meet the needs of all community members. A central goal of transportation is to facilitate social and economic opportunities by providing equitable levels of access to affordable and reliable transportation options based on the needs of the populations being served, particularly populations that are traditionally underserved. It is important to note that transportation equity does not mean equal. Equitable transportation considers the circumstances impacting a community's mobility and connectivity needs.

In addition, transportation equity can be understood as a process and outcome (Dadashova et al. 2024):

- Provides meaningful opportunities for underserved communities to participate in the transportation decisions that affect them;
- Allocates resources based on communities' needs and priorities, with the aim of addressing existing disparities and removing the effects of past and present-day discrimination;
- Fairly distributes benefits and burdens of transportation policies, plans, projects, and funding between individuals and groups that differ by race, socio-economic status, ability, age, gender, and other social factors that produce disparities; and
- Aims to protect and increase the benefits—with an emphasis on safe access—for underserved communities, especially Black and Indigenous communities with low socio-economic status.

### *Social determinants of equity*

As a principle, equity acknowledges that individuals and communities have been impacted differently by circumstances, historical events, and contexts designed to intentionally advantage some, while unjustly and intentionally disadvantaging others. Those who have been unjustly disadvantaged now require a disproportionately greater allocation of resources and opportunities to help them achieve universal outcomes of optimal health and well-being (Porter and Pamukcu, 2025).

For the purposes of this report, 'social determinants of equity' means:

Systems of power that govern the distribution of resources and populations through decision-making structures, policies, practices, norms, and values that often operate as social determinants of inequity by differentially distributing resources and populations (Jones 2014). The social determinants of equity include (but are not limited to) structural racism and discrimination, sexism, nativism, ableism, ageism, heterosexism, cissexism, and poverty.

## Justice

Justice is a principle that captures the twin moral impulses that animate public health: to advance human well-being by improving health and to do so particularly by focusing on the needs of the most disadvantaged (Gostin and Powers 2006).

For the purposes of this report, the definition of ‘justice’ means:

Justice embraces the requirements for equity that all individuals and populations are valued equally, historical injustices are recognized and rectified, and resources are provided according to need (2) but goes a step further by repairing and transforming circumstances, structures, contexts, and systems themselves so that they are equitable by default (Porter and Pamukcu 2025). While equity-related efforts are typically led by individuals, agencies, and institutions that have dominant power (e.g., government agencies), justice-related efforts must be led by communities that are most impacted by structural racism and other forms of systemic inequity and oppression, as justice is tied to self-determination and autonomy in decision-making (Coalition of Communities of Color). Government agencies and staff can and should be partners in justice-related efforts, but they cannot lead or be decision-makers with regard to these efforts.

### *Transportation Justice*

Transportation justice refers to the elimination of inequities in mobility and interconnected systems (equity) as well as a transformative and liberating redistribution of power, resources, and opportunities (justice) to those experiencing the greatest inequities today to ensure that all transportation system users and enjoy the same access to safe, reliable, equitable, sustainable, and affordable transportation options (Portland Bureau of Transportation, 2024).

### *Mobility Justice*

Mobility justice is a vision for a world rooted in social justice where people feel safe existing on the streets and can build lives experiencing the full joy of movement regardless of their race, religion, background, or physical ability (America Walks 2023). Mobility justice demands that we fully excavate, recognize, and reconcile the historical and current injustices experienced by communities – with impacted communities given space and resources to envision and implement planning models and political advocacy on streets and mobility that actively work to address historical and current injustices experienced by communities (The Untokening 2017).

## 3 Health Impacts of Public Transportation

This chapter summarizes the literature reviewed as part of this study linking public transportation investments to a broad range of health impacts. The purpose of this chapter is to equip agencies with the baseline information needed to understand myriad ways in which the provision of public transportation can promote or undermine individual and community health, as well as the diverse pathways by which public transportation investments influence these outcomes.

### Health Impacts Associated with Public Transportation

A growing body of health and transportation related research recognizes that the provision of public transportation can have important effects on health and health equity as well as the need to better align health and transportation goals at the local, state and federal level (Health Affairs Health Policy Brief 2021). To do so requires an understanding of the many pathways linking public transportation to broader health outcomes. The following section summarizes these links based on a review of academic and policy literature. It is important to note that:

- The provision of public transportation does not guarantee a change in travel behavior. Reduced fares, investments in more frequent and connective service, integration with other modes, and transit-oriented development augment and improve the customer experience and encourage actual mode shift. These considerations work synergistically to magnify the benefits of public transportation and minimize the downsides that may also occur. Therefore, without deliberate and intentional strategic maintenance, investment, and on-going evaluation of existing public transportation system benefits may not materialize.
- Some of the health benefits of public transportation are experienced directly by the transit user, such as through better physical and mental health, and cost savings associated with lower car ownership and use.
- Benefits can also be realized by people who do not use transit. For example, the environmental and safety impacts of reduced automobile use accrue to the entire population, regardless of whether each individual uses transit.
- Many of the benefits of public transportation are mediated by the social determinants of health. High-quality transportation options, particularly for people who experience barriers to

car ownership and use, offer access to opportunities and resources that ultimately contribute to improved health outcomes.

For the purposes of this study, impacts are grouped generally into four categories:

- Travel behavior – impacts that are directly linked to an individual’s decision to use transit often mediated through increased physical activity.
- Safety impacts – impacts related to personal and road safety
- Access to destinations and services – impacts related to access to key destinations, service and opportunities
- Environmental impacts – often thought of as externalities, these are impacts to surrounding communities

**Table 3.1** provides a summary of the health impacts identified in this report and the relevance to transit agencies.

**3.1: Summary of health impacts and relevance to transit agencies**

Category	Determinant	Potential Outcome	Relevance to Transit Agencies
<b>Travel behavior</b>	<b>Physical activity</b>	Cardiovascular health Reduced chronic disease Reduced stress	Links between public transportation and physical activity are well documented in the literature. Benefits from physical activity depend on change in individual’s behavior (mode shift, or increased transit usage, and usage of active modes to transit).
<b>Safety impacts</b>	<b>Personal safety</b>	Increased/decreased risk of crime	The relationship between public transportation and personal safety and incidence of crime (including perceptions of) were explored by several studies. Attempts to analyze personal safety and crime can negatively impact communities of color and perpetuate harms. Approaches to quantify and measure safety-related impacts should be explicit about the definitions of “safety” and recognize how personal bias and other social factors (structural racism, poverty, classism) interact with “safety” externalities.

Category	Determinant	Potential Outcome	Relevance to Transit Agencies
	<b>Traffic safety</b>	Reduced casualties and fatalities from vehicle collisions	Reductions in automobile use as a result of increased transit usage can reduce the incidence of vehicle-involved collisions. Improvements in traffic safety as a result of public transportation investment also depend on the degree of mode shift from vehicle usage and the quality of street design around transit stations. For example, increased transit usage could also lead to pedestrian involved collisions if conditions around stations lead to unsafe pedestrian-vehicle conflicts.
<b>Access to destinations and services</b>	<b>Access to health-related services and destinations</b>	Access to transportation network Access to medical services Access to recreational/green spaces Access to healthy food sources	Improvements to healthcare access also depend on other factors (such as health insurance); however, transit agencies can incorporate health-related focus into their service planning efforts by considering healthcare destinations such as pharmacies, urgent care, hospitals, outpatient clinics, and specialist medical facilities.
	<b>Access to economic and educational opportunities</b>	Access to jobs Access to education	Access to economic and educational opportunities are crucial to improved health outcomes for individuals and communities. These social determinants of health have a circular relationship; they lead to increased access to other social determinants. This area of research could benefit from further study, to understand the complex relationship between high-quality public transportation services and access to economic (job) and educational opportunities at the neighborhood, city, county, or regional levels.

Category	Determinant	Potential Outcome	Relevance to Transit Agencies
	<b>Access to social networks</b>	Access to social networks Access to public spaces and social interaction	Research has focused on the connection between different dimensions of public space and the ability to foster social interaction. The role that public transportation plays in this is less well-documented; but transit agencies can focus on efforts to integrate transit and land uses.
<b>Environmental impacts</b>	<b>Air quality</b>	Reduced air pollution and greenhouse gas emissions	Reductions in air pollution and greenhouse gas emissions associated with a reduction in automobile use benefit transit riders and non-riders alike. Approaches to measuring air quality impacts broadly align with tools and approaches used for environmental impact analysis. Local and regional data is often available; however, it can be difficult to isolate the effects of public transportation from other external variables.

**Travel Behavior**

*Physical Activity*

Individuals who use public transportation in place of driving may increase their physical activity through active transportation modes (e.g., walking, biking, rolling) which can improve both physical and mental health. The relationship between public transportation and physical activity, and associated health benefits, is well-established in the literature reviewed for this study. Roughly two-thirds of the sources reviewed addressed physical activity and its implications (Knell et al. 2018, Xiao et al. 2019, CDC 2023, Frank et al. 2019, Miller et al. 2015, Durand et al. 2016, Lee et al. 2023). In some cases, physical activity is used as a proxy for health outcomes; in other studies it is clearly identified as a determinant that influences more specific health conditions such as obesity (body mass index) and other chronic diseases.

Some studies compared cohorts of individuals living near new light rail and bus rapid transit (BRT) services, with control groups of individuals who did not, to demonstrate that living near quality transit services can lead to induced physical activity (Frank et al. 2019, MacDonald et al. 2010).

Other studies have focused on population-level effects. One study compared rates of public transportation -related walking in MSAs with and without rail infrastructure and found that transit walkers added a median of 20 minutes of physical activity per day walking to transit, and that roughly 30 percent of transit walkers obtained more than an added 30 minutes per day (James et al. 2014). Another study examined commute to work variables with state level prevalence of

obesity, finding that automobile usage contributed to these outcomes while public transportation usage negatively impacted these outcomes (Chen and Menifield 2017).

Research has also focused specifically on children (adolescents), reporting that moderate-to-vigorous physical activity is positively associated with frequent public transportation use across all observed adolescent racial groups and genders (Granado et al. 2021).

Substantial research has also explored the influence of the built environment on increased physical activity, specifically variables such as intersection density, sidewalk coverage, traffic volumes, and land use mix and others believed to enhance walkability (Metrolinx 2018). The literature review excluded these studies for the most part, but much of the research recognizes the interaction of public transportation with other important planning and design features, such as pedestrian-scale lighting. Increased transit ridership and the use of active modes to access transit can also be influenced by the quality of the service (route, frequency), station area design, and other amenities that make public transportation more attractive to riders.

Chronic health conditions such as obesity, heart disease, and cardiovascular disease can be alleviated by increases in physical activity. Some studies have also shown a more direct link between public transportation usage and these outcomes. For example, rail commuting was directly linked to a decreased rate of all-cause and cardiovascular disease mortality as well as incident cancer (Arizona DHS et al. 2012). Another study that examined the change in obesity rates at the county level related to increased transit funding across the U.S. reported that a 1 percent increase in *frequent* public transportation ridership (defined as equal or greater than riding two times per week) was associated with a 0.47 percent decrease in obesity rates at the county-level while average obesity rates increased (She et al. 2019).

Several studies linked use of public transportation usage to reductions in stress associated with driving, as well as other stress-reducing social determinants of health such as access to social and recreational activities and greater community cohesion (Litman 2020, Wener and Evans 2007). However, public transportation has the potential to incur its own stressors, including those associated with crowding, long wait times, and perceived threats on transit. Measures to address these negative impacts were associated with improved mental wellness (Bell and Cohen 2009). Additionally, increased neighborhood walkability is also associated with reduced symptoms of depression (Berke et al. 2007).

## **Safety Impacts**

### *Personal Safety*

Several studies discussed the relationship between public transportation and “public safety” (Litman 2020). Public safety encompasses different concepts (feelings of security or crime for example) that should not be used interchangeably.

Personal safety can refer to individual perceptions of security, which are important to transit riders’ physical and mental health. Individual perceptions, however, can also be informed by personal biases.

Some studies reported that increased public transportation leads to decreased crime rates (Litman 2020). Increased use of public transportation and associated walking and biking can generate

more “eyes on the street”, particularly if paired with design enhancements to transit station/stop features, streetscape, and service frequency (Brown et al. 2018). On the other hand, studies have noted that an increase in the number of public transportation users may lead to more opportunities for crimes to occur (Human Impact Partners and UC Berkeley 2012, Brown et al. 2018), such as vandalism, fare evasion, physical assault, and drug use.

Public safety concerns and strategies used to address them can create barriers for historically marginalized individuals and communities to access the benefits of public transportation and even result in negative health outcomes. For example, the use of law enforcement as a security measure on public transportation to address fare evasion negatively affects ethnic and racial groups who experience racial discrimination and police misconduct (Klingbaum et al. 2021). There are also numerous examples of fatal and near-fatal encounters that people of color have had with police over minor infractions or having done nothing wrong at all. Police presence may therefore exacerbate feelings of stress for racialized transit riders and negatively impact their personal safety and ultimately decrease transit usage.

Public safety concerns and strategies used to address them can create barriers for historically marginalized individuals and communities to access the benefits of public transportation and even result in negative health and safety outcomes. For example, the use of law enforcement as a security measure on public transportation to address fare evasion can negatively affect members of ethnic and racial groups who experience racial discrimination and police misconduct (Klingbaum et al. 2021, Carter and Johnson 2023). Research suggests that Black individuals experience disparate rates of police use-of-force and are overrepresented in police-involved shootings (NASEM 2022). Police presence may therefore exacerbate feelings of stress for racialized transit riders and negatively impact their personal safety and ultimately decrease transit usage.

Various organizations and transit agencies in cities across the U.S. have considered and published information on the relationship between safety and public transportation, noting the urgent need to reconsider approaches to police enforcement and ensuring safety for all public transit riders that do not introduce additional risks and perpetuate harms (TransitCenter 2021).

### *Road Safety*

Traffic safety improvements depend on the degree of mode shift and the quality of street design around transit stations.

Several studies reviewed referenced crash safety as a health benefit, including reductions in motor vehicle crashes (Litman 2020, Williams et al. 2021) and bicycle and pedestrian-involved crashes (Litman 2020, Williams et al. 2021). The Victoria Transport Policy Institute notes in their 2020 report that strategies that shift drivers to public transportation or active modes are highly effective in that they reduce time in a car, and therefore the possibility of an accident (Litman 2020).

It is important to note that pedestrian injury exposures could increase in the vicinity of a new transit station or one with poor pedestrian access. Street and station design features to improve pedestrian access are required to achieve these health benefits.

## Access to Destinations and Services

Public transportation can provide critical access to jobs, educational opportunities, social and recreational opportunities and other goods and resources that provide benefits to individual and community health. Access to these goods and services is critical, particularly for those who are transit dependent or face barriers to using other modes. The following section explores evidence in the literature linking public transportation to resources, services and opportunities linked to social determinants of health.

### *Access to Healthcare Services*

Public transportation services which provide transit riders with improved access to healthcare services, including doctor's appointments, medical treatments, mental health services, and substance abuse services, can directly and profoundly improve health outcomes, particularly for those who are chronically ill, or require routine medical treatment, such as dialysis patients (Litman 2020, 10, Williams et al. 2021, Frank et al. 2019). For both those with and without disabilities, a longitudinal study of adults in Australia showed that rates of general practitioner visits were higher with greater public transportation availability (Arcury et al. 2005).

It is important to note that an increase in healthcare visits does not necessarily mean better quality healthcare. A variety of outcomes and factors also influence healthcare access and utilization, including access to health insurance and medical providers that accept those insurance policies (James et al. 2014).

Emergency services are a subset of healthcare related services that appear less frequently in the literature. One source noted that public transportation can provide decreased evacuation time to safe areas and shelters in emergency situations especially for high-hazard areas (Williams et al. 2021).

Healthcare cost may serve as another indicator of overall health outcomes, although the relationship between public transportation usage and healthcare costs was mixed. One of two studies that reviewed these effects reported that those who used light rail transit more than three times per week were associated with the lowest relative overall healthcare costs, including outpatient services and medication costs (Rep 2021). Indirectly related to healthcare costs, two studies which examined the impact of public transportation access on health care showed that higher public transportation availability and lower transportation barriers were associated with fewer prescriptions and fewer emergency department visits, respectively (Wolfe et al. 2020, Arcury et al. 2005).

### *Access to Healthy foods and Destinations*

Access to healthy foods is often defined by physical proximity to full-service grocery stores or farmer's markets, which have the means to offer fresh, perishable foods that provide key nutrients for physical and mental health. Specifically, research has shown that access to high quality, nutritious food can result in a lower body mass index and decreased likelihood of diabetes and other diet-related diseases (Arizona DHS 2015).

Public transportation can provide access to healthy foods, especially for residents and community members who may not have access to such foods by other modes. In their HIA of the Phoenix

Light Rail Transit Extension, the Arizona Department of Health Services found that study participants cited transportation time and costs as contributing to food insecurity, especially for single parent working families and adults with chronic conditions or disabilities (Arizona DHS 2015).

Two studies also referenced access to “health-promoting destinations” as a benefit to public transportation (Litman 2020, Frank et al. 2019). These include destinations that may not be used for direct medical care, but nonetheless promote physical and mental health such as green spaces, places of socializing and recreation preventative health centers (Frank et al. 2019).

#### *Access to Economic Opportunities*

Several studies note the importance of access to economic opportunities, particularly jobs (Williams et al. 2021, Metrolinx 2018). American urban patterns tend to place disadvantaged communities far from job centers. Without practical, effective transportation, low-income users are either cut off from economic opportunity, or are forced to endure long commute times, which infringes on sleep, time to access health care, and other factors that affect health.

In addition, reductions in transportation costs can reduce financial burdens and allow individuals to invest in housing, healthy food, and medical care (Litman 2020, Williams et al. 2021).

Efforts to ensure housing affordability near transit lines may be necessary to mitigate transportation inequities caused by gentrification and displacement, which can occur as unintended consequences of introducing transit service in low-income communities. A literature review on the neighborhood-level impact of new light rail service in urban areas in Canada and the U.S. indicates that introducing new public transportation service may indirectly result in negative health outcomes due to the influence of the new service on the social determinants of health (Klingbaum et al. 2021). Specifically, the article notes several impacts, including increases in residential property values which impact housing quality, increases in median household income which impact neighborhood racial makeup and population growth, new business openings which impact employment density, and improved neighborhood perception which impacts sense of community. In addition, the review authors reported that the introduction of new light rail service resulted in an overall decline in transit ridership, especially if bus service was decreased as a trade-off.

This area of research could benefit from further study, to understand the complex relationship between high-quality public transportation services and access to economic and educational opportunities.

#### *Access to Social Networks*

Two review articles also cited benefits to mental and physical health as a result of improved community cohesion (Allen 2008) and access to social and recreational activities (Appleyard et al. 1981). Access to recreational activities can also lead directly to improvements in physical activity.

#### *Heat-Related Illness*

As a public service, access to transit vehicles and stations themselves can provide critical cooling services especially for transit riders with existing conditions that make them vulnerable to heat (Arizona DHS et al. 2012). This linkage was highlighted in health impact assessments but did not

emerge in the academic literature. The same may also be true for transit riders experiencing extreme cold conditions.

### **Environmental Impacts**

Although automobiles provide a major form of day-to-day mobility for many people, high levels of automobile use and a lack of alternative transportation options can also have negative impacts. Automobile use has been associated with many negative externalities, including air pollution and greenhouse gas emissions, community severance, and increased traffic fatalities. Investments in public transportation that make transit more competitive with driving have the potential to reduce the downsides associated with dependence on automobiles. The degree of the effect, however, also depends on the mode and the scale of the mode shift. Different transit modes, such as bus, light rail, and heavy rail may incur their own negative externalities. Similarly, while transit service likely results in better overall regional air quality, there is risk that transit riders in highly polluted corridors may be exposed to more air pollution.

#### *Air Quality*

Approaches to measuring air quality impacts broadly align with tools and approaches used for environmental impact analysis; however, it can be difficult to isolate the effects of public transportation from other variables.

Several studies also linked the provision of public transportation to the reduced exposure to air pollutants, which are associated with increased respiratory and cardiovascular problems, as well as the development of cancer (CDC 2023, Rep 2019, Thomas et al. 2022). One study, however, also found that public transportation users may be more exposed to air pollutants as pedestrians because of "increased duration of travel" and "increased breathing rates" (Kim et al. 2017).

Increased public transportation usage and the associated decrease in automobile usage can specifically result in lower vehicle emissions (Litman 2020, Williams et al. 2021). Historically, public transportation has a lower pollution per passenger mile than private automobiles. Research also noted that newer and alternative fuel buses produce less emissions than older diesel buses; therefore, the health benefits related to local air quality are augmented by a transition to cleaner bus and rail vehicles.

Notably, the benefits of better air quality affect transit and non-transit riders. These impacts can be seen in the community and the region (CDC 2023, Thomas et al. 2022). Underserved populations are more likely to experience environmental racism such as proximity to toxic industries and highway infrastructure; due to this proximity, these populations are more prone to cardiovascular and respiratory maladies, such as asthma (Thomas et al. 2022, USDOT 2015). Therefore, investments in public transportation that reduce air pollution sources can be used to address past harms.

Greenhouse gas emissions constitute a specific subset of air pollutants that contribute to global warming and are regulated by local, regional, and state governments to mitigate climate change. One study specifically linked increased use of public transportation to decreased carbon dioxide emissions contributing to global climate change and associated health effects (James et al. 2014).

*Water Pollution*

Although not a major health impact, public transportation usage was also linked to better water quality. Specifically, a reduction in automobile use resulted in reductions in particulates found in the sewer system (Brown et al. 2018).

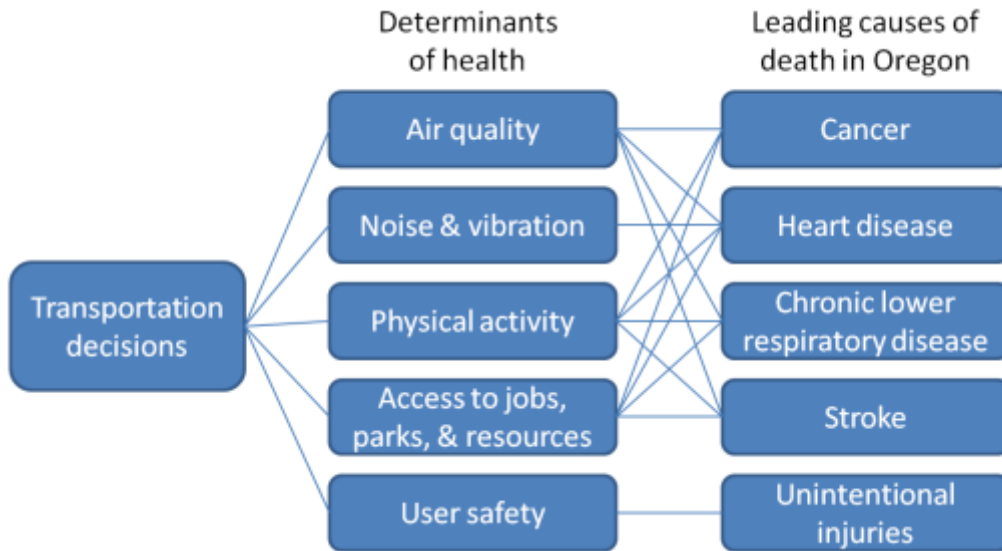
**Frameworks for Understanding Health Impacts**

The following section provides an overview of different conceptual frameworks for understanding how public transportation has been linked directly and indirectly to a range of different individual and community health outcomes. This section includes examples that illustrate how frameworks have been applied to help understand the relationship between health and public transportation and the different pathways by which investments in public transportation can influence individual and community health.

**Example 1: Oregon Transportation and Health Impact Assessments**

The following framework from the Oregon State Health Population Report (Oregon Health Authority, 2014) demonstrates how transportation decisions (including the choice to take public transportation) can influence determinants of health and their relationship to key health outcomes. In this example, researchers mapped transportation decisions to five indicators that are the leading causes of death in Oregon. It illustrates the indirect relationship between transportation decisions and the causes of death, and how determinants of health are linked to varying numbers of causes of death.

**Figure 1. Influence of transportation decisions on the leading causes of death in Oregon (from the Oregon State Population Health Indicators Report).**



## Example 2: BRT Pathways -Mapping Policy Decisions to Health Outcomes

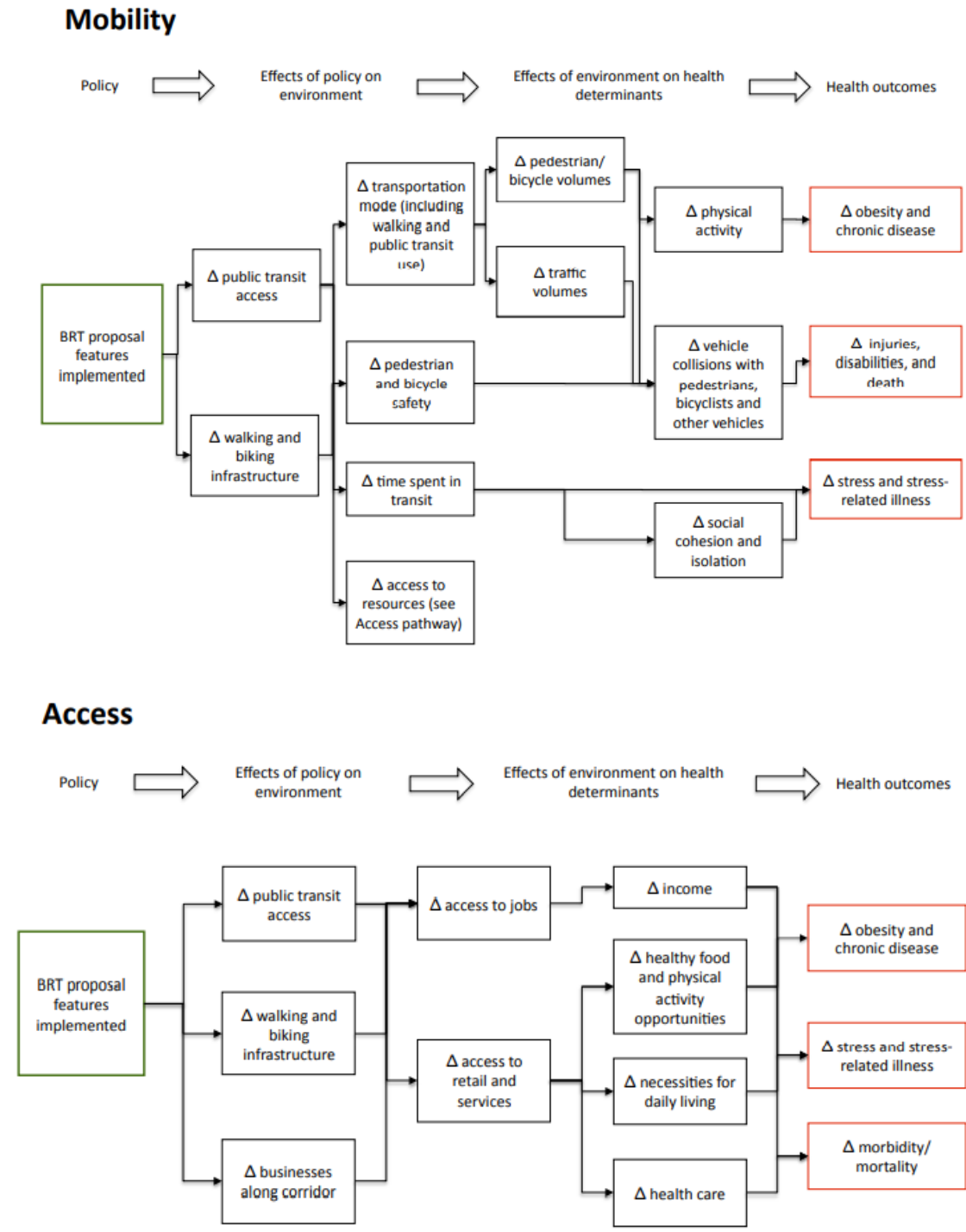
Brown et al. (2018) developed the following several diagrams showing the relationship between investments in new bus rapid transit service and various chronic diseases, injuries and death, and stress and stress-related illnesses for the Health Impact Assessment of Rainier RapidRide Bus Rapid Transit Project.

**Figure 2 Mobility** addresses both mobility and access. Mobility describes how public transportation access and the associated enhancements in active transportation infrastructure can induce physical activity and cause changes in vehicle collisions, levels of social isolation, and access to resources. Importantly, the direction of change in collisions and social isolation is not specified. Without proper infrastructure, an increase in walking and biking to transit could potentially cause an increase in pedestrian- or bicycle-involved collisions. Similarly, the experience of longer transit rides could produce more stress and isolation from social networks. The provision of public transportation does not equate to the provision of good public transportation – reliable, fast, and frequent service for people to get where they need to go.

**Figure 2 Access** presents links between access to the BRT network and health. It expands upon the relationship between access to jobs and other services and the pathways by which these also influence health outcomes.

Both of these diagrams emphasize the indirect chains of causality between a public transportation policy and health outcomes.

Figure 2. Bus Rapid Transit (BRT) Scope Pathways Diagrams

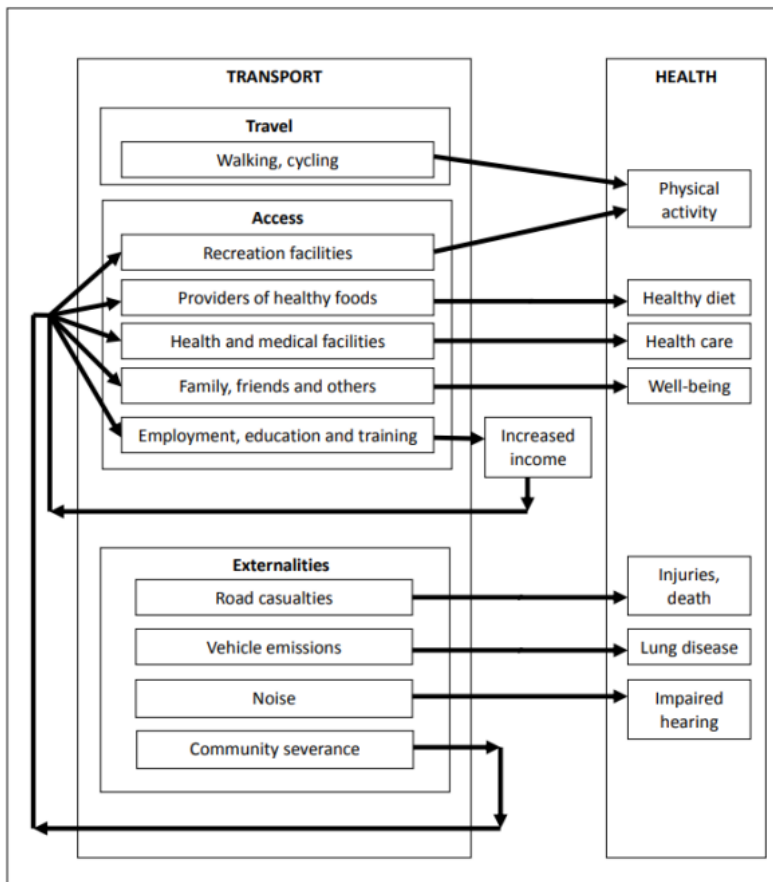


### Example 3: Transportation, Social Exclusion and Health

In a paper published in the Journal of Transport & Health, Mackett et al. (2015) present a model that examines how transportation-related social exclusion influences health. It illustrates direct impacts, such as greater walking and bicycling leading to increased physical activity. It also shows indirect impacts, such as how changes in access leading to certain facilities influence health, and how transportation externalities can be linked to adverse outcomes.

The diagram also acknowledges circular relationships that exist. People with better access to employment, education, and training likely experience increased income, which enables them to gain better access to facilities or reallocate time and energy for physical activity that can have a positive impact on health. In addition, it shows how community severance is an externality that can, in turn, hinder access.

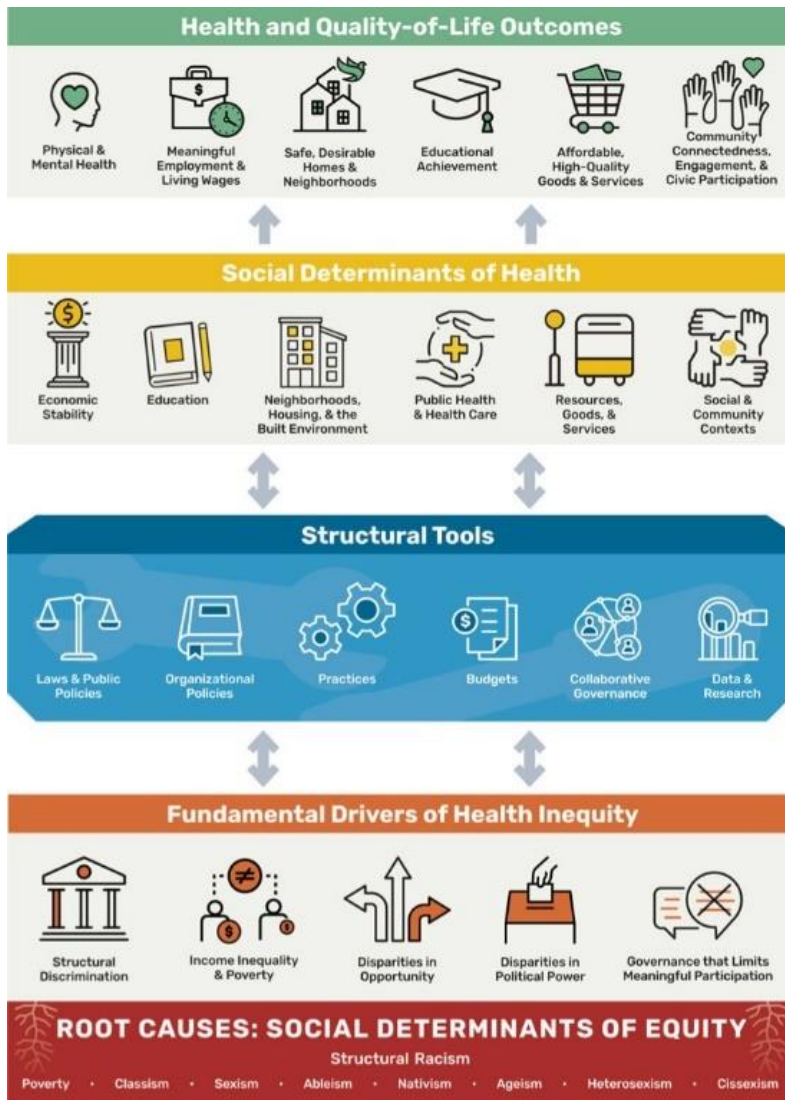
Figure 3. Links between transportation and health



**Example 4: Linking Social Determinants of Equity to Social Determinants of Health and Health Outcomes**

In contrast to the previous examples, Porter et al. (2021) developed an equity-focused model in the *Journal of Public Health Management and Practice* linking the fundamental drivers of health inequity to health and quality-of-life outcomes (Figure 4). This model illustrates how investments in public transportation can be aligned with other structural tools, to influence social determinants of equity, social determinants of health, and ultimately health and quality-of-life outcomes. In addition, it highlights the two-way relationships between social determinants of health, structural tools, and fundamental drivers of health inequity.

**Figure 4. Conceptual Framework Connecting the SDoE, Structural Tools, the SDoH, and Health and Quality-of-Life Outcomes**



## 4 Embedding Community Health in Decision-Making Processes

---

The purpose of this chapter is to build upon the research presented on health impacts and explore directly how transportation and public health professionals can incorporate this information into the planning and decision-making processes.

---

This chapter provides practical information to explain why community health matters to public transportation agencies and where health considerations emerge in planning processes across different project types and planning stages. The chapter also features examples from case studies to show how strategic goals and performance measures may be used to plan and evaluate transit projects.

---

“Health is a positive outcome that can be actively promoted.” (Miller et al. 2022)

---

Transportation professionals focus on a range of direct and indirect benefits to transit riders when planning or evaluating system improvements: mobility outcomes, mode shift, and access to key destinations and jobs, among others. However, health is a major, fundamental positive outcome that can be actively promoted through thoughtful delivery of public goods and services like public transit.

This chapter explores why health matters to public transportation agencies, how the projects and services delivered by transit agencies could better support public health, and how to incorporate health considerations into these agencies’ plans and decisions.

*Community health as a concept is expansive and a vital component to quality of life.*

Community health and wellbeing are critical components to overall quality of life. Public health professionals understand “health” broadly in terms of integrated well-being, whereas professionals in other sectors may be more inclined to view health solely through the lens of illness, disease and medical care (Miller et al. 2022). An expansive, holistic definition of health also draws more connections with public transit services as a determinant of health. Public transit services enhance individual and community mobility, providing access to critical social,

educational, and economic opportunities. Models of public health<sup>1</sup> and associated research have shown that access to these opportunities can improve physical and psychological health.

*Health benefits are intertwined with other social determinants of health.*

The relationship between public transit and economic, environmental, social and equity benefits is often touted as a reason to invest in public transit. Health benefits are intertwined with all these benefits. Transit agencies typically rely upon being able to communicate specific benefits to advocate for new or continued investment in public transit – including benefits that may come from a major capital investment in a new service, or increasing the span or frequency of existing services, or electrifying fleets. However, each of these benefits are also connected to potential health benefits for communities. By understanding these relationships, transit planners can build stronger, more compelling cases for investments in public transit. By drawing clear connections between public transit and the full range of social determinants of health, transit agencies can provide a comprehensive and compelling picture of how transit is a social determinant of health that can provide immense benefits to people and communities.

*Groups who experience barriers to mobility also experience more health problems.*

Public transit agencies have increasingly sought to bring an equity focus to their planning and decision-making activities, demonstrating that more disadvantaged groups must receive their fair share of service compared to more advantaged groups. As defined in previous chapters of this report, equitable planning processes seek to address existing disparities, achieve a fair distribution of benefits and burdens, and involve meaningful participation in transportation decisions by people from underserved communities.<sup>2</sup> In some cases, these communities must receive a disproportionately larger share of the benefits associated with transit service provision given historic and contemporary underinvestment in access for more disadvantaged groups. Many of the same people who lack access to reliable and accessible mobility options – addressed through the provision of public transit – are the same people that suffer disproportionately from negative health outcomes, like exposure to high levels of pollution from automobiles, communities severed by highways, higher rates of cardiovascular disease and obesity, less access to healthy foods, and so on. Therefore, by focusing on provision of public transit to these communities, transit agencies can also work to address long-standing sources of structural inequity and inequality.

*Health benefits from public transit are good for everyone.*

Investments in public transit that benefit public health do not just accrue to those who use transit. These benefits also provide larger net health benefits to neighborhoods, communities, and regions. By recognizing the link between public health and public transit, public transit agencies can be better positioned to secure community, political, and funding support, all of which are necessary to advance these vital services.

---

<sup>1</sup> Models of public health and explicit definitions of community health and social determinants of health are included in the interim report. This information will be discussed in earlier chapters of the final report and therefore are not repeated here.

<sup>2</sup> Krapp, Agustina, Transportation Equity Project Prioritization Criteria. <https://hdl.handle.net/2142/108931>

## How health can be embedded into transit agency decision-making

Planning for improved community health can be incorporated into decisions that span many project types throughout a project lifecycle.

Transit agencies undertake a range of activities associated with planning and implementing projects, as well as day-to-day management and operations. “Making the case” for transit investments can mean convincing community members to support a revenue measure aimed at raising funds for capital or operating expenses for new or expanded services. It could also mean generating support from an agency’s own board for changes in fare policies that make services more affordable and accessible for areas that need transit service the most.

Across these circumstances, opportunities for using health benefits to influence decision-making emerges in two scenarios:

- **Decisions to allocate capital or operating funds to transit agencies.** Transit agencies need to make decisions about how to spend capital and operating funds, or whether to pursue additional capital and operating funds to deliver key investments. Health benefits can bolster strategies and efforts to build coalitions of support around transit investments, whether among decision makers internal to the transit agency or broadly among community members, elected officials, federal and state agencies, and other partners.
- **Choosing among or prioritizing different options.** Transit agencies can incorporate health benefits into the planning, design and operations of services in a way that maximizes the benefits of investments. Evaluation frameworks can be developed to compare different investment options and assess their effectiveness at delivering specific health benefits that are prioritized by communities and other key parties.

### Decision Use Cases

The ways in which health can be incorporated into these decision-making processes will vary depending on the specific project type of transit investment being considered and the stage of the project lifecycle that it falls within. The following section explores different types of transit investments and lifecycle considerations.

*Can health be a key outcome (goal) of its own or is it related to other goals?*

Relevant to all of this is a core tension between whether health should be elevated to a specific desired outcome (goal) or whether it falls under the umbrella of other outcomes. Ultimately, there are benefits associated with both ways of thinking, and the appropriate course of action will depend on the specific context, project, and priorities of transit agencies and the communities they serve.

*Types of public transit investments*

The types of transit investments being considered will influence the types of health impacts that transit agencies focus on, as well as the strategies they choose to advance their goals. For example, including health outcomes as an explicit goal in decision-making should present itself early in the long-range planning process for capital investments. At this stage, when significant

resources will be recruited and community input obtained, it is important to think expansively about health as it matters to different audiences – particularly communities that will be most impacted by these investments. Conversely, in the context of annual budget planning, agencies may be focused on a narrower set of health outcomes that are linked to day-to-day operations (for example, what staff mix do you need and where will you need to deploy them?).

**Table 5.1** provides a series of questions to help guide planning processes for different types of investments in transit infrastructure, services, facilities and policies.

**4.1: Types of Transit Investments and questions to explore related health considerations**

Types of investments	Description	Health-related Considerations
Major capital investments (e.g., new service, new infrastructure, new facilities and stations, and/or new vehicles)	Major capital investments involve the planning, design and construction of new heavy rail, light rail or high-frequency fixed-route bus services. This also includes introduction of new bus, ADA complementary paratransit, or dial-a-ride routes or stops.	<ul style="list-style-type: none"> <li>• What kinds of overall health benefits could be unlocked by this investment?</li> <li>• What destinations (job centers, health services, outdoor and cultural spaces) could be served to maximize health outcomes?</li> <li>• What level of service is required to produce different levels of benefits?</li> <li>• How can land use be integrated with transit to minimize community severance, gentrification, and support ridership?</li> <li>• How will this investment affect access to healthcare services – and other services related to health, like access to job centers and educational institutions – especially for underserved or marginalized communities?</li> <li>• Will the benefits of the new service or vehicles be distributed equitably among different demographic groups, including those historically marginalized or disadvantaged and mobility-limited?</li> </ul>
Expansion or reduction of service	This includes changes to existing service, such as increasing or reducing service frequency, hours of operations, and changes to stops served.	<ul style="list-style-type: none"> <li>• How do changes in levels of service affect different groups?</li> <li>• What destinations and level of service are required to maximize benefits?</li> <li>• Are there opportunities for community input and feedback to ensure that the changes align with the needs and priorities of diverse populations?</li> <li>• Are there strategies in place to mitigate potential unintended consequences of the changes, such as increased wait times or decreased service quality for certain groups?</li> </ul>

Types of investments	Description	Health-related Considerations
Maintenance of Business As Usual (BAU) Service	Day-to-day management and operations activities, which may be accounted for in the annual budget.	<ul style="list-style-type: none"> <li>• What resources are needed to operationalize health benefits?</li> <li>• How can health impacts be captured even at the quantitative level in transit agency annual reports?</li> <li>• What kinds of partnerships with public health professionals could support better delivery of transit services?</li> <li>• Are there disparities in access to the current service, and if so, what measures are in place to address them?</li> <li>• Does the BAU service adequately meet the needs of all demographic groups, including those historically underserved or marginalized?</li> </ul>
Fare policy and media changes	Changes in fares and fare media can affect whether public transit is an affordable option for many riders.	<ul style="list-style-type: none"> <li>• What is the typical housing/cost burden of transit customers and how do changes in fare policy affect this?</li> <li>• If monetized, how do health benefits of affordable fares compare with the cost of subsidy?</li> <li>• How will fare policy changes impact the affordability of public transit for individuals with low-incomes or from underserved communities?</li> <li>• Are various discounts and concessions available across different fare media?</li> <li>• Are there strategies in place to provide financial assistance or subsidies for individuals who cannot afford the increased fares?</li> <li>• Are there mechanisms in place for ongoing community input and feedback to ensure that fare changes align with the transportation needs and priorities of diverse populations?</li> </ul>
Fleet upgrades	Upgrades in vehicle fleets may include replacing older vehicles with newer models or changes in power source.	<ul style="list-style-type: none"> <li>• Do vehicle upgrades allow changes in platform height, all-door boarding and ensure greater accessibility across the transit network for people with disabilities?</li> <li>• Are lower or zero emission vehicle options available that could reduce greenhouse gas and other emissions?</li> <li>• Are upgrades being targeted in areas that have the most need based on key indicators?</li> <li>• How will the fleet upgrades be distributed across different routes and neighborhoods?</li> <li>• Are the fleet upgrades environmentally sustainable and do they contribute to reducing emissions and improving air quality in communities, particularly those disproportionately affected by pollution?</li> </ul>

Types of investments	Description	Health-related Considerations
Station area and facilities improvements	Station area improvements can include a variety of physical enhancements to make stations safer and more navigable for transit riders.	<ul style="list-style-type: none"> <li>• How can station area improvements improve access to a diverse range of users, including people with different types of disabilities?</li> <li>• How can stations be enhanced to provide greater comfort and safety to transit riders?</li> <li>• How well integrated are transit stations with other active modes to encourage people to walk, bike or roll to stations?</li> <li>• Are there amenities such as seating, shelters, restrooms, and public art that enhance the overall experience for passengers of all ages and backgrounds?</li> <li>• Have community members, including residents, businesses, and advocacy groups, been engaged in the planning and design process for station area improvements?</li> </ul>
Supportive policies	It is essential to examine how existing and proposed policies can promote fairness, accessibility, and inclusivity for all members of the community.	<ul style="list-style-type: none"> <li>• How do supportive policies ensure equitable access to public transit services for all demographic groups, including low-income individuals, seniors, people with disabilities, and marginalized communities?</li> <li>• Do supportive policies include fare subsidies, discounted passes, or income-based fare structures to ensure that public transit remains affordable for all residents, regardless of their socioeconomic status?</li> <li>• Do supportive policies prioritize the implementation of universal design principles and accessibility standards to ensure that public transit infrastructure, vehicles, and services are accessible to individuals with disabilities?</li> <li>• How do supportive policies prioritize investments in underserved neighborhoods and communities with limited access to public transit?</li> <li>• Do supportive policies include investments in agency staff such as driver training, health-certified station ambassadors, to health-related pop-ups?</li> </ul>

### Project Lifecycle Considerations

Similarly, questions about health outcomes may vary depending on where the project sits in the lifecycle. The following **Table 5.2** explores different health considerations during the project lifecycle.

#### 4.2: Health considerations during the project lifecycle

Project Stage	Health Considerations
<p><b>Long-term/ strategic planning</b></p>	<ul style="list-style-type: none"> <li>• During the long-range planning stages, it is helpful to think broadly about the types of health benefits that may be unlocked by an investment and the best ways to maximize those benefits.</li> <li>• Potential health impacts will likely be forecasted using modeled data that can be benchmarked against observations from previous projects.</li> <li>• At this stage, transit agency staff should consider the best way to capture desired health outcomes, particularly health outcomes that are community-focused (e.g., decreased air pollution, reduced traffic congestion, equitable access to job and educational opportunities, etc.) in strategic goals and objectives.</li> <li>• It may also be helpful to monetize benefits, when possible and appropriate, to compare how investments in public transportation may lead to other returns.</li> </ul>
<p><b>Community Engagement</b></p>	<ul style="list-style-type: none"> <li>• Efforts to engage communities that are affected by changes in transit investments and activities should be cross-cutting. Transit agency staff must meaningfully, intentionally, and equitably engage community members – particularly those that live in areas or are part of communities that will be directly impacted by a project – early and throughout the project lifecycle from initial planning, to design, implementation, and post-implementation.</li> <li>• Engagement efforts that bring community members and partners in to identify health benefits can be successful at rallying community, political, and funding support. Transit agency-led efforts intended to engage communities and address equity issues can also connect to, bolster, and uplift community-led justice efforts related to public transit advocacy and community organizing.</li> <li>• It is also critical to collect qualitative data – e.g., stories, lived experiences, interviews, etc. – from community members, as these data sources can provide key insights that inform the specific health-related community priorities on which transit agencies should focus their strategies and approach.</li> <li>• Community-based organizations that have been organizing around and advocating for better transportation access and affordability likely already have these kinds of data, and transit agencies can partner with (and fund) these organizations to collect, analyze, and interpret these kinds of data.</li> </ul>

Project Stage	Health Considerations
<b>Design</b>	<ul style="list-style-type: none"> <li>• During the design phase, transit agency staff can think more strategically about what destinations, levels of service, and other considerations can help advance the goals of a decision, which should be defined during the strategic planning phase.</li> <li>• It may be necessary to disaggregate health information and analysis at different scales: for example, corridor, route, or stop level depending on the types of investments or policy options being developed.</li> </ul>
<b>Alternatives Analysis/Evaluation and Environmental Review</b>	<ul style="list-style-type: none"> <li>• During alternatives analysis, transit agency staff can assess how well different options may compare with respect to health goals and objectives.</li> <li>• For instance, some health data may be related to the environmental impacts and therefore may be linked to available estimates of reductions in VMT, pollutants and greenhouse gas emissions for each alternative.</li> </ul>
<b>Funding</b>	<ul style="list-style-type: none"> <li>• Funding considerations emerge at different phases of the project lifecycle but can be closely linked to the delivery phase. Transit agency staff may consider a range of different funding sources that require different timescales, for example:                         <ul style="list-style-type: none"> <li>– Ballot measures (for example for local sales tax funding)</li> <li>– Grant applications</li> <li>– Funding allocations – state, local, federal funding</li> </ul> </li> <li>• The health benefits of a project could be helpful during the application process to make the case for funding awards; the nature of the health benefits may be linked to specific grant or funding partners, their mission and key concerns, and the policy intent behind the funding source.</li> <li>• If feasibility of a project is linked to specific funding sources, it is worth incorporating the health considerations at the long-range/strategic planning phase.</li> </ul>
<b>Delivery</b>	<ul style="list-style-type: none"> <li>• How will construction activities disrupt neighborhoods (noise, traffic flows, air quality, bike and pedestrian movements) and how can those be mitigated?</li> <li>• Are there adequate policy safeguards in place to prevent displacement of residents and businesses, particularly in areas that have significant populations of communities of color and other underrepresented populations?</li> <li>• Does the project require temporary transit service to ensure continued access for people reliant on transit services?</li> </ul>
<b>Operations/Maintenance</b>	<ul style="list-style-type: none"> <li>• Maintaining transit services requires ongoing decisions about operations and maintenance with potentially fluctuating funding sources (for example revenues, grant sources).</li> <li>• It also requires maintaining a state of good repair to ensure safety of the system.</li> </ul>

## How transit agencies can make more strategic decisions to influence community health

Transit agencies can identify explicit goals and objectives that support the realization of positive community health outcomes. These should be linked to performance metrics to support evaluation frameworks and show progress towards these goals.

### Formalizing Health through Strategic Goals and Objectives

Public health professionals recognize health data has often been used to evaluate existing actions or programs after they have been implemented, but less commonly at the beginning of decision-making processes when it is necessary to plan for future investments (Miller et al. 2022). To successfully integrate health into decision-making for short, medium, and long-term transit actions, transit agency staff should identify explicit goals and objectives in their project or program strategy and assess how they are linked to specific health issues and challenges that are priorities for their respective communities.

In addition, many state and federal agencies, including the Federal Transit Administration and USDOT include key terms such as equity, sustainability, safety, resiliency, and connected communities in their mission statements; concepts which are drivers and social determinants of health. Transit agencies can demonstrate their alignment with state and federal initiatives while promoting health by incorporating health-related concepts into their own organizational mission and goals.

**Strategic goals** define the key drivers for achievement of a vision or strategy. They identify desired outcomes (such as new ridership, economic growth, access to opportunity, or improved health).

**Strategic objectives** are the priorities which, undertaken together, organize the actions needed to help realize those goals. Strategic objectives ultimately determine what successful achievement of a goal will look like and should therefore be specific, measurable, and time-oriented to demonstrate how they support public and community health.

Together, the goals and objectives (for a project, program, or even organizational plan) establish the plan or strategy to achieve the vision over a defined timeframe. They are further used to identify specific actions for implementation and performance measures.

#### *Tips for developing strategic goals and objectives:*

- Begin with a clear understanding of values – what is most important to the transit agency, community, health partners and funding partners, and what is most needed to achieve that vision?
- Develop goals/outcomes that best articulate those values and preferences and can highlight trade-offs between choices or options during evaluation.
- Simplify and prioritize goals and objectives over a defined timeframe (for example). Ask the question, “Do I have too many objectives?” A focused, digestible, and streamlined plan will be

delivered more successfully than a complicated strategy that attempts to incorporate everything.

### Identifying Performance Measures

Evaluation frameworks are an integral part of project or program planning that allow agencies to answer questions central to the decision-making progress:

- Will this investment deliver health (and other benefits)?
- Which investment will deliver the most benefits and carry the least risks to deliver?
- Can these benefits be monetized and how do they compare with the financial costs to deliver the project?
- Has an investment made an impact on stated health goals and objectives?
- What is the status of the project/program/organizational strategy – has an agency achieved its stated goals and objectives?

### Utilizing Evaluation Frameworks

Evaluation frameworks require transit agencies to identify specific performance metrics that illustrate key benefits, impacts or trade-offs associated with an investment. When incorporated into a strategic plan, these performance metrics that are measured using qualitative and quantitative data should be linked to specific strategic objectives and actions as benchmarks and used to determine progress toward objectives and strategic goals.

This can occur for different planning purposes and at different stages of project lifecycle, for example:

- Long range/strategic planning efforts to determine whether a new public transit capital investment is worth advancing to the next stages.
- Comparing different projects and or phasing plans to prioritize transit investments across a network.
- During the grant application process, to demonstrate how a project performs against criteria established by a funding agency.
- During a post-project evaluation, to highlight ways that a project did or did not deliver on health outcomes. This could be done to report back on the success of transit program or be conducted with academic partners to better understand linkages between health and transit investments. In turn, the results from post-project evaluations can then be used to inform the estimation of health impacts of future projects.

*Tips for selecting performance measures:*

- Understand the context of the evaluation framework – is the tool being applied to forecast potential health benefits or to report back on outcomes using observed data?
- Differentiate between performance measures that will be used to track overall progress of the work (management metrics) versus those that will be useful to report back or communicate to community members (a primary audience, given the impact of public transit decisions on their daily lives) and other key audiences.
- Assess decision-maker bandwidth and policy agendas – aim to have a mix of metrics that align with key policy decisions and those that support considerations at the staff level.

- Be sure to prototype the framework - imagine two options and ask: does this help make the case? Does this help differentiate between options?

Governments and agencies often use Benefit-Cost Ratios (BCRs) as a key metric to understand the value for money of an investment. A BCR generally compares the total monetized benefits of an investment/project to the monetized costs. However, projects that deliver high equity benefits compared to others may not score as well as projects that deliver larger overall benefits and lower equity benefits. One approach to account for this is to consider equity benefits to costs individually. But overall, agencies that rely on BCRs should consider weighting equity benefits/considerations more highly in transit decision-making processes. For example, increasing access to transit for persons with disabilities is important for equity and should be given priority, even though it may have a relatively lower BCR score.

### Community Engagement

Professionals in fields across the social determinants of health – particularly those in public health, transportation, and public transit sectors – increasingly recognize that projects, programs, planning processes, and efforts to analyze and interpret “big data” must be grounded in people’s lived experiences and informed by their priorities and preferences *and* they must utilize approaches and practices that advance equity. This is particularly true in places that will be most directly impacted by transit decisions.

Community engagement strategies and activities are cross-cutting and should apply to every all stages of every project; however, community engagement efforts serve a particularly important purpose in understanding the relationships that exist between individual and community health and public transportation decisions. Community members have unique, specific, and deeply practical perspectives on the ways that public transit influences their health, both negatively and positively. By prioritizing community engagement efforts, being intentional and purposeful about obtaining community members’ input and insights, and being communicative with communities throughout all stages of a project – especially regarding how decisions are being made *based on their input and priorities* – transit agencies can gain valuable information related to community health that can make their strategies more effective and persuasive, and also build credibility and trust with communities that will be mutually beneficial for the long-term. Moreover, to compound the effectiveness of transit agency-led approaches to community engagement, transit agency staff should partner and collaborate with community-based organizations who are (and have been for decades) working to advance transportation justice efforts. Transit agency staff should connect to, bolster, and uplift community-led justice efforts related to public transit advocacy and community organizing, as they, community-based organizations, and community members and organizers often have mutual, intersecting goals.

Although it is important to incorporate specific goals and objectives into strategic decision making, an emphasis on “measurement” can result in data collection methods that over-rely on quantitative data. Qualitative data – such as focus groups, co-creation workshops, and meetings with community members at events (e.g., church functions, community events, etc.) – can be equally or more valuable for measurement and implementation efforts. The intersection of public transit and health is an issue that is important to many mission-driven community-based organizations; as such, transit agency staff should engage and partner with local community-based

organizations – particularly community power-building organizations – to facilitate important ongoing dialogues with community members and partners that ensure planning activities address public health issues that are most relevant to the local communities and to ensure that community members’ insights and input (including those related to their health) continually inform the planning and decision-making processes of transit agencies. To continually and meaningfully engage community members and infuse their insights into decision-making strategies, transit agency staff can:

*Build long-term partnerships and trusting relationships with community-based organizations (particularly community power-building organizations) and public health organizations, and other cross-sector partners.*

To reach communities that are or will be most affected by the effects of transit-related decisions and investments (or disinvestments) and community health outcomes, transit agency staff must forge trusting relationships and long-term partnerships with non-profit community-based organizations and public health organizations. Relationships with these organizations – not just for one project, but for the long-term – can help transit agencies obtain invaluable, community-centered input, identify connections between transit decisions and community health that can bolster transit agencies’ strategies and messages, and build support for shared transit-related projects and goals. However, as transit agency staff work to build these relationships, it is essential that they acknowledge the power imbalances that exist when it comes to decision-making and work to shift power (i.e., provide opportunities to make decisions and determine outcomes) to communities and the community-based organizations that represent them whenever possible. Forging strong cross-sector partnerships with community organizations, organizers, advocates, and other government agencies can be crucial to amplify messages, add momentum to transit-related efforts, and build support for transit-specific goals.

*Make time to obtain and understand communities’ contexts, needs, and priorities – including those at the intersection of transit and health, and ensure this time is built into transit agency-led procedures, agendas, and plans.*

As the saying goes, one can only “move at the speed of trust.” With that in mind, transit agency staff should intentionally make time within their planning period to connect with communities that will be most affected to better understand their respective contexts, learn about the connections they see between public transit and health, obtain alignment on priorities and approaches between community members and the transit agency, engage community members in decision-making processes, and ensure that community members are kept informed about the status and timing of project decisions and implementation efforts. This kind of intentional and continued engagement of communities can help transit agency staff make truly community-informed decisions, obtain information that makes strategies and messages more persuasive and community-driven, and manage expectations of communities while encouraging their continued engagement.

*Use diverse and inclusive engagement strategies that prioritize inclusion of under-represented and marginalized groups that most depend on public transit.*

For example, smaller focus groups and workshops may provide better opportunities for people to share detailed experiences and insights, whereas larger “open houses” may be more appropriate

to share back information and project progress with larger audiences. Community-based organizations can be valuable partners in helping transit agency staff determine what engagement strategies are most feasible and appropriate for a given community.

- **Preemptively address participation and engagement barriers** by attending and appearing at events that occur after work hours or on weekends, and by providing childcare, food, and translation and interpreter services. Transit agency staff should also consider offering funds or partnering with community-based organizations to provide transportation to venues to increase accessibility. This can also help convey the value that the transit agency puts on mobility and supporting communities that need assistance the most so that everyone has an opportunity to attend events and share their perspectives.
- **Communicate updates regularly and convey how decisions are being informed by community input.** Transit agency staff should regularly connect with community members – via partners at community-based organizations and other platforms – to share how the insights, feedback, and other qualitative data from community members are being used to inform transit-related plans and decisions. This can involve an array of activities – from sending a summary of the focus group discussions for participant review to affirm what community members have shared, to inviting feedback on preliminary assessment reports, to providing updates that juxtapose what community members have shared with how the transit plan or project will change in response to that feedback. The key is to ensure that transit agency staff convey three elements to the communities they are engaging: (1) We hear you; (2) We affirm and value your input; and (Arizona DHS 2015) This is how we are implementing your feedback.

## Examples from Case Studies

The following examples from case studies demonstrate ways in which agencies and partners could incorporate health outcomes into strategic goals and objectives during project planning. For more real-world examples that use health information to make the case for transit investments see **Appendix A**.

### *Example 1: Extending Light Rail in Maricopa County, Arizona*

The Arizona Department of Health Services (2012) partnered with the Maricopa Public Health Department and local advocacy groups to conduct a health impact assessment to examine the benefits of extending a proposed light rail transit (LRT) network in Phoenix, Arizona. The HIA focused on the impacts to the South Central neighborhood of Phoenix, and specifically highlighted the unique needs of pregnant women; families with children or youth with special health care needs; and adults with chronic conditions. The study focused on six health pathways that were linked to chronic diseases and health conditions prevalent in the community:

- Landscape/shade structures that impact heat related morbidity and mortality;
- Household transportation costs, which affect household income, insurance status, and mobility;
- Employment/entrepreneurship that has repercussions on poverty, insurance, and community safety;
- Housing, which relates to stress and social cohesion;

- Access to resources and services, specifically health services, healthy food, and recreation; and
- Active transportation, automobile usage and transit ridership, including bicycling and walking that impact injury and physical activity.

The case study's proposed approach demonstrates the intricate ways in which public transit influences specific health outcomes and how decisions from early planning stages to delivery to partnerships can work together to maximize health benefits:

- Pathways are linked to local health priorities that were identified by community participants through active engagement with a project-specific insight committee and are therefore specific to the study area and equity priority groups there.
- Pathways encompass a range of health-related impacts and illustrate an expansive definition of community health that ranges from comfort and safety to economic opportunities, to household transportation costs.
- Each recommendation (objective) is linked to a performance measure that could be used to measure progress towards program goals.
- The HIA also identifies responsible parties for each of these recommendations; laying additional groundwork for building partnership to implement the plan.

This case study included a detailed list of recommendations on how the project could maximize health benefits. These recommendations lay out a compelling set of priorities that could be serve as the basis for an evaluation framework to secure funding to advance the LRT project, to compare and select a preferred LRT alternative, or develop a comprehensive delivery roadmap to ensure that the project delivers on strategic health goals and objectives.

**Table 5.3** shows a condensed version of excerpted recommendations to illustrate how the HIA research team considered to link health outcomes to specific interventions.

**4.3: Health Impact Assessment Example: Using Strategic Goals and Objectives**

Pathway	Recommendations (Objectives)	Proposed Performance Measures
Pathway 1: Landscaping, shade structures and safety	Install improved lighting features at bus stops and LRT stations	<ul style="list-style-type: none"> <li>Number of light rail stations that incorporate improved lighting features</li> </ul>
	Explore unique opportunities to increase shade coverage	<ul style="list-style-type: none"> <li>Percent canopy coverage increase within the study area</li> </ul>
	Explore partnerships with local businesses to fund expanded construction of cooling centers	<ul style="list-style-type: none"> <li>Number of new cooling centers retrofitted/constructed along existing and future transit stops</li> </ul>
	Prioritize implementation of Phoenix Compete Streets Policy in and near the study areas	<ul style="list-style-type: none"> <li>Number of proposed and implemented projects in and near the study area</li> </ul>
Pathway 2: Household transportation costs	Expand the promotion and education of the Valley Metro Reduced Fare Program and provide application assistance for those with disabilities	<ul style="list-style-type: none"> <li>Number of enrollees from the study area in the reduced fare program</li> </ul>
	Expand categorical eligibility of Valley Metro Reduced Fare Program	<ul style="list-style-type: none"> <li>Categorical eligibility expansion</li> </ul>
	Offer discounted unlimited ridership passes in longer durations (3-month, 6-month and/or 1-year)	<ul style="list-style-type: none"> <li>Long-term, discounted passes offered</li> </ul>
Pathway 3: Construction, Business Development and Employment	Provide guidance and assistance for existing business retention and new business development along light rail extension	<ul style="list-style-type: none"> <li>Number of new and existing businesses along the light rail extension that receive business assistance</li> </ul>
	Provide walkable/safe travel paths along the construction area, especially for people who may be using assistive devices or travelling with strollers.	<ul style="list-style-type: none"> <li>Number of miles of walkable/safe travel paths along light rail construction</li> </ul>
Pathway 4: Housing Availability, Affordability, Gentrification and Displacement	Prioritize affordable mixed-used, mixed-income, higher density housing development along transit corridors.	<ul style="list-style-type: none"> <li>HUD prioritization/implementation of affordable housing near transit corridors</li> </ul>
	Adopt the Transit-Oriented Development (TOD) overlay district	<ul style="list-style-type: none"> <li>Adoption of a TOD Overlay District for South Central Avenue</li> </ul>
	To minimize displacement, explore a property tax freeze or cap for existing low-income homeowners	<ul style="list-style-type: none"> <li>Establishment of property tax freeze/cap for low-income homeowners</li> </ul>
Pathway 5: Access to Resources and Services	Encourage and incentivize medical practices that accept <b>Arizona</b> Health Care Cost Containment System ( <b>AHCCCS</b> ) to locate along the light rail	<ul style="list-style-type: none"> <li>Number of medical practices that locate along light rail</li> </ul>
	Actively explore funding to open more grocery stores/supermarkets and/or	<ul style="list-style-type: none"> <li>Number of new grocery stores/supermarkets or smaller</li> </ul>

Pathway	Recommendations (Objectives)	Proposed Performance Measures
	encourage smaller convenience stores to offer fresh produce within the study area	convenience stores that offer fresh produce within first year of light rail
	Strengthen community engagement plans and protocols to engage neighborhood residents in the review of bus level of service modifications in the study area	<ul style="list-style-type: none"> <li>• Inclusion of engagement plans/protocols for service reduction considerations</li> </ul>
Pathway 6: Active Transportation	Incorporate enhanced maps and signage for pedestrians and bicyclists at existing and new light rail stops	<ul style="list-style-type: none"> <li>• Number of light rail stations and trains featuring enhanced maps and signage.</li> </ul>
	Implement bike share hub locations near light rail stations	<ul style="list-style-type: none"> <li>• Number of bike share hub locations along light rail extension</li> </ul>

*Example 2: Service Cuts and Fare Increases in Boston, Massachusetts*

Boston's regional planning agency, the Metropolitan Area Planning Council (MAPC), led a health impact assessment with help from researchers at Harvard and Boston Universities to inform decision makers about potential impacts resulting from service and fare cuts in transit service. The HIA (James et al. 2014) evaluated health and economic effects of two fare increase and service cut scenarios in Boston's public transportation system proposed to close a \$161 million budget gap faced by the Massachusetts Bay Transportation Authority (MBTA) in the 2013 fiscal year.

The HIA focuses on seven pathways that lead to negative health impacts that could be readily quantified to meet time constraints, including:

- Time spent in traffic and fuel costs
- Crashes
- Air pollution
- Physical activity
- Access to healthcare
- Carbon dioxide emissions
- Noise

This example highlights a way in which health outcomes can be used to evaluate different policy options and influence decision-making processes.

- Health impacts are analyzed at the regional level; many drawing upon initial calculations such as change in ridership, vehicle miles travelled (VMT), and vehicle hours travelled (VHT) using modelling forecasts for baseline conditions and two policy scenarios.
- The HIA primarily uses existing data sources and methods drawn from established frameworks, guidelines and sources, such as the Physical Activity: Health Economic Assessment Tool (HEAT) from WHO; 2009 National Highway Traffic Safety Administration; American Automobile Association (AAA); Access to Healthcare: American Community Survey (ACS); and Carbon Dioxide Emissions: National Academy of Sciences (NAS), among others.
- The evaluation used quantifiable metrics linked to each of these pathways and then monetized them, showing that reductions in overall transit service would result in roughly \$270 to \$378 million increases in annual health and economic costs. To do so, researchers used industry standard benchmarks (for example the statistical value of life and hospitalizations to monetize mortality outcomes).
- In addition to the metrics used in the evaluation, additional metrics such as overall fare increases and number of trips affected by service reductions were used for communication purposes and to frame the conditions of each scenario.
- The HIA was a partnership with health researchers and professional planners and provided a process for engagement with decision-makers and the public. findings from the report were published and presented at the public hearing held at the Massachusetts State House for the decision in question.

**Table 5.4** shows how the metrics were applied within an evaluation framework.

**4.4: Health Impact Assessment Example: Evaluation Framework**

Evaluations Criteria	Metrics	Tools and Methods
Time spent in traffic and fuel costs	<ul style="list-style-type: none"> <li>• People who shift from transit to driving</li> <li>• Additional person-hours spent in traffic for current drivers</li> <li>• Additional gallons of gasoline/diesel</li> <li>• Cost of additional time spent in traffic</li> <li>• Cost of additional fuel</li> <li>• Additional deaths per year</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Average traffic speed across the region (VMT/VHT) was used to calculate average time spent in traffic and average fuel economy. VMT and VHT were derived from modelling forecasts which show reductions in transit ridership as a result of service cuts and increase in vehicle miles travelled and vehicle hours travelled from baseline scenario.</li> </ul>
Crashes	<ul style="list-style-type: none"> <li>• New deaths per year</li> <li>• Cost of additional crashes</li> </ul>	<ul style="list-style-type: none"> <li>• Used forecasted VMT increases to estimate traffic fatalities by multiplying projected increases in VMT under the two proposed scenarios by the fatality rate per VMT for Massachusetts from the National Highway Traffic Safety Administration (2009).</li> <li>• To estimate the costs of congestion and crashes, multiplied the projected increases in VMT by the cost per VMT of congestion in large urban areas from the American Automobile Association (AAA).</li> </ul>
Air pollution	<ul style="list-style-type: none"> <li>• Additional deaths/hospitalizations due to asthma and select diseases</li> <li>• Cost of additional mortality and hospitalizations</li> </ul>	<ul style="list-style-type: none"> <li>• Uses the MOBILE 6.2 emissions model from US EPA, MassCHIP, CDC, and EPA Benefits Mapping and Analysis Program (BenMAP) to estimate impacts. Source Receptor Matrix from EPA used to estimate changes in the air quality at the county level.</li> </ul>
Physical activity	<ul style="list-style-type: none"> <li>• Change in minutes of walking per day</li> <li>• Change in calories burned per day</li> <li>• New cases of obesity per year</li> <li>• Cost of lives lost to decreased physical activity</li> </ul>	<ul style="list-style-type: none"> <li>• Used National Household Travel Survey data to derive physical activity, obesity, and mortality risk estimates. Simulated different scenarios where driving was increased/transit use decreased using the Physical Activity: Health Economic Assessment Tool (HEAT) from WHO, and National Household Travel Survey</li> </ul>

Evaluations Criteria	Metrics	Tools and Methods
Access to healthcare	<ul style="list-style-type: none"> <li>• Transportation dependent households isolated from healthcare resources</li> </ul>	<ul style="list-style-type: none"> <li>• Used ArcGIS to map healthcare locations and routes that would be affected by cuts. Used infoUSA, data on healthcare locations, Census 2010 data, and the 2006–2010 American Community Survey (ACS) for information about healthcare locations.</li> </ul>
Carbon dioxide emissions	<ul style="list-style-type: none"> <li>• Change in metric tons of CO<sub>2</sub> emitted per year</li> <li>• Cost of carbon emissions</li> </ul>	<ul style="list-style-type: none"> <li>• Used social cost of carbon estimates from the National Academy of Sciences (NAS); midrange estimate of the social cost of carbon (\$31.18 2012 USD per ton) was multiplied by the annual increased carbon emissions from the CTPS transportation models.</li> </ul>
Noise	<ul style="list-style-type: none"> <li>• Change in people who are exposed to &gt;60dB of noise on an average day</li> </ul>	<ul style="list-style-type: none"> <li>• FHWA’s Transportation Noise Model (TNM) was used to estimate noise levels for each traffic analysis zone. Inputs included average traffic volume by transportation analysis zone (VMT/length of roadway in the TAZ).</li> </ul>

## 5 Measuring Health Impacts

---

This chapter explores different methods used to quantify and measure changes in health resulting from transportation-related interventions.

---

Demonstrating a relationship between investments in public transportation and health outcomes requires the ability to quantify and measure changes in health resulting from public transportation-related interventions. Approaches to measuring health impacts can also be used to estimate the potential health benefits of future investments. Methods for measuring health impacts depend on the types of data available, but generally must be clear, robust, and replicable to ensure credibility during the planning and decision-making processes.

The research team reviewed several studies that documented approaches to quantifying and measuring impacts to health – both a change in observed health outcomes and the degree of influence on a determinant of health (for example, increase in access to health services or healthy food sources). The following section provides a review of tools and methodologies currently used to measure the health impacts of public transportation, including:

- Physical activity and related health outcomes
- Safety benefits
- Access to destinations and resources
- Economic benefits
- Environmental benefits

This review excluded methodologies used to calculate mobility and other benefits that were not studied in the context of health outcomes. For example, some of these methodologies linked public transportation to increased tourism or transportation system reliability.

Some key findings from this review include:

- Health impacts linked to physical activity are well-studied, as documented in Chapter 3. As a result, approaches to measuring various health indicators like obesity, Body Mass Index (BMI) and physical activity are prevalent in the literature. In many cases, disaggregated findings are presented by sociodemographic factors like age and race.
- Factors that influence health, especially those related to community wellbeing, stability, and access to social and cultural resources, may be more complex to quantify, but are no less important.

- The review also indicated knowledge gaps and the low quantity of studies that use primary data to evaluate health outcomes, especially disproportionate impacts through an equity framework.

## Physical Activity and Related Health Outcomes

Approaches to measuring and quantifying health impacts use an array of methodologies to understand the relationship between mode choice or transit use specifically, and individual health outcomes, such as physical activity, chronic disease, and healthcare costs as well as other mediating factors such as access to health-serving destinations and services. The most common method observed in the literature includes longitudinal studies using public datasets or agency datasets. These datasets could be self-reported annual surveys, census data, or general clinical surveys. Another method used in the literature was spatial analysis using geographic data variables, such as spatial scales (e.g., census blocks) or locations (e.g., addresses).

### 5.1: Methodologies to measure health impacts and related social determinants of health

Subcategory	Measure	Description	Observations
Physical health (impact)	BMI and obesity	Longitudinal studies that were examined for this report include the impact of frequent public transportation ridership on obesity rates, using annual health data and annual transportation data. Primary data variables were BMI rates and self-reported transit use frequencies. The impact of travel mode to school on BMI and percentage body fat in children. The primary data variables were parent responses on their children’s travel mode to school and the child’s BMI.	Datasets from multiple agencies can be used to examine the relationship between transit variables and health impacts, such as policy changes that encourage transit ridership to improve health outcomes through physical activity.
Physical health (impact and social determinant)	Activity	Of the studies examined, the impact of public transportation on physical activity was measured using cross-sectional data analysis.  Cross-sectional data analyses used regression models to assess the relationship between multiple variables in a single public or agency datasets, such as the National Household Transportation Survey or the National Cancer Institute Family Life, Activity, Sun, Health, and Eating Study. In addition, cross-sectional data analysis can be used to analyze data collected directly from study participants. Physical	The collection of primary data through observed measurement, such as with accelerometers, can be the most precise way to gauge health impacts and achieve statistical confidence.

Subcategory	Measure	Description	Observations
		activity can be measured using an accelerometer to be analyzed with the participant's reported transit use.	
Health-related costs (impact)	Health-related costs	The studies in this report which examined impact of public transportation on healthcare costs were conducted by healthcare organizations using internal datasets. Variables included in a cross-sectional analysis were healthcare expenditures, resident distance from public transportation, and sociodemographic variables.	Indicated that additional studies are needed. Health care costs occurring with changes in transit use represent an association, but do not prove causation.
Chronic disease (impact)	Health outcomes	Longitudinal studies can analyze commute mode against all-cause mortality, cardiovascular disease mortality, cancer mortality, and cancer incidence.	Datasets that report on health outcomes may not include comprehensive information on potential confounding factors that can impact health outcomes within cohort or participant survey data.

## Safety Impacts

Improvements in traffic and personal safety also influence individual health outcomes with respect to the occurrence of physical injury and death. Traffic safety indicators are relatively easy to model, given that traffic data may be more available to transportation agencies and modeling approaches are consistent with other common forecasting methodologies.

Personal safety is a broad concept that is used to reference individual perceptions of risk and insecurity as well as incidence of crime. These are not interchangeable terms and constructs, however. Crime is a legal term, while personal safety is not. Personal safety perceptions, while important to transit riders' physical and mental health, are highly subjective and can be influenced by personal bias and demographic characteristics.

As noted earlier in this report, approaches to evaluating personal safety require extra care to avoid perpetuating racist narratives that cause harm to transit riders who face discrimination. Some methodologies reviewed here that aim to measure "personal safety" relied on indicators that can reflect broader economic disinvestment and systemic neglect that negatively impact communities of color and low-income individuals (for example, prevalence of liquor stores). Attempts to measure safety that improperly conflate these indicators with poor personal safety outcomes penalize disadvantaged communities and perpetuate harms.

**5.2: Methodologies to measure safety impacts**

Subcategory	Measure	Description	Observations
Traffic Safety (Impact)	Percent Change in Vehicle-Pedestrian/Cyclist Injury Collisions	Accident prediction modeling - how changes in vehicle, pedestrian and cyclist volumes affect the frequency of vehicle pedestrian and vehicle-cyclist injury collision.	Requires a screen line analysis (comparing traffic volumes across specific locations) to first determine the change in auto trip/transit trips which are the basis of this analysis. Data tool that many agencies have experience working with.
Traffic Safety (Impact)	Severity of vehicle-pedestrian collisions	Assessment of how changes in traffic speed (associated with public transportation project) will affect risk of severe injury in vehicle-pedestrian collisions.	Good for understanding the importance of traffic calming/speed limit reductions in conjunction with public transportation improvements (which will increase pedestrian/cyclist activity). Requires an engineering analysis to determine how speeds are predicted to change along certain corridors. Speed changes may be induced by traffic calming features or reduced speed limits.
Personal Safety (Impacts and Social Determinant)	Number of incidents/destinations within proximity to transit stops	Spatial analysis of proposed transit corridor/transit station area identifying prevalence or number of liquor and convenience stores, quality of life crimes, property crimes, and violent crimes within a buffer of transit stops; uses existing data.	Issues with identification of liquor and convenience stores as contributing factor, given these are more prevalent in low-income areas and food deserts. Doesn't produce a quantitative estimate of crime prevalence and doesn't account for the changes in crime-related indicators brought about by transit improvements.

## Access to Destinations and Services

Approaches to measuring access considered both access to the public transportation system itself as well as access to the key destinations and services. Typically, these approaches involved spatial analyses but also considered how provision of quality transit service (frequent and reliable service) would influence outcomes.

### 5.3: Methodologies to measure access to destinations and services

Subcategory	Measure	Description	Observations
Access (social determinant)	Public Transportation Access	Cross-sectional analysis of longitudinal datasets was used to determine the association between public transportation availability and healthcare behaviors . Variables used for analysis can include distance to transit stops, frequency of transit use, rates of medical visits, and medical prescription rates.	Spatial analysis can help explore the relationship between health behaviors, such as healthcare visits, and public transportation access/availability.
Access to destinations (social determinant)	Access to health promoting services	Spatial analysis assessed various data sources to important health promoting destination points (including healthcare services, grocery stores). Variables used to assess access to healthcare can include land use, transportation asset data (e.g., sidewalks, roadway types), community asset locations, transit frequency, transit networks, and ridership data.	Can help to understand and analyze the extent to which proposed project could improve access to health promoting destinations.

## Economic Impacts

Economic benefits related to the health impacts of public transportation primarily focus on monetizing benefits to be included in cost-benefit analysis. These benefits can be used for evaluating transit investments at the regional scale.

### 5.4: Methodologies to measure economic impacts

Subcategory	Measure	Description	Observations
Wider economic benefits (impact)	Productivity	Economic density has a positive impact on productivity, defined by the Bureau of Labor Statistics as a measure comparing the amount of goods and services produced (outputs) compared to the amount of goods and services used to produce those services (inputs). Transportation modelling is used to produce an assessment of total productivity gains from agglomeration (benefits that come when firms and people locate near one another together in cities and industrial clusters). Monetized as the total net present value of benefits.	Agglomeration benefits, resulting from firms and workers being concentrated in the same location, are most likely to be present in major economic centers. These benefits may be more related to land density than public transportation/health.
Wider economic benefits (Impact)	Cost savings (community scale) including health, accident, vehicle operating and environmental costs	Monetization of changes in workplace, school, and household/community-based travel behavior. Analysis is based on the reduction in private car trips. The composite benefit values include benefits to the people changing their travel behavior as well as benefits to remaining road users and the general community, such as reduced health costs and accident cost savings, vehicle operating cost savings and environmental benefits.	Monetized benefits can be used for cost-benefit analysis (Waka Kotahi NZ Transport Agency 2023).
Equity (Impact)	Social cost-benefit	A different approach than financial cost-benefit analysis by incorporating social, economic, environmental, and cultural impacts.	Limitations in ability to fully quantify the benefits

Subcategory	Measure	Description	Observations
Equity (Impact)	Equity distributional benefits	Distribution of benefits within communities and populations to determine who benefits the most/least. Typically conducted geographically.	Can help determine distributional equity. Limitations from geographic nature of analysis (ecological fallacy is a logical error that occurs when the characteristics of a group are attributed to an individual).

## Environmental Impacts

5.1 Environmental benefits focus primarily on quantifying the impact of emissions, air pollution, and noise on health. These analyses focus heavily on the environmental impacts of private vehicle usage. Changes in air pollution levels and in ambient noise levels directly attributable to an improved public transit system may be small and difficult to measure. Notably, this review did not include tools to document changes in air or water pollution or in noise as health impacts resulting from public transportation.

### 5.5: Methodologies to measure environmental impacts

Subcategory	Measure	Description	Observations
Air Quality (Impact)	Air Pollutants: Particulate emissions, fuel economy, concentrations of fine particulate matter (PM <sub>2.5</sub> ), ambient air quality using AQI, asthma cases per 1,000, lung cancer deaths per 1,000. GHG Emissions: levels of carbon emissions	Used to quantify the health impacts of air pollutants and greenhouse gases. Used to assess broader community impacts of emissions, and relationship between commute mode and exposure to air pollutants.	Can be used to assess broader health impacts to communities or to transportation user themselves.
Noise (Impact)	Ambient noise pollution levels (>55 Db outdoors, >45 Db indoors)	Looks at impact of noise on health, classifies low-med-high ranges for dB(A) for measuring impact.	

## 6 Communication Tools

This chapter provides communications tools that articulate important links between public transportation and health and key considerations for agencies and partners during the planning process. These tools are intended to serve as a resource for transit agencies and their partners when communicating with different audiences that can be adapted and expanded for different contexts.

The communication tools include series of one-page summaries of different transit impacts organized into three parts:

- Key messages or take-aways specific to each impact;
- Description of the impact;
- Evidence from this study’s review of literature that can be used to substantiate; and
- Considerations to help transit agencies maximize the benefits, often through coordination with related planning activities.

The role of public transportation in shaping community health is complex; it influences many different outcomes from physical and mental health to social inclusion, access to resources and services, and economic opportunities. The following table summarizes the key messages of these communication tools and provides suggestions on additional framing for key audiences:

- For the public, emphasize that small changes in daily personal travel behavior can have positive health outcomes. Also emphasize the convenience and comfort of using public transit compared to car travel and commuting. Some environmental and road safety benefits may also be realized by non-transit users.
- For health professionals, emphasize the strongest connections between community health and public transportation and areas where future research could help fill gaps in knowledge.
- For decision-makers, highlight the importance of maximizing health benefits through integration with other elements of system planning, conversion to electric fleets, street design, and integration with urban form.

**Table 6.1: Summary of key messages and suggestions for target audiences**

Key Message	Public	Health Partners	Decision-Makers
<p><b>Physical Activity</b></p> <p>Better public transportation options promote physical activity, which positively impacts a transit user’s health.</p>	<p>Small changes in daily travel behavior can influence personal health.</p>	<p>Some of the strongest evidence supports the role that transit can play in increasing physical activity and addressing chronic health conditions like cardiovascular disease and obesity.</p>	<p>Transit agencies can promote health through planning and delivery of transit services but should ensure that access to transit through active means is also safe and reliable.</p>
<p><b>Social Cohesion</b></p> <p>Public transportation can reduce stress and foster social cohesion by connecting people to social networks and public spaces.</p>	<p>Daily travel choices can also influence mental well-being by reducing the stress of driving and connecting people to social networks.</p>	<p>Specific demographic groups, such as older adults, may benefit the most from the social benefits of reliable transit networks.</p>	<p>Transit agencies can foster social inclusion for older adults and reconnecting communities that have been physically severed in the past by transportation infrastructure.</p>
<p><b>Healthy Places</b></p> <p>Public transportation provides access to health-promoting places like medical services, groceries, and green places.</p>	<p>Public transportation connects people to places and services that support a healthy lifestyle and enable other key drivers of personal wellness.</p>	<p>Public transportation connects people to places and services that support a healthy lifestyle and enable other key drivers of personal wellness.</p>	<p>Access to healthy places is particular crucial for people with fewer travel options – this includes rural communities where public transportation services may be the provider of last resort.</p>
<p><b>Opportunity</b></p> <p>Public transportation connects people to jobs and educational opportunities, helping individuals achieve personal and financial growth and bringing economic benefits to communities.</p>	<p>Public transportation brings economic benefits to communities that may be realized even by those that do not use public transportation on a regular basis.</p>	<p>More research needs to be conducted to understand the complex relationship between public transportation and health particularly the role of access and economic opportunity to communities. Additional evidence could help transit agencies and public</p>	<p>The connection between public transportation and economic growth is commonly used to make the case for strategic investments even at the regional level. Agencies can emphasize the feedback loop that economic development has on</p>

		health organizations advocate for public transportation as a positive economic intervention.	quality of life and health in communities.
<p><b>Road Safety</b></p> <p>Public transportation can reduce the number of vehicles on the streets which make streets safer for all road users.</p>	Road safety benefits of public transportation may be realized by those who do not use public transportation.	Improvements in road safety are dependent on the degree of mode shift and quality of street design around transit stops and stations.	Improvements in road safety are dependent on the degree of mode shift and quality of street design around transit stops and stations.
<p><b>Air Quality</b></p> <p>Better public transportation options improve air quality, which means reduced incidence of strokes, and heart and lung diseases.</p>	Increased public transportation usage and the associated decrease in automobile usage can result in lower vehicle emissions, decreasing air pollution and greenhouse gas emissions and increasing communities' health.	Underserved populations by public transportation are more likely to experience environmental racism such as proximity to toxic industries and highway infrastructure.	Air quality benefits are often used to make the case for public transit improvements, but these benefits may not be experienced directly by the transit rider in dense urban areas which also experience higher congestion. Agencies should focus on conversion to zero- and low-emission fleets to maximize these benefits.
<p><b>Public Safety</b></p> <p>Public transportation contributes to a safe environment when it is vibrant, clean, and active.</p>	Perceptions of safety threats on transit can often outweigh the actual risk. Transit agencies can implement many safety measures that are sensitive to communities and needs of different riders and improve safety for those accessing and riding transit.	More research is needed to understand how public transit-related infrastructure design and systems operations (e.g., frequency, rider experience, etc.) most contribute to perceptions of (and actual) safety and well-being.	Particularly since the pandemic, threats on public transportation have been a key concern for the public and transit agencies. However, increased transit usage, more eyes on the street, and safety enhancements both on transit and at stations can dramatically improve perceptions of safety.

# Physical Activity

Better public transportation options promote physical activity, which positively impacts a transit user's health.

People who use public transportation in place of driving may increase their physical activity by walking, biking, and rolling, which can improve cardiovascular health and reduce risks associated with a range of chronic diseases.



## What the Research Says

- Using public transportation adds a median of 20 minutes of physical activity per day to transit users.<sup>1</sup>
- Public transportation use is associated with reduced rates of heart disease, diabetes, obesity, hypertension, blood pressure, osteoporosis and falls in the elderly, depression, and anxiety symptoms.<sup>2</sup>
- A 1% increase in frequent public transportation ridership is associated with a 0.5% decrease in obesity rates.<sup>3</sup>
- Individuals who use transit more than 3 times per week were found to have the lower healthcare costs compared to infrequent and non-transit users.<sup>3</sup>
- Additionally increases in public transit funding have been associated with decreased obesity rates.<sup>4</sup>

## How to Maximize the Benefits

- The transit service (route, frequency), station area design, and other amenities should be of high quality to influence the use of transit and active modes.<sup>5</sup>
- Land use density, sidewalk coverage, and land-use mix can enhance the appeal and usefulness of transit.<sup>4</sup>
- Lack of adequate infrastructure such as bike lanes and accessible sidewalks can represent a safety risk when promoting active modes.

<sup>1</sup> James, Peter, Kate Ito, Jonathan Buonocore, Jonathan Levy, and Mariana Arcaya. 2014. "A Health Impact Assessment of Proposed Public Transportation Service Cuts and Fare Increases in Boston, Massachusetts (U.S.A.)." *International Journal of Environmental Research and Public Health* 11 (8): 8010–24. doi:10.3390/ijerph110808010.

<sup>2</sup> South Central Neighborhoods Transit Health Impact Assessment. Arizona Department of Health Services, 2015.

<sup>3</sup> Rep. 2021. *Transit Equity & Environmental Health in Baltimore City*. Baltimore, Maryland: Johns Hopkins School of Public Health.

<sup>4</sup> She, ZW, DM King, and SH Jacobson. 2019. "Is Promoting Public Transit an Effective Intervention for Obesity? A Longitudinal Study of the Relation between Public Transit Usage and Obesity." *TRANSPORTATION RESEARCH PART A-POLICY AND PRACTICE* 119 (January): 162–69. <https://doi.org/10.1016/j.tra.2018.10.027>.

<sup>5</sup> Metrolinx. 2018. Rep. GO Expansion Full Business Case. Metrolinx.

## Social Cohesion

Public transportation can reduce stress and foster social cohesion by connecting people to social networks and public spaces.

Public transportation use is linked to reductions in driving-related stress, and it is indirectly linked to improved community cohesion and improved mental health through access to destinations (such as green spaces and social networks) that can reduce emotional/financial stress.

### What the Research Says

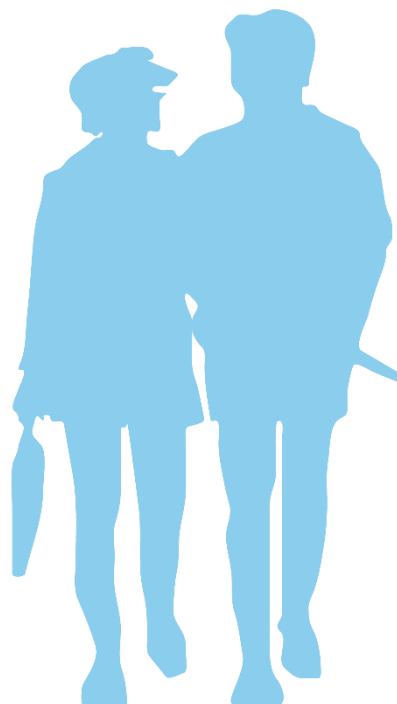
- Walkability and transit use can promote social cohesion, as the potential for interactions increases when people spend more time in public space and/or make use of public services.<sup>6</sup>
- Having a variety of modes of transportation particularly helps older adults maintain social networks outside their neighborhoods, reducing feelings of loneliness<sup>7</sup>.

### How to Maximize the Benefits

- Public transportation stations can serve as conduits of overlapping social activities, which can strengthen social ties.<sup>14</sup>
- Cities can work towards reducing the inequity gap through public transportation, particularly

by prioritizing aging adults and communities of color in transit design and development.<sup>8</sup>

- It is important to remember that public transportation has the potential to cause riders stress, due to crowding, long wait times, and perceived threats on transit.<sup>9</sup> These can also be addressed and mitigated by transit agencies.
- Culture plays a part in to what extent people will interact on public transit, so social cohesion may vary depending on demographics and background.<sup>14</sup>
- Transit infrastructure must be built with the intention of connecting previously disconnected neighborhoods, as some transportation infrastructure has severed communities in the past.<sup>10</sup>



<sup>6</sup> Qi, J., Mazumdar, S. & Vasconcelos, A.C. Understanding the Relationship between Urban Public Space and Social Cohesion: A Systematic Review. *Int. Journal of Com. WB* (2024). <https://doi.org/10.1007/s42413-024-00204-5>

<sup>7</sup> Berke, Ehan M., Laura M. Gottlieb, Anne Vernez Moudon, and Eric B. Larson. 2007. "Protective Association Between Neighborhood Walkability and Depression in Older Men," *Journal of the American Geriatrics Society* 55, No. 4, (2007): 526–533.

<sup>8</sup> LADOT (2024). *Changing Lanes, A Gender Equity Transportation Study* [changing-lanes-report.pdf \(lacity.gov\)](https://www.lacity.gov/files/default/2024/07/2024-07-15-changing-lanes-report.pdf)

<sup>9</sup> Bell, Judith, and Larry Cohen. 2009. "The Transportation Prescription: Bold New Ideas for Healthy, Equitable Transportation Reform in America", *PolicyLink and the Prevention Institute Convergence Partnership*, [www.convergencepartnership.org/transportationhealthandequity](http://www.convergencepartnership.org/transportationhealthandequity).

<sup>10</sup> Geurs, K. T., Boon, W., & Van Wee, B. (2009). Social Impacts of Transport: Literature Review and the State of the Practice of Transport Appraisal in the Netherlands and the United Kingdom. *Transport Reviews*, 29(1), 69–90. <https://doi.org/10.1080/01441640802130490>

## Healthy Places

Public transportation provides access to health-promoting places like medical services, groceries, and green places.

Access to healthy food sources as well as routine, preventative, and emergency medical services are crucial for a healthy community. Public transportation plays a vital role in access to these key destinations, especially for transit dependent individuals who have limited choice of other modes.

### What the Research Says

- Decreased travel times for transit users to healthcare services are associated with greater utilization of healthcare services.<sup>11,12</sup>
- Rates of general practitioner visits were higher with public transit availability.<sup>19</sup>
- Higher public transportation availability and lower transportation barriers increases routine and preventative care, reducing emergency department visits and prescription issued.<sup>18 19</sup>
- Lack of transportation, particularly in rural areas, is the largest barrier to access healthy foods.<sup>13</sup>

<sup>11</sup> Metrolinx. 2018. Rep. GO Expansion Full Business Case. Metrolinx.

<sup>10</sup> Davidson Design for Life. 2012. Rep. *Health Impact Assessment: Red Line Regional Rail*. Davidson, NC: Town of Davidson.

Wolfe, Mary K., Noreen C. McDonald, and G. Mark Holmes. 2020. "Transportation Barriers to Health Care in the United States: Findings From the National Health Interview Survey, 1997–2017." *American Journal of Public Health* 110 (6): 815–22. <https://doi.org/10.2105/AJPH.2020.305579>.

<sup>12</sup> Badji, Samia, Hannah Badland, Jerome N. Rachele, and Dennis Petrie. 2021. "Public Transport Availability and Healthcare Use for Australian Adults Aged 18–60 Years, with and without Disabilities." *Journal of Transport & Health* 20 (March): 101001. <https://doi.org/10.1016/j.jth.2020.101001>.

<sup>13</sup> Del Rio, Michelle, William Hargrove, Joe Tomaka, and Marcelo Korc. 2017. "Transportation Matters: A Health Impact Assessment in Rural New Mexico." *International Journal of Environmental Research and Public Health* 14 (6): 629. doi:10.3390/ijerph14060629.

### How to Maximize the Benefits

- American urban patterns tend to place disadvantaged communities far from their destination points, which impacts their commute times, infringing on sleep, time to access health care, and time for leisure.<sup>4,10,14</sup>
- Access to these resources is also influenced by reliability of transit service, network coverage, affordability, and accessibility for people with disabilities.
- Future public transportation projects should be planned with access to health centers, recreation and green places, jobs, and education districts.
- Access to healthy foods is often defined by physical proximity to full-service grocery stores or farmer's markets, which offer fresh and perishable foods that provide key nutrients.<sup>20</sup>
- Efforts to ensure housing affordability near transit lines are necessary to mitigate transportation inequities.<sup>15</sup>
- Special attention must be given to public transportation schedules to ensure that those who work outside the typical 9 to 5 work shift can still access health promoting places in a reasonable amount of time.<sup>16</sup>



<sup>14</sup> USF Center for Urban Transportation Research. 2021. Rep. *Transportation Equity Toolkit: Transportation Equity Needs Assessment & Project Prioritization*. Center for Transportation Equity, Decisions & Dollars.

<sup>15</sup> Klingbaum, Alissa, Adwoa Afful, Vinusha Gunaseelan, and Thrmiga Sathiyamoorthy. 2021. "Impacts of Light Rail Transit Development on Neighborhood Health: A Scoping Review through a Social Determinants of Health Lens." *Journal of Transport & Health* 21 (June).

<sup>16</sup> Widener, M. J., Minaker, L., Farber, S., Allen, J., Vitali, B., Coleman, P. C., & Cook, B. (2017). How do changes in the daily food and transportation environments affect grocery store accessibility? *Applied Geography* (Sevenoaks), 83, 46–62. <https://doi.org/10.1016/j.apgeog.2017.03.018>

# Opportunity

Public transportation connects people to jobs and educational opportunities, helping individuals achieve personal and financial growth and bringing economic benefits to communities.

Public transportation brings people closer to economic and educational opportunities which are themselves important social determinants of health and equity. Public transportation itself can attract jobs and development to a community.

## What the Research Says

- Across the United States, in cities with the highest public transportation use, \$1 invested in transit yields more than \$1 in economic growth.<sup>17</sup>
- Reductions in household transportation costs can reduce an individual’s overall financial burden, allowing them to invest in housing, healthy food, and medical care<sup>5,6,8,20, 22,18,19</sup>.

## How to Maximize the Benefits

- Fostering a mix of land uses creates more opportunities and activities in a smaller radius.
- Ensuring housing affordability near transit lines aids in mitigating transportation inequities.
- Affordable, timely, and well-located public transportation is key to ensure that public transportation achieves its economic potential.<sup>22</sup>
- Knowledge gaps remain as to what extent investments in transit can change the socioeconomic and demographic makeup of residents, types of businesses, school attendance rates, and other social determinants of health.
- Varied community land trust or affordable property protections can help to ensure that a new transit station does not displace longtime residents of a neighborhood.
- Public transportation agencies themselves can serve as a key employer in a region.



<sup>17</sup> Glover, J., Wennink, A., Blum, E. & Waas, S. (2020) “Transit Means Business”. Metropolitan Planning Council. <https://transitmeansbusiness.metroplanning.org/>

<sup>18s</sup> Litman, Todd. 2020. Evaluating Public Transportation Health Benefits. Victoria Transport Policy Institute.

<sup>6</sup> Fielding, Jonathan, Richard Jackson, Brian Cole, Riti Shimkhada, Tamana Rahman. 2012. *Wilshire Corridor Transit Alternatives Health Impact Assessment*. UCLA School of Public Health, Los Angeles County Department of Public Health.

<sup>8</sup> Brown, Melanie, Ariel Scholten, and Louie Leiva, eds. 2018. Rep. Health Impact Assessment of Rainier RapidRide Bus Rapid Transit Project. Seattle, Washington: University of Washington.

<sup>20</sup> “Social Determinants of Health,” US Department of Health & Human Services, Office of Disease Prevention and Health Promotion, last modified August 27, 2023, <https://health.gov/healthypeople/priority-areas/social-determinants-health>.

<sup>22</sup> USF Center for Urban Transportation Research. 2021. Rep. *Transportation Equity Toolkit: Transportation Equity Needs Assessment & Project Prioritization*. Center for Transportation Equity, Decisions & Dollars.

US Department of Transportation. 2015. “Transportation and Health Tool.” Last modified August 24, 2015. <https://www.transportation.gov/transportation-health-tool>

<sup>19</sup> Tech. 2020. *Plan Performance Public Health*. Southern California Association of Governments. [https://scag.ca.gov/sites/main/files/file-attachments/0903fconnectsocial\\_public-health.pdf?1606001755](https://scag.ca.gov/sites/main/files/file-attachments/0903fconnectsocial_public-health.pdf?1606001755).

# Personal Safety

Public transportation contributes to a safe environment when it is vibrant, clean, and active.

While serious personal safety threats have been well documented, research demonstrates that high quality public transportation, with adequate staffing, lighting, and visibility, actually enhance perceptions of risk and insecurity in public spaces. Taking proactive and community-sensitive measures to improve system safety and security contribute to transit riders' feeling safe, which in turn improves their physical and mental health.

## What the Research Says

- Increasing public transportation can decrease crime rates.<sup>5,8,20,26,20</sup>
- Increasing use of public transportation and associated walking and biking can generate more "eyes on the street."<sup>8</sup>
- Perceptions of safety increase the use of public transit, as the fear of crime is more potent than the actual risk.<sup>21</sup>
- People feel safer when there are many riders and public transit workers at the station.<sup>30</sup>
- When areas near transportation hubs feel safe, people feel safer riding public transportation.<sup>30</sup>

## How to Maximize the Benefits

- Frequency and reliability of transit services aids in achieving a feeling of safety through reducing waiting times and exposure.<sup>30</sup>
- Adequate lighting, staffing, emergency "panic buttons" and clear signage, transit maps, and stop information support the feeling of safety for transit users.<sup>30</sup>
- Riders feel most unsafe during the nighttime, which can be addressed by reducing wait times, better lighting, and increasing personnel.<sup>30</sup>
- Campaigns to promote a safe ridership culture, such as respecting personal space, can ensure that design changes are also enhanced by cultural shifts.
- Approaches to evaluating personal safety require diligence to avoid perpetuating racist narratives that cause harm to transit riders who face discrimination.
- Police presence in transportation systems may exacerbate feelings of stress for racialized transit riders and negatively impact personal safety.<sup>23</sup>.
- Special attention to gendered safety concerns must be addressed to ensure that women, who make up the largest group of public transportation riders, are safe.<sup>29</sup>
- Members of the LGTBQIA+ community are often victims of crimes on public transportation; thus, safety measures should include considerations for vulnerable groups.



<sup>20s</sup> Litman, Todd. 2020. Evaluating Public Transportation Health Benefits. Victoria Transport Policy Institute.

<sup>8</sup> Brown, Melanie, Ariel Scholten, and Louie Leiva, eds. 2018. Rep. Health Impact Assessment of Rainier RapidRide Bus Rapid Transit Project. Seattle, Washington: University of Washington.

<sup>20</sup> "Social Determinants of Health," US Department of Health & Human Services, Office of Disease Prevention and Health Promotion, last modified August 27, 2023, <https://health.gov/healthypeople/priority-areas/social-determinants-health>.

<sup>23</sup> Klingbaum, Alissa, Adwoa Afful, Vinusha Gunaseelan, and Thrmiga Sathiyamoorthy. 2021. "Impacts of Light Rail Transit Development on

Neighborhood Health: A Scoping Review through a Social Determinants of Health Lens." *Journal of Transport & Health* 21 (June).

<sup>26</sup> Tech. 2020. *Plan Performance Public Health*. Southern California Association of Governments. [https://scag.ca.gov/sites/main/files/file-attachments/0903fconnectsocial\\_public-health.pdf?1606001755](https://scag.ca.gov/sites/main/files/file-attachments/0903fconnectsocial_public-health.pdf?1606001755).

*A Health Impact Assessment of the East Bay Bus Rapid Transit (BRT) Project*. Human Impact Partners and UC Berkeley Schools of Public Health and City & Regional Planning, 2012.

<sup>21</sup> Loukaitou-Sideris, A. (2014). Fear and safety in transit environments from the women's perspective. *Security Journal*, 27(2), 242–256. <https://doi.org/10.1057/sj.2014.9>

# Road Safety

Public transportation can reduce the number of vehicles on the streets which make streets safer for all road users.

High quality public transportation can enhance road safety in its surroundings. Road safety refers to the measures, practices, and design aimed at reducing injuries and fatalities caused by traffic collisions.

## What the Research Says

- Reductions in automobile use because of increased transit usage can reduce the incidence of vehicle-involved collisions and fatalities<sup>5</sup>.
- ‘Unintentional injuries’ (which include traffic accidents) are the leading cause of death among teenagers in the USA.<sup>22</sup>
- Using public transportation has historically been safer than driving.

## How to Maximize the Benefits

- Improvements in road safety as a result of public transportation investment depend on the degree of mode shift from private vehicle usage.
- Improvements in road safety also depend on the quality of street design around transit stops and stations to ensure pedestrians and bicyclists have safe access to transit.
- *Safe Routes to Transit* is a concept that promotes improvements to the pedestrian environment around transit stops to try to minimize risk of those using active travel to access transit being involved in vehicle crashes.
- Pairing public transportation with alternate modes of travel, such as biking and walking, can help make streets safer for all.
- Slower traffic and integrated public transportation support the circulation of people with disabilities or people who need more time to cross the road or get onto public transit.
- Pedestrians and cyclists are the most at risk when involved in a collision.<sup>23</sup>
- Public transportation must be well integrated into the community to ensure ridership and intended safety outcomes.



<sup>22s</sup> Litman, Todd. 2020. Evaluating Public Transportation Health Benefits. Victoria Transport Policy Institute. National Center for Health Statistics – Adolescent Health 2022 [FastStats - Adolescent Health \(cdc.gov\)](#)

<sup>23</sup> National Highway Traffic Safety Administration [Pedestrian Safety: Prevent Pedestrian Crashes | NHTSA](#)

# Air Quality

Better public transportation options improve air quality, which means reduced incidence of strokes, and heart and lung diseases.

Increased public transportation usage and the associated decrease in automobile usage can result in lower vehicle emissions, decreasing air pollution and greenhouse gas emissions and increasing communities' health.

## What the Research Says

- Public transportation has a lower pollutant emission rate per passenger mile traveled than private automobiles.<sup>5,8,9,22</sup>
- Increased use of public transportation decreases local carbon dioxide emissions, which can help to reduce global climate change and its associated health effects.<sup>1</sup>
- Public transportation users, pedestrians, and bicyclists may be more exposed to air pollutants because of increased duration of travel and increased breathing rates.<sup>24</sup>
- Public transportation usage is linked to better water quality. Reduction in automobile use results in reductions in particulates found in the sewer system.<sup>8</sup>

## How to Maximize the Benefits

- The transition to low and zero-emission fleets are crucial to unlocking these benefits. Newer and alternatively fueled buses and rail vehicles produce less emissions than older diesel buses.<sup>5,8,9,22</sup>
- Underserved populations by public transportation are more likely to experience environmental racism such as proximity to toxic industries and highway infrastructure.<sup>25</sup>



<sup>24</sup> Kim, K.-H., P. Kumar, J.E. Szulejko, A.A. Adelodun, M.F. Junaid, M. Uchimiya, and S. Chambers. 2017. "Toward a Better Understanding of the Impact of Mass Transit Air Pollutants on Human Health."

Chemosphere 174: 268–79.  
<https://doi.org/10.1016/j.chemosphere.2017.01.113>.

## References

1. James, Peter, Kate Ito, Jonathan Buonocore, Jonathan Levy, and Mariana Arcaya. 2014. "A Health Impact Assessment of Proposed Public Transportation Service Cuts and Fare Increases in Boston, Massachusetts (U.S.A.)." *International Journal of Environmental Research and Public Health* 11 (8): 8010–24. <https://doi.org/10.3390/ijerph110808010>.
2. South Central Neighborhoods Transit Health Impact Assessment. Arizona Department of Health Services, 2015. [https://www.phoenix.gov/pddsit/Docs/PZ/pdd\\_pz\\_pdf\\_00501.pdf](https://www.phoenix.gov/pddsit/Docs/PZ/pdd_pz_pdf_00501.pdf).
3. She, ZW, DM King, and SH Jacobson. 2019. "Is Promoting Public Transit an Effective Intervention for Obesity? A Longitudinal Study of the Relation between Public Transit Usage and Obesity." *TRANSPORTATION RESEARCH PART A-POLICY AND PRACTICE* 119 (January): 162–69. <https://doi.org/10.1016/j.tra.2018.10.027>.
4. Metrolinx. 2018. Rep. *GO Expansion Full Business Case*. Metrolinx. [https://assets.metrolinx.com/image/upload/v1667497052/Images/Metrolinx/GO\\_Expansion\\_FBC.pdf](https://assets.metrolinx.com/image/upload/v1667497052/Images/Metrolinx/GO_Expansion_FBC.pdf).
5. Litman, Todd. 2020. *Evaluating Public Transportation Health Benefits*. Victoria Transport Policy Institute. [https://www.vtpi.org/tran\\_health.pdf](https://www.vtpi.org/tran_health.pdf).
6. Fielding, Jonathan, Richard Jackson, Brian Cole, Riti Shimkhada, Tamana Rahman. 2013. *Wilshire Corridor Transit Alternatives Health Impact Assessment*. UCLA School of Public Health, Los Angeles County Department of Public Health. [https://www.ph.ucla.edu/hs/health-impact/docs/WilshireCorridor\\_Report\\_22Mar2013.pdf](https://www.ph.ucla.edu/hs/health-impact/docs/WilshireCorridor_Report_22Mar2013.pdf).
7. Rep. 2019. *Public Transit and Health: Best Practices Report*. Ohio Department of Public Health. [https://odh.ohio.gov/wps/wcm/connect/gov/45bd0d74-43f5-44d4-b451-3bbb8924861a/2019\\_09\\_25\\_Transit+Report\\_Best+Practices\\_WEB\\_FINAL\\_DRAFT.pdf?MOD=AJPERE&CONVERT\\_TO=url&CACHEID=ROOTWORKSPACE.E.Z18\\_K9I401S01H7F40QBNUJ3SO1F56-45bd0d74-43f5-44d4-b451-3bbb8924861a-mUUb7lm](https://odh.ohio.gov/wps/wcm/connect/gov/45bd0d74-43f5-44d4-b451-3bbb8924861a/2019_09_25_Transit+Report_Best+Practices_WEB_FINAL_DRAFT.pdf?MOD=AJPERE&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.E.Z18_K9I401S01H7F40QBNUJ3SO1F56-45bd0d74-43f5-44d4-b451-3bbb8924861a-mUUb7lm).
8. Brown, Melanie, Ariel Scholten, and Louie Leiva, eds. 2018. Rep. *Health Impact Assessment of Rainier RapidRide Bus Rapid Transit Project*. Seattle, Washington: University of Washington. [https://www.seattle.gov/documents/Departments/SDOT/TransitProgram/RapidRide/RainierRapidRide\\_HIA\\_final\\_7June2018.pdf](https://www.seattle.gov/documents/Departments/SDOT/TransitProgram/RapidRide/RainierRapidRide_HIA_final_7June2018.pdf).
9. Ricklin, Anna. 2008. *The Red Line Transit Project Health Impact Assessment*. Baltimore, Maryland: Baltimore City Department of Transportation. <https://assessment.communitycommons.org/entities/3cd888a5-059a-4527-aa5b-fdbc493a2fad>
10. Davidson Design for Life. 2012. Rep. *Health Impact Assessment: Red Line Regional Rail*. Davidson, NC: Town of Davidson. <https://www.communitycommons.org/entities/d986d187-ce92-46de-bb1b-1e208383caa7>
11. Wener, Richard E. and Gary W. Evans. 2007. "A Morning Stroll: Levels of Physical Activity in Car and Mass Transit Commuting," *Environment and Behavior* 39, No. 1 (2007): 62-74, <http://eab.sagepub.com/cgi/content/abstract/39/1/62>.
12. Rep. 2021. *Transit Equity & Environmental Health in Baltimore City*. Baltimore, Maryland: Johns Hopkins School of Public Health. [https://americanhealth.jhu.edu/sites/default/files/2021-09/JHU-016%20Transit%20Equity%20Report-FINAL\\_0.pdf](https://americanhealth.jhu.edu/sites/default/files/2021-09/JHU-016%20Transit%20Equity%20Report-FINAL_0.pdf).
13. Berke, Ehan M., Laura M. Gottlieb, Anne Vernez Moudon, and Eric B. Larson. 2007. "Protective Association Between Neighborhood Walkability and Depression in Older Men," *Journal of the American Geriatrics Society* 55, No. 4, (2007): 526–533. <https://doi.org/10.1111/j.1532-5415.2007.01108.x>.
14. Qi, J., Mazumdar, S. & Vasconcelos, A.C. Understanding the Relationship between Urban Public Space and Social Cohesion: A Systematic Review. *Int. Journal of Com. WB* (2024). <https://doi.org/10.1007/s42413-024-00204-5>.
15. LADOT (2024). Changing Lanes, A Gender Equity Transportation Study. <https://ladot.lacity.gov/sites/default/files/documents/changing-lanes-report.pdf>.
16. Bell, Judith, and Larry Cohen. 2009. "The Transportation Prescription: Bold New Ideas for Healthy, Equitable Transportation Reform in America", *PolicyLink and the Prevention Institute Convergence Partnership*. <https://www.preventioninstitute.org/sites/default>

- [It/files/publications/The%20Transportation%20Pr  
escription 0.pdf.](#)
17. Geurs, K. T., Boon, W., & Van Wee, B. (2009). Social Impacts of Transport: Literature Review and the State of the Practice of Transport Appraisal in the Netherlands and the United Kingdom. *Transport Reviews*, 29(1), 69–90. <https://doi.org/10.1080/01441640802130490>.
  18. Wolfe, Mary K., Noreen C. McDonald, and G. Mark Holmes. 2020. “Transportation Barriers to Health Care in the United States: Findings From the National Health Interview Survey, 1997–2017.” *American Journal of Public Health* 110 (6): 815–22. <https://doi.org/10.2105/AJPH.2020.305579>.
  19. Badji, Samia, Hannah Badland, Jerome N. Rachele, and Dennis Petrie. 2021. “Public Transport Availability and Healthcare Use for Australian Adults Aged 18–60 Years, with and without Disabilities.” *Journal of Transport & Health* 20 (March): 101001. <https://doi.org/10.1016/j.jth.2020.101001>.
  20. “Social Determinants of Health,” US Department of Health & Human Services, Office of Disease Prevention and Health Promotion, last modified August 27, 2023, <https://health.gov/healthypeople/priority-areas/social-determinants-health>.
  21. Del Rio, Michelle, William Hargrove, Joe Tomaka, and Marcelo Korc. 2017. “Transportation Matters: A Health Impact Assessment in Rural New Mexico.” *International Journal of Environmental Research and Public Health* 14 (6): 629. <https://doi.org/10.3390/ijerph14060629>.
  22. Williams, K. M., Kramer, J., Keita, Y., & Boyd, T. (2021). *Transportation Equity Toolkit: Transportation Equity Needs Assessment & Project Prioritization*. Center for Transportation Equity, Decisions & Dollars. <https://www.cutr.usf.edu/wp-content/uploads/2021/09/CTEDD-Transportation-Equity-Toolkit-04212021.pdf>.
  23. Klingbaum, Alissa, Adwoa Afful, Vinusha Gunaseelan, and Thrmiga Sathiyamoorthy. 2021. “Impacts of Light Rail Transit Development on Neighborhood Health: A Scoping Review through a Social Determinants of Health Lens.” *Journal of Transport & Health* 21 (June). <https://doi.org/10.1016/j.jth.2021.101063>.
  24. Widener, M. J., Minaker, L., Farber, S., Allen, J., Vitali, B., Coleman, P. C., & Cook, B. (2017). How do changes in the daily food and transportation environments affect grocery store accessibility? *Applied Geography* (Sevenoaks), 83, 46–62. <https://doi.org/10.1016/j.apgeog.2017.03.018>.
  25. US Department of Transportation. 2015. “Transportation and Health Tool.” Last modified August 24, 2015. <https://www.transportation.gov/transportation-health-tool>.
  26. Tech. 2020. *Plan Performance Public Health*. Southern California Association of Governments. [https://scag.ca.gov/sites/main/files/file-attachments/0903fconnectsocial\\_public-health.pdf?1606001755](https://scag.ca.gov/sites/main/files/file-attachments/0903fconnectsocial_public-health.pdf?1606001755).
  27. Glover, J., Wennink, A., Blum, E. & Waas, S. (2020) “Transit Means Business”. Metropolitan Planning Council. <https://transitmeansbusiness.metroplanning.org/>.
  28. *A Health Impact Assessment of the East Bay Bus Rapid Transit (BRT) Project*. Human Impact Partners and UC Berkeley Schools of Public Health and City & Regional Planning, 2012. <https://www.communitycommons.org/entities/8511cb4c-91fc-4f51-b270-251b10391a6c>
  29. Loukaitou-Sideris, A. (2014). Fear and safety in transit environments from the women’s perspective. *Security Journal*, 27(2), 242–256. <https://doi.org/10.1057/sj.2014.9>.
  30. Iseki, H., & Taylor, B. (2010). Style versus Service? An Analysis of User Perceptions of Transit Stops and Stations. *Journal of Public Transportation*, 13(3), 23–48. <https://doi.org/10.5038/2375-0901.13.3.2>.
  31. National Center for Health Statistics – Adolescent Health 2022. <https://www.cdc.gov/nchs/fastats/adolescent-health.htm>.
  32. National Highway Traffic Safety Administration. “Pedestrian Safety”. USDOT. <https://www.nhtsa.gov/road-safety/pedestrian-safety>.
  33. US Department of Transportation. 2015. “Transportation and Health Tool.” Last modified August 24, 2015. <https://www.transportation.gov/transportation-health-tool>
  34. Kim, K.-H., P. Kumar, J.E. Szulejko, A.A. Adelodun, M.F. Junaid, M. Uchimiya, and S. Chambers. 2017. “Toward a Better Understanding of the Impact of Mass Transit Air Pollutants on Human Health.” *Chemosphere* 174: 268–79.

[https://doi.org/10.1016/j.chemosphere.2017.01.](https://doi.org/10.1016/j.chemosphere.2017.01.113)

[113.](https://doi.org/10.1016/j.chemosphere.2017.01.113)

# 7 Conclusions

---

This chapter presents a series of conclusions that emerged through the synthesis of this research.

---

This study explored the myriad health impacts linked to public transportation and different models for understanding how public transportation influences health outcomes available in academic and policy literature, with a focus on five case studies. Based on this information, the study considered how transit agencies can incorporate health impacts into decision-making processes and communicate the health benefits of public transportation to wider audiences.

## **Public transportation contributes to diverse health benefits.**

Overall, the literature review and case studies demonstrate an array of beneficial associations between investments in public transportation and health outcomes for individuals and communities. Investments in public transportation, including new services, better frequency, and reduced fares were all linked to improvements in physical and mental health, either directly or via their influence on key determinants of health and health equity. Health benefits at the community level included increases in physical activity, reductions in obesity rates, and improved air quality.

Some health benefits are better understood than others. Research has generally focused on the relationship between public transportation and physical activity. Numerous studies investigated whether the provision of a new transit service (typically high-frequency, fixed route) could induce physical activity and thereby improve health conditions related to obesity, cardiovascular health, and other chronic diseases. As a result, approaches to measuring various health indicators like obesity, Body Mass Index (BMI) and physical activity are prevalent in the literature.

In many cases, disaggregated findings are presented by sociodemographic factors like age and race. In addition, the relationship between public transportation and improved air quality (both greenhouse gas emissions and other air pollutants) has also been well documented in policy and academic literature. This is likely due to the prevalence of federal and state regulations which require governments to monitor and improve air quality, as well as increasingly ambitious strategies to address climate change.

Benefits can also be realized by people who do not use transit. For example, the environmental and safety impacts of reduced automobile use accrue to the entire population, regardless of whether each individual uses transit. This is important distinction when communicating the value of public transportation to decision-makers and the public.

Many of the benefits of public transportation are mediated by the social determinants of health. High-quality transportation options, particularly for people who experience barriers to car ownership and use, offer access to opportunities and resources that ultimately contribute to improved health outcomes.

However, the magnitude of benefits from public transportation are uncertain, and sometimes difficult to measure. The provision of public transportation does not guarantee a change in travel behavior. Reduced fares, investments in more frequent and connective service, integration with other modes, transit-oriented development, and anti-displacement measures augment and improve the customer experience and encourage actual mode shift. These considerations work synergistically to magnify the benefits of public transportation and minimize the downsides that may also occur. Therefore, without deliberate and intentional strategic maintenance, investment, and on-going evaluation of existing public transportation system benefits may not materialize.

### **Transit agencies should promote health through goals and objectives.**

Transit agencies provide vital services to people and communities, particularly those who have and continue to experience structural oppression, poverty, and other barriers to opportunity that create health inequities. Public transportation is a social determinant of health that connects people to essential aspects of life, including schools, jobs, homes, and recreation areas. Frequent, reliable, and affordable public transportation is therefore essential to the health of communities. Transit agencies should acknowledge their role in advancing and realizing better community health outcome by promoting specific health-related goals and objectives throughout the project life cycle and for a range of different transit investments.

The process of building a strategic case for public transportation investments itself can be a community and stakeholder engagement tool to build support with decision-makers and the public. Stakeholder engagement is often a requirement or mandate for state and federal funding, but public transportation agencies should recognize that community-driven processes can provide opportunities to validate evidence, educate and inform, and build partnership and coalitions.

Finally, transit agencies should focus on and lead with core values grounded in equity and social justice. Many of those who experience barriers to reliable and accessible mobility options suffer disproportionately from negative health outcomes such as higher rates of cardiovascular disease and obesity. By focusing on provision of public transit to historically marginalized and disadvantaged communities, transit agencies can also work to address long-standing sources of structural inequity and inequality.

### **Health impacts and methodologies should be fit-for-purpose.**

Health benefits are complex. Factors that influence health, especially those related to community wellbeing, stability, and access to social and cultural resources, may be more complex to quantify, but are no less important. The challenges in quantifying health benefits arise for a variety of reasons including limited availability and reliability of personal data related to health, challenges conducting research over long periods and document long-term outcomes, and difficulty in removing or narrowing study focus to remove external factors.

Public transportation agencies likely don't have the resources to identify, quantify, and measure every health impact associated with a proposed public transportation investment. The more

actionable approach involves identifying specific health impacts and outcomes that are most relevant to the local and regional context and developing a study or case for investment that provides the best estimation of benefits for that purpose. This requires understanding local health issues and the priorities of community members, local public health professionals, and key decision-makers (e.g., elected officials).

### **Partnerships between transit agencies and health can help address gaps and build knowledge and support.**

This study has also highlighted that there remain many gaps in the research:

- The influence of access to economic, educational, social, cultural, and other opportunities on individual and community health has been less studied and is less understood than other areas. However, this line of inquiry is significant and of mutual interest to practitioners in public transportation and public health.
- Investment in transit has inconclusive impacts on community health. The benefits of existing public transportation access are known; however, the extent of impacts from new public transportation at neighborhood and local levels is less understood. Knowledge gaps remain as to what extent investments in transit can change the socioeconomic and demographic makeup of residents, types of businesses, school attendance rates, and other social determinants of health.
- The degree of influence of public transportation on the health behaviors of rural residents is unclear. More research is needed to understand how the lack of public transportation impacts the health outcomes and health behaviors of residents and communities in rural environments compared to their suburban and urban counterparts.

Transit agencies can and should collaborate with a variety of partners that can help them study, assess, and communicate the individual and community health benefits of public transportation investments. These include, but are not limited to, public health agencies, universities and other research institutions, and non-profit organizations.

## 8 References

*A Health Impact Assessment of the East Bay Bus Rapid Transit (BRT) Project.* Human Impact Partners and UC Berkeley Schools of Public Health and City & Regional Planning, 2012.

Allen, Heather. 2008. "Sit Next To Someone Different Every Day - How Public Transport Contributes To Inclusive Communities", *Paper presented at the Thredbo Conference*, [https://thredbo-conference-series.org/downloads/thredbo10\\_papers/thredbo10-plenary-Allen.pdf](https://thredbo-conference-series.org/downloads/thredbo10_papers/thredbo10-plenary-Allen.pdf).

Appleyard, Donald, M. Sue Gerson, and Mark Lintell. 1981. *Livable Streets*. Berkeley: University of California Press.

Arcury, Thomas A., John S. Preisser, Wilbert M. Gesler, and James M. Powers. 2005. "Access to Transportation and Health Care Utilization in a Rural Region." *The Journal of Rural Health* 21 (1): 31–38. doi: 10.1111/j.1748-0361.2005.tb00059.x.

Arizona Dept of Health Services, American Planning Association - Arizona Chapter, Arizona State University, Arizona Department of Transportation, Sonoran Institute, Maricopa County Dept of Public Health. 2012. *Tempe Streetcar Project*. Tempe, Arizona.

Badji, Samia, Hannah Badland, Jerome N. Rachele, and Dennis Petrie. 2021. "Public Transport Availability and Healthcare Use for Australian Adults Aged 18–60 Years, with and without Disabilities." *Journal of Transport & Health* 20 (March): 101001. <https://doi.org/10.1016/j.jth.2020.101001>.

Bell, Judith, and Larry Cohen. 2009. "The Transportation Prescription: Bold New Ideas for Healthy, Equitable Transportation Reform in America", *PolicyLink and the Prevention Institute Convergence Partnership*. [https://www.preventioninstitute.org/sites/default/files/publications/The%20Transportation%20Prescription\\_0.pdf](https://www.preventioninstitute.org/sites/default/files/publications/The%20Transportation%20Prescription_0.pdf).

Berke, Ehan M., Laura M. Gottlieb, Anne Vernez Moudon, and Eric B. Larson. 2007. "Protective Association Between Neighborhood Walkability and Depression in Older Men," *Journal of the American Geriatrics Society* 55, No. 4, (2007): 526–533.

Billings, Stephen, "Estimating the value of a new transit option," *Estimating the value of a new transit option*," *Regional Science and Urban Economics* 41 (2011): 525–536.

Brown, Melanie, Ariel Scholten, and Louie Leiva, eds. 2018. Rep. *Health Impact Assessment of Rainier RapidRide Bus Rapid Transit Project*. Seattle, Washington: University of Washington.

Bureau of Labor Statistics, "Productivity 101." December 2, 2024. <https://www.bls.gov/k12/productivity-101/content/what-is-productivity/>

Carter, T. J., & Johnson, L. T. (2023). "Blacks Can't Jump": The Racialization of Transit Police Responses to Fare Evasion. *Race and Justice*, 13(4), 463-487.

<https://doi.org/10.1177/21533687211007548>

Chen, C, and CE Menifield. 2017. "An Ecological Study on Means of Transportation to Work and Obesity: Evidence from US States." *TRANSPORT POLICY* 59 (October): 174–80.

<https://doi.org/10.1016/j.tranpol.2017.07.017>.

Christina Xiao, Yevgeniy Goryakin, Michele Cecchini. Physical Activity Levels and New Public Transit: A Systematic Review and Meta-analysis. *American Journal of Preventive Medicine*, 2019, 56, pp.464 - 473. 10.1016/. <https://hal.science/hal-03486103/>

Coalition of Communities of Color, <https://www.coalitioncommunitiescolor.org/>

Cole B., Agyekum G., Hoffman S., Shimkhada R. Mass Transit HIA: Potential Impacts of Governor's Proposed Redirection of California State Transportation Spillover Funds. HIA-CLIC; Los Angeles, CA, USA: 2008.

Dadashova, B., D. Reyes, C. Lee, C. Zhu, O. Wang, Z. Elgart, J. Schoner, R. Sandars, R. Thompson Panik, A. Boutros, M. Chioyenda, and J. Eisert. "Exploring Potential Contributors to Racial and Socioeconomic Inequities in Pedestrian and Bicyclist Morbidity and Mortality" (2024).

Del Rio, Michelle, William Hargrove, Joe Tomaka, and Marcelo Korc. 2017. "Transportation Matters: A Health Impact Assessment in Rural New Mexico." *International Journal of Environmental Research and Public Health* 14 (6): 629. doi:10.3390/ijerph14060629.

Durand, Casey P., Abiodun O. Oluyomi, Kelley Pettee Gabriel, Deborah Salvo, Ipek N. Sener, Deanna M. Hoelscher, Gregory Knell, et al. 2016. "The Effect of Light Rail Transit on Physical Activity: Design and Methods of the Travel-Related Activity in Neighborhoods Study." *Frontiers in Public Health* 4. <https://doi.org/10.3389/fpubh.2016.00103>.

"Equity in Transportation," Planning Portal, US Department of Transportation, last accessed August 27, 2023, [https://www.planning.dot.gov/planning/topic\\_transportationequity.aspx](https://www.planning.dot.gov/planning/topic_transportationequity.aspx).

Frank, L. D., Kuntz, J. L., Chapman, J. E., Fox, E. H., Dickerson, J. F., Meenan, R. T., Saelens, B. E., Young, D. R., Boone-Heinonen, J., & Fortmann, S. P. (2019). The Health and economic effects of light rail lines: design, methods, and protocol for a natural experiment. *BMC public health*, 19(1), 200. <https://doi.org/10.1186/s12889-019-6518-6>

Frank, Lawrence D., Eric H. Fox, Jared M. Ulmer, James E. Chapman, and Lindsay M. Braun. 2022. "Quantifying the Health Benefits of Transit-Oriented Development: Creation and Application of the San Diego Public Health Assessment Model (SD-PHAM)." *Transport Policy* 115 (January): 14–26. <https://doi.org/10.1016/j.tranpol.2021.10.005>.

Frank, Lawrence D., Jennifer L. Kuntz, James E. Chapman, Eric H. Fox, John F. Dickerson, Richard T. Meenan, Brian E. Saelens, Deborah R. Young, Janne Boone-Heinonen, and Stephen P. Fortmann. 2019. "The Health and Economic Effects of Light Rail Lines: Design, Methods, and Protocol for a Natural Experiment." *BMC Public Health* 19 (1). doi:10.1186/s12889-019-6518-6.

Freedman, David H, “Why Scientific Studies Are So Often Wrong: The Streetlight Effect,” Discover, last updated December 9, 2010, <https://www.discovermagazine.com/the-sciences/why-scientific-studies-are-so-often-wrong-the-streetlight-effect>.

Gostin LO, Powers M, “What does social justice require for the public's health? Public health ethics and policy imperatives,” *Health Affairs* 4 (Jul-Aug 2006):1053-60. doi: 10.1377/hlthaff.25.4.1053. PMID: 16835186.

Granados, Isa, Elizabeth L. Haderer, Cody D. Neshteruk, Sarah C. Armstrong, Asheley C. Skinner, and Emily M. D’Agostino. 2021. “The Association Between Neighborhood Public Transportation Usage and Youth Physical Activity.” *American Journal of Preventive Medicine* 61 (5): 733–37. <https://doi.org/10.1016/j.amepre.2021.04.035>.

Hansmann, Kellia J, Maggie Grabow, and Carolyn McAndrews. 2022. “Health Equity and Active Transportation: A Scoping Review of Active Transportation Interventions and Their Impacts on Health Equity.” *Journal of Transport & Health* 25 (June): 101346. <https://doi.org/10.1016/j.jth.2022.101346>.

“Health Equity,” CityHealth, last modified 2021, <https://www.cityhealth.org/about-us/equity-statement/>.

Hillier, Bill and Ozlem Sahbaz. 2006. “High Resolution Analysis of Crime Patterns in Urban Street Networks”, Presented at *University College London*.

Infrastructure Investment and Jobs Act, Pub. L. No. 117-58 (2021), <https://www.govinfo.gov/app/details/PLAW-117publ58>.

James, Peter, Kate Ito, Jonathan Buonocore, Jonathan Levy, and Mariana Arcaya. 2014. “A Health Impact Assessment of Proposed Public Transportation Service Cuts and Fare Increases in Boston, Massachusetts (U.S.A.)” *International Journal of Environmental Research and Public Health* 11 (8): 8010–24. doi:10.3390/ijerph110808010.

Jones, Camara, “Systems of Power, Axes of Inequity Parallels, Intersections, Braiding the Strands,” *Medical Care Volume* 52 (2014): No. 10 Suppl 3: 71-75, [http://www.tfah.org/wp-content/uploads/2020/08/Jones\\_SystemsofPower.pdf](http://www.tfah.org/wp-content/uploads/2020/08/Jones_SystemsofPower.pdf).

Karner, Alex, Jonathan London, Dana Rowangould, and Kevin Manaugh, “From Transportation Equity to Transportation Justice: Within, Through, and Beyond the State,” *Journal of Planning Literature* 35, No. 2 (May 2020): DOI:10.1177/0885412220927691.

Kim, K.-H., P. Kumar, J.E. Szulejko, A.A. Adelodun, M.F. Junaid, M. Uchimiya, and S. Chambers. 2017. “Toward a Better Understanding of the Impact of Mass Transit Air Pollutants on Human Health.” *Chemosphere* 174: 268–79. <https://doi.org/10.1016/j.chemosphere.2017.01.113>.

Klingbaum, Alissa, Adwoa Afful, Vinusha Gunaseelan, and Thrmiga Sathiyamoorthy. 2021. “Impacts of Light Rail Transit Development on Neighborhood Health: A Scoping Review through a Social Determinants of Health Lens.” *Journal of Transport & Health* 21 (June). <https://doi.org/10.1016/j.jth.2021.101063>.

Knell, Gregory, Casey P. Durand, Kerem Shuval, Harold W. Kohl, Iii, Deborah Salvo, Ipek N. Sener, and Kelley Pettee Gabriel. 2018. “Transit Use and Physical Activity: Findings from the Houston

Travel-Related Activity in Neighborhoods (TRAIN) Study.” *Preventive Medicine Reports* 9 (March): 55–61. <https://doi.org/10.1016/j.pmedr.2017.12.012>.

Krapp, Agustina. "Transportation Equity Project Prioritization Criteria." MUP Capstone, 2020, <https://hdl.handle.net/2142/108931>.

Laverty, Anthony A, Thomas Hone, Anna Goodman, Yvonne Kelly, and Christopher Millett. 2021. "Associations of Active Travel with Adiposity among Children and Socioeconomic Differentials: A Longitudinal Study." *BMJ Open* 11 (1): e036041. <https://doi.org/10.1136/bmjopen-2019-036041>.

Le, Vi T., and Andrew L. Dannenberg. 2020. "Moving Toward Physical Activity Targets by Walking to Transit: National Household Transportation Survey, 2001-2017." *American Journal of Preventive Medicine* 59 (3): e115–23. <https://doi.org/10.1016/j.amepre.2020.02.023>.

Lee, Chanan, Wei Li, Marcia Ory, Xuemei Zhu, Suojin Wang. 2023. "Fighting Obesity by Reinventing Public Transportation: A Natural Experiment."

Litman, Todd. 2020. *Evaluating Public Transportation Health Benefits*. Victoria Transport Policy Institute. [https://www.vtpi.org/tran\\_health.pdf](https://www.vtpi.org/tran_health.pdf).

MacDonald, John M., Stokes Robert J., Cohen, Deborah A., Kofner, Aaron, Ridgeway, Greg K., "The Effect of Light Rail Transit on Body Mass Index and Physical Activity," *American Journal of Preventative Medicine* 39, no 2 (2010): 105-112.

Mackett, Roger and Roselle Thoreau, "Transport, social exclusion and health," *Journal of Transport & Health* 2 (2015), 610-617. DOI:10.1016/j.jth.2015.07.006

Maizlish, Neil, Kenji Tomari, ChengSheng Jiang, Amy Weiher, Sarah Grajdura, Jonathan London, Linda Rudolph. 2019. "Integrated Transport and Health Impact Model." *CARB, CADPH, Nicholas Linsech Legacy Fund*.

Meenan, Richard T., Lawrence D. Frank, Brian E. Saelens, Deborah R. Young, Jennifer L. Kuntz, John F. Dickerson, Behram Wali, Erin M. Keast, and Stephen P. Fortmann. 2022. "Effects of an Urban Light Rail Line on Health Care Utilization and Cost: A Pre-Post Assessment." *Transport Policy* 123 (July): 112–20. <https://doi.org/10.1016/j.tranpol.2022.05.005>.

Metrolinx. 2018. Rep. *GO Expansion Full Business Case*. Metrolinx. [https://assets.metrolinx.com/image/upload/v1667497052/Images/Metrolinx/GO\\_Expansion\\_FBC.pdf](https://assets.metrolinx.com/image/upload/v1667497052/Images/Metrolinx/GO_Expansion_FBC.pdf).

Miller, Harvey J., Calvin P. Tribby, Barbara B. Brown, Ken R. Smith, Carol M. Werner, Jean Wolf, Laura Wilson, and Marcelo G. Oliveira. 2015. "Public Transit Generates New Physical Activity: Evidence from Individual GPS and Accelerometer Data before and after Light Rail Construction in a Neighborhood of Salt Lake City, Utah, USA." *Health Place* 36: 8–17. doi:10.1016/j.healthplace.2015.08.005.

Miller, Mark, Brian C. Castrucci, Rachel Locke, Julia Haskins, and Grace Castillo, eds. *Talking Health: A New Way to Communicate about Public Health*. Oxford University Press, 2022.

"Mobility Justice," *America Walks*, last accessed on August 27, 2023, <https://americawalks.org/resources/mobility-justice/>.

National Academies of Sciences, Engineering, and Medicine. 2022. Policies and Practices to Minimize Police Use of Force Internationally. Washington, DC: The National Academies Press. <https://doi.org/10.17226/26582>.

Oregon Health Authority (2014) "Transportation and Health: Health Impact Assessment," <https://www.oregon.gov/oha/PH/PROVIDERPARTNERRESOURCES/HEALTHINALLPOLICIES/Documents/transportation-hias.pdf>.

Patterson, Richard, Jenna Panter, Eszter P Vamos, Steven Cummins, Christopher Millett, and Anthony A Laverty. 2020. "Associations between Commute Mode and Cardiovascular Disease, Cancer, and All-Cause Mortality, and Cancer Incidence, Using Linked Census Data over 25 Years in England and Wales: A Cohort Study." *The Lancet Planetary Health* 4 (5): e186–94. [https://doi.org/10.1016/S2542-5196\(20\)30079-6](https://doi.org/10.1016/S2542-5196(20)30079-6).

Porter JM, Giles-Cantrell B, Schaffer K, Dutta EA, Castrucci BC, "Awareness of and Confidence to Address Equity-Related Concepts Across the US Governmental Public Health Workforce," *J Public Health Manag Pract* 29, Suppl 1, (Jan-Feb 2023): S87-S97. doi: 10.1097/PHH.0000000000001647. Epub 2022 Oct 12. PMID: 36223509; PMCID: PMC9722375.

Porter, J. and Pamukcu, A. (2025). *Advancing Equity and Justice*. American Public Health Association (APHA) Press. [Publication forthcoming].

"Principles of Mobility Justice," The Untokening, last modified November 11, 2017, <http://www.untokening.org/updates/2017/11/11/untokening-10-principles-of-mobility-justice>.

Public Health Alliance of Southern California. 2018. "California Healthy Places Index." <https://www.healthyplacesindex.org/>

"Public Transportation In The US: A Driver Of Health And Equity," Health Affairs Health Policy Brief, July 29, 2021. DOI: 10.1377/hpb20210630.810356

Rep. 2019. Public Transit and Health: Best Practices Report. Ohio Department of Public Health.

Rep. 2021. *Transit Equity & Environmental Health in Baltimore City*. Baltimore, Maryland: Johns Hopkins School of Public Health.

Richard Patterson and others, Associations of Public Transportation Use with Cardiometabolic Health: A Systematic Review and Meta-Analysis, *American Journal of Epidemiology*, Volume 188, Issue 4, April 2019, Pages 785–795, <https://doi.org/10.1093/aje/kwz012>

Ricklin, Anna. 2008. *The Red Line Transit Project Health Impact Assessment*. Baltimore, Maryland: Baltimore City Department of Transportation. <https://www.pewtrusts.org/-/media/assets/2008/12/19/baltimoredredline.pdf>.

Saelens, Brian E., Richard T. Meenan, Erin M. Keast, Lawrence D. Frank, Deborah R. Young, Jennifer L. Kuntz, John F. Dickerson, and Stephen P. Fortmann. 2022. "Transit Use and Health Care Costs: A Cross-Sectional Analysis." *Journal of Transport & Health* 24: 101294. <https://doi.org/10.1016/j.jth.2021.101294>.

"Safety for All." July 2021. TransitCenter, <https://transitcenter.org/wp-content/uploads/2021/07/SafetyForAll.pdf>.

She, ZW, DM King, and SH Jacobson. 2019. "Is Promoting Public Transit an Effective Intervention for Obesity? A Longitudinal Study of the Relation between Public Transit Usage and Obesity." TRANSPORTATION RESEARCH PART A-POLICY AND PRACTICE 119 (January): 162–69.

<https://doi.org/10.1016/j.tra.2018.10.027>.

"Social Determinants of Health," US Department of Health & Human Services, Office of Disease Prevention and Health Promotion, last modified August 27, 2023, <https://health.gov/healthypeople/priority-areas/social-determinants-health>.

*South Central Neighborhoods Transit Health Impact Assessment*. Arizona Department of Health Services, 2015. [https://www.phoenix.gov/pddsites/Documents/PZ/pdd\\_pz\\_pdf\\_00501.pdf](https://www.phoenix.gov/pddsites/Documents/PZ/pdd_pz_pdf_00501.pdf)

Tech. 2020. *Plan Performance Public Health*. Southern California Association of Governments. [https://scag.ca.gov/sites/main/files/file-attachments/0903fconnectsocial\\_public-health.pdf?1606001755](https://scag.ca.gov/sites/main/files/file-attachments/0903fconnectsocial_public-health.pdf?1606001755).

Thomas, Destiny N., Navjot Heer, Imani Wyatt Mitchell, Alex Karner, Kaylyn Levine, Jonathan Shuster, and Kendra Ma. 2022. *Racial Equity, Black America, and Public Transportation, Volume 1: A Review of Economic, Health, and Social Impacts*. doi:10.17226/26710.

U.S. Department of Transportation, and Los Angeles County Metropolitan Transportation Authority. 2020. Rep. *Final Environmental Statement/Final Environmental Report for the East San Fernando Valley Transit Corridor Project*. Vol. 1. Los Angeles, CA.

United States. Centers for Disease Control and Prevention. *CDC Recommendations for Improving Health through Transportation Policy*. <https://www.cdc.gov/transportation/index.html>.

US Department of Transportation, Equity Action Plan 2023 Update, last updated September 2023, <https://www.transportation.gov/sites/dot.gov/files/2023-12/2023%20update%20to%20the%20DOT%20Equity%20Action%20Plan.pdf>.

US Department of Transportation. 2015. "Transportation and Health Tool." Last modified August 24, 2015. <https://www.transportation.gov/transportation-health-tool>.

Waka Kotahi NZ Transport Agency. 2023. *Monetised Benefits and Costs Manual*. Waka Kotahi NZ Transport Agency.

Wener, Richard E. and Gary W. Evans. 2007. "A Morning Stroll: Levels of Physical Activity in Car and Mass Transit Commuting," *Environment and Behavior* 39, No. 1 (2007): 62-74.

Williams, K. M., Kramer, J., Keita, Y., & Boyd, T. (2021). *Transportation Equity Toolkit: Transportation Equity Needs Assessment & Project Prioritization*. Center for Transportation Equity, Decisions & Dollars. <https://www.cutr.usf.edu/wp-content/uploads/2021/09/CTEDD-Transportation-Equity-Toolkit-04212021.pdf>.

Wolfe, Mary K., Noreen C. McDonald, and G. Mark Holmes. 2020. "Transportation Barriers to Health Care in the United States: Findings From the National Health Interview Survey, 1997–2017." *American Journal of Public Health* 110 (6): 815–22.

<https://doi.org/10.2105/AJPH.2020.305579>.

# A Case Studies

## Overview and Selection

The following table presents a summary of the five criteria that were used to assess and select each of the case studies.

### A.1: Summary of Selection Criteria

Study Objectives (Assessment Criteria)	Guiding Questions	Summarized Objective
<p><b>Key health benefits.</b> Present best available research on the health benefits of public transportation in urban, suburban, and rural areas including, but not limited to,</p> <ul style="list-style-type: none"> <li>the physical and mental health of transit passengers,</li> <li>air and noise quality of communities,</li> <li>access to destinations that address the social determinants of health (such as work, grocery stores, healthcare, education, and green space), and</li> <li>improved safety.</li> </ul>	<ul style="list-style-type: none"> <li>Does the case study cover a wide range of health outcomes (scope)?</li> <li>Does the case study address social determinants of health and/or community health?</li> <li>Does the case study touch on any topics that are not normally analyzed?</li> </ul>	<p>Presents best available research on a comprehensive range of health outcomes (scope) resulting from public transportation investments</p>
<p><b>Equity.</b> Address equity considerations and barriers regarding the health benefits of public transportation for all communities and for current and potential transit riders.</p>	<ul style="list-style-type: none"> <li>Does the impact area include majority disadvantaged populations?</li> <li>Does the study disaggregate to specify the impact on disadvantaged populations?</li> <li>Does the study provide recommendations to improve the equitable outcomes?</li> </ul>	<p>Address equity considerations and barriers regarding the health benefits of public transportation</p>
<p><b>Added health benefits.</b> Identify improvements that public transportation agencies and their partners can implement to further increase health benefits and mitigate the adverse health effects of public transportation.</p>	<ul style="list-style-type: none"> <li>Does the case study provide recommendations on what can be done to further augment the health benefits of the investment (beyond stating that the project should/should not continue)?</li> <li>Does the case study present any methods to mitigate the adverse effects?</li> <li>Does the study provide recommendations to improve the equitable outcomes?</li> </ul>	<p>Identify improvements that agencies can make to maximize health benefits and minimize adverse health effects</p>
<p><b>Assessment.</b> Identify data, methods, and potential metrics that can be used to measure and track the</p>	<ul style="list-style-type: none"> <li>Does the case study make any contextualized quantitative estimates of outcomes?</li> </ul>	<p>Use of data, methods, and potential metrics</p>

Study Objectives (Assessment Criteria)	Guiding Questions	Summarized Objective
health benefits of public transportation.	<ul style="list-style-type: none"> <li>• What type of data does the case study use (literature review, secondary data review, focus groups, assessments)?</li> <li>• What level of aggregation is the data?</li> </ul>	
<p><b>Communication.</b> Provide actionable communication tools for use by public transportation agencies and their partners. The information presented should be in a format that can easily be conveyed to the public, transportation planners, and decision-makers (including policymakers and funders) on the health benefits of public transportation.</p>	<ul style="list-style-type: none"> <li>• Has the case study resulted in any new communication tools?</li> <li>• How are the results of the case study presented?</li> <li>• Are the results presented in a way that is digestible to the public and/or decision-makers?</li> </ul>	Provide actionable communication tools for use by various agencies

Based on this assessment and further feedback from the project panel, five studies were ultimately selected to serve as case studies, and they are discussed below.

The consideration of health impacts of public transportation has been most commonly undertaken through a Health Impact Assessment (HIA). This means that three of the five case studies are HIAs, which explore potential health impacts and benefits before projects are implemented. HIAs generally follow a six-step approach to assess different health outcomes:

- **Screening:** Determines the need for and value of HIA
- **Scoping:** Identifies the potential health impacts to evaluate (varies by case study), often includes Stakeholder Engagement to help scope the focus of the evaluation
- **Assessment:** Uses qualitative and quantitative data, expertise, and experience to judge magnitude and direction of potential health impacts and promoting positive health impacts
- **Recommendations:** Presents evidence-based mitigation strategies to promote potential positive impacts of a proposed project or policy and address any identified negative health impacts
- **Reporting:** Delivers results to stakeholders
- **Monitoring and Evaluation:** Efforts to track the effects of HIA, often limited in concrete steps or commitments that support delivery of this element.

In order to complement the pre-implementation nature of HIAs, the other two case studies are post-implementation studies.

Each of the case studies are organized to discuss the following aspects of each study:

- Overview and significance
- How public transportation agencies can use the case study
- Health impacts studied

- Methodology, tools, and approaches
- Outcome
- Key challenges and solutions
- Communication and engagement tools
- References

## Case Study 1: A Health Impact Assessment of Proposed Public Transportation Service Cuts and Fare Increases in Boston, Massachusetts (2014)

A Health Impact Assessment of Proposed Public Transportation Service Cuts and Fare Increases in Boston, Massachusetts	
<p><b>Overview &amp; Significance</b></p>	<p>The Health Impact Assessment of Proposed Public Transportation Service Cuts and Fare Increases in Boston, Massachusetts is a rapid Health Impact Assessment (HIA). The HIA evaluated health and economic effects of two fare increases and service cut scenarios in Boston’s public transportation system proposed to close a \$161 million budget gap faced by the Massachusetts Bay Transportation Authority (MBTA) in the 2013 fiscal year. This report was conducted over the course of eight weeks by Boston’s regional planning agency, the Metropolitan Area Planning Council (MAPC), with the help of a group of academics from Harvard and Boston Universities, in order to inform decision makers in the Massachusetts Legislature in the face of the budget gap. The report was conducted in the Boston, MA region, where the MBTA serves 175 cities and towns in a 3244 square mile area.</p> <p>This example is notable because it involves comparison of different policy options/alternatives related to transit affordability and was conducted by a regional planning agency in partnership with academic researchers.</p>
<p><b>How Can Public Transportation Agencies Use This?</b></p>	<p>This study is an example of how public agencies may use HIAs in order to inform their decision making when faced with a complicated legislative issue. It also demonstrates recognition of the interconnected nature of health impacts as they relate to public transportation; this kind of thinking is increasingly relevant to public agencies as they face the realities of dwindling budgets and increased demand moving forward.</p> <p>Because the study primarily relies on existing data sources rather than observed data, it would be feasible for other agencies to replicate aspects of this report to meet their needs. The modularity of the pathways would make this methodology easy to adapt to varying contexts and problems faced by the diverse transportation agencies.</p>
<p><b>Health Impacts Studied</b></p>	<p>The HIA focuses on seven health impacts that could be readily quantified, referred to as “pathways”:</p> <ul style="list-style-type: none"> <li>• Time Spent in Traffic and Fuel Costs</li> <li>• Crashes</li> <li>• Air pollution</li> <li>• Physical activity</li> <li>• Access to healthcare</li> <li>• Carbon Dioxide Emissions</li> <li>• Noise</li> <li>• The majority of these health impacts are focused on elements of community health, with the exception of crashes and physical activity, which are individual health markers.</li> </ul>

<p><b>Methodology, Tools &amp; Approaches</b></p>	<p>The purpose of the report was to compare how the two proposed fare increase and service cut scenarios would affect the seven pathways of the study. Because of time constraints, modelling and data analysis primarily cited existing data sets and tools, rather than the creation of any new, innovative methodology. The report utilized previously developed conceptual models for transportation HIAs but focused on environmental, social, and economic pathways.</p> <p>Datasets used varied in scope and origin based on the pathway being examined. The report also relied on significant collaboration with the Central Transportation Planning Staff (CTPS) of Boston’s Metropolitan Planning Organization for data. Data sources used include:</p> <ul style="list-style-type: none"> <li>• <b>Air pollution:</b> MOBILE 6.2 emissions model from US EPA, MassCHIP, CDC, EPA Benefits Mapping and Analysis Program (BenMAP)</li> <li>• <b>Physical Activity:</b> Health Economic Assessment Tool (HEAT) from WHO, National Household Travel Survey</li> <li>• <b>Crashes:</b> 2009 National Highway Traffic Safety Administration, American Automobile Association (AAA)</li> <li>• <b>Access to Healthcare:</b> American Community Survey (ACS)</li> <li>• <b>Carbon Dioxide Emissions:</b> National Academy of Sciences (NAS)</li> <li>• <b>Noise:</b> FHWA’s Transportation Noise Model (TNM)</li> <li>• </li> </ul> <p>This data-based approach was chosen for its efficiency given the time constraint for the research period. Similarly, because the question at hand was about budget management, a quantitative approach was the most relevant and effective. Through monetization of these quantified impacts, it was demonstrated that the additional health and economic costs under both scenarios exceeded the budget gap that needed to be filled.</p>
<p><b>Outcome</b></p>	<p>Because the study focused on examining the effects of proposals on the health pathways, the report fed directly into the decision-makers’ process towards coming up with a solution for the budget gap. By presenting monetized impacts in a succinct report, it appears the results were able to gain traction, and broaden the discourse to include consideration of health impacts.</p> <p>The final decision made by lawmakers was to use a third solution not originally proposed, using state and outside funding to close the budget deficit, which would allow for less fare increases and service cuts than either original proposal. While it is unclear if the proposed effects presented by the findings had any direct influence on the decisions made by the MBTA and Massachusetts Legislature, the report shed negative light on the health and economic impacts that the proposed service cuts would have on the community.</p>
<p><b>Key Challenges &amp; Solutions</b></p>	<p>The most significant barrier to the research process was the time constraint; the researchers completed the report in eight weeks. In order to address time limitations, certain methodologies and research avenues that were deemed too time-consuming and not valuable enough were eliminated; the most significant of these methods was stakeholder interviews and public engagement.</p> <p>Because of the narrow focus of the report and the time constraints, the research and results focus entirely on quantitative pathways or impacts and do not examine qualitative ones such as social equity and mental health.</p>

<p><b>Communication &amp; Engagement Tools</b></p>	<p>The communication tools used for engagement with decision-makers and the public were fairly straightforward. The report itself was kept relatively short at 20 pages plus a one-page executive summary and infographic, in order to keep the information legible to a wide audience. The findings from the report were published and presented at the public hearing held at the Massachusetts State House for the decision in question. Because of this, the report also gained traction with the press, and was picked up by local radio and tv stations to reach a broader public audience.</p>
<p><b>Reference</b></p>	<p>James, Peter, Kate Ito, Jonathan Buonocore, Jonathan Levy, and Mariana Arcaya. 2014. "A Health Impact Assessment of Proposed Public Transportation Service Cuts and Fare Increases in Boston, Massachusetts (U.S.A.)." <i>International Journal of Environmental Research and Public Health</i> 11 (8): 8010–24. doi:10.3390/ijerph110808010.</p>

**Case Study 2: Lynx Blue Line Cross-Sectional Studies in Charlotte, North Carolina (2010, 2011)**

<p><b>Lynx Blue Line Cross-Sectional Studies in Charlotte, North Carolina</b></p>	
<p><b>Overview &amp; Significance</b></p>	<p>This case study includes two papers that examined the impacts surrounding the Lynx Blue Line in Charlotte, North Carolina.</p> <p>Macdonald et al. specifically examines how LRT use affects the physical health of nearby residents and users using BMI, obesity, and meeting weekly recommended physical activity (RPA) levels as marker. The study is authored by a group of academics at the Universities of Pennsylvania and Drexel, in collaboration with medical professionals associated with the RAND Corporation.</p> <p>Billings et al. is not a Health Impact Assessment, but rather an economic study on the value of LRT for nearby neighborhoods. It is included in this assessment for its inclusion of factors that may be used as social determinants health in assessing value. The study was conducted by academics at the University of North Carolina-Charlotte’s Belk College Center for Real Estate.</p>
<p><b>How Can Public Transportation Agencies Use This?</b></p>	<p>The Macdonald et al. case could be highly relevant and duplicable for transit agencies looking to measure the impacts of a public transportation line before and after its implementation on the most geographically proximate communities. Analysis on how built environment would affect statistical likelihood of baseline characteristics would be highly transferable and useful to other agencies hoping to do similar comparative survey studies. The data used to identify the households surveyed was all public, and phone survey data only requires manpower and time to undertake. Though it is an easily quantifiable number, transit agencies may want to consider whether BMI is a relevant factor when examining the effects of public transportation on the physical health of users.</p> <p>Billings et al. may be a useful study in gauging the qualitative value of an LRT line and examining how perceived and real rates social determinants of health such as crime, may affect use of such projects in nascent planning stages.</p>

Lynx Blue Line Cross-Sectional Studies in Charlotte, North Carolina	
Health Impacts Studied	<p>Macdonald et al. focuses exclusively on the impacts on physical health as elements of individual health, using the following markers:</p> <ul style="list-style-type: none"> <li>• BMI</li> <li>• Obesity (BMI <math>\geq 30</math>)</li> <li>• Weekly RPA levels</li> </ul> <p>The outcome of the study found that LRT users in Charlotte lost, on average, 6.42lbs, saw a decrease in BMI, and were 81% less likely to become obese.</p> <ul style="list-style-type: none"> <li>• Billings et al. does not examine health impacts, but rather studies crime as a factor that can be associated with social determinants of health. The study found that the announcement of the new LRT opening was associated with a decreased rate of crime. However, the actual opening of the LRT had no effect on crime.</li> </ul>
Methodology, Tools & Approaches	<p>Macdonald et al. used telephone survey data along with data on physical landmark characteristics taken from Info USA, the U.S. GDC Park Landmarks, and Census Tiger/Line Files. Telephone survey data was used to assess user perception of physical and social environments, and daily travel and exercise patterns. Data on BMI was self-reported.</p> <p>The first part of the study examined how individual and neighborhood environment factors affect factors such as BMI, odds of obesity, and odds that respondents meet recommended RPA, in order to establish a baseline prior to LRT exposure. The second part of the report had participants of the survey, living within a mile radius of the South Corridor Light Rail line, surveyed before and after the opening of the light rail line on their physical activity. A key part of the methodology was to mitigate the potential influence of selection bias by using a model that sought to equalize the treatment and control groups on baseline variables that predicted the use of LRT. The results from the surveys were then compared to see if transit has any effect on physical activity and health. Physical activity was assessed using a modified version of the International Physical Activity Questionnaire.<sup>1</sup></p>
Outcome	<p>The Macdonald et al. case study provides evidence that links public transportation use to increased physical activity (in this case additional walking), as manifested by reduced levels of obesity.</p>
Key Challenges & Solutions	<p>The study notes a few challenges:</p> <ul style="list-style-type: none"> <li>• Surveys involved self-reported health information which can lead to unreliable estimates of height and weight (and therefore BMI). However, the study does note that the estimated average weight reduction appears to be plausible, given the amount of additional amount of walking that could be expected to be associated with use of the new LRT.</li> <li>• Because of the low proportion of LRT users in the sample, the confidence intervals were large, suggesting that a larger sample size could have been beneficial.</li> <li>• Related to above, there was a notable loss of sample in the after survey, because of the need to continuously reside in the catchment area. There is also the potential that other confounding variables were not captured.</li> </ul> <p>The authors suggest that establishing longer term impact of light rail on obesity would require subsequent follow-up studies, that include large samples and direct measurement of walking distance (such as by using pedometers).</p>

Lynx Blue Line Cross-Sectional Studies in Charlotte, North Carolina	
Communication & Engagement Tools	Neither study used additional tools to engage with stakeholders and public about findings from the study.
Reference	<p>MacDonald, John M., Stokes Robert J., Cohen, Deborah A., Kofner, Aaron, Ridgeway, Greg K., "The Effect of Light Rail Transit on Body Mass Index and Physical Activity," <i>American Journal of Preventative Medicine</i> 39, no 2 (2010): 105-112.</p> <p>Billings, Stephen, "Estimating the value of a new transit option," <i>Regional Science and Urban Economics</i> 41 (2011): 525-536.</p>

### Case Study 3: Southern New Mexico Transportation Matters (2017)

Southern New Mexico Transportation Matters: A Health Impact Assessment in Rural New Mexico	
<b>Overview &amp; Significance</b>	<p>This case study consists of a HIA that was conducted to provide evidence to inform a decision to expand local bus service to rural, low-income communities in Dona Ana County, a primarily rural county in southern New Mexico. Researchers representing the Center for Environmental Resource Management (CERM) at the University of Texas at El Paso, the College of Health and Social Sciences at New Mexico State University, and the World Health Organization conducted the study over a two-year period (2015-2017).</p> <p>This study is among the first of its kind conducted on public transportation (specifically fixed-route bus service) in rural areas. The pilot bus service was also the first/only public transportation option for residents.</p>
<b>How Can Public Transportation Agencies Use This?</b>	<p>This study reveals how public transportation agencies can leverage quantitative (surveys) and qualitative methods (focus groups and interviews) to understand the potential local health impacts of a new fixed-route bus service. The community survey was translated into Spanish, acknowledging the importance of language equity.</p> <p>This provided evidence on health benefits to enable a more balanced public discourse that does not solely focus on operating costs. This was achieved by setting out the benefits of public transportation investment to users, in this case specifically for rural residents. Although this study does note that more in-depth quantitative analysis may have been beneficial, its outcomes show that even where quantitative analysis is not possible, qualitative assessment can still provide locally specific evidence that can lead to more informed conversations around health benefits.</p>
<b>Health Impacts Studied</b>	<p>The study primarily examined impacts on social determinants of health, including access to:</p> <ul style="list-style-type: none"> <li>• Health care services</li> <li>• Healthy foods</li> <li>• Education opportunities (e.g., community colleges, universities, adult learning)</li> <li>• Economic development opportunities (e.g., jobs, workforce training, and consumer goods activities)</li> </ul>
<b>Methodology, Tools &amp; Approaches</b>	<p>The study used the following tools and approaches to collect information from residents about their health issues and their likelihood of using public transportation:</p> <ul style="list-style-type: none"> <li>• <b>Community Survey</b> (offered in Spanish and English): Distributed to individuals living within the study area, the survey asked residents about the types of services (such as goods and services) they would like to access.</li> <li>• <b>Bus Rider Survey</b>: Distributed to current bus passengers, this survey collected information about passengers’ intended destinations, travel time, transportation mode used to access bus stops, and perceptions, as well as personal information.</li> <li>• <b>Informant Interviews</b>: The research team conducted interviews with professionals from sectors such as health, education, business, and economic development to understand the impacts of public transportation with respect to health, education, economy, workforce development, and the environment.</li> </ul>

Southern New Mexico Transportation Matters: A Health Impact Assessment in Rural New Mexico	
	<ul style="list-style-type: none"> <li> <b>Focus Group:</b> The research team convened one focus group with 13 <i>promotoras</i> (paraprofessional community health workers) to explore local health conditions and the benefits of public transportation.                     </li> </ul> <p>The study wove in national statistics as a way to touch on elements the authors were unable to investigate themselves. For example, in examining the benefits of access to healthcare, the study cites several examples from the National Prevention Strategy of the U.S. Department of Health and Human Services of how preventative healthcare is in fact cost-effective. Some of these examples include:</p> <ul style="list-style-type: none"> <li>A 5% reduction in prevalence of hypertension could save \$5 billion nationally in 5 years. This translates to about \$250,000 in southern Dona Ana County</li> <li>Increasing use of preventative services, such as tobacco cessation screening, alcohol abuse screening and aspirin use, could save \$3.7 billion annually nationwide, or about \$350,000 in southern Dona Ana County</li> <li>Asthma, high blood pressure, smoking, and obesity each reduce annual productivity by between \$200 and \$440 per person.</li> </ul> <p>The study notes that the aforementioned statistics do not exist for New Mexico and therefore county estimates may be skewed.</p>
<b>Outcome</b>	<p>At the time of the study’s publication, the pilot remained operational; though, no decision had yet been made with respect to long-term permanent funding. However, the authors of study conducted this HIA in part to inform the practice of HIA in resource-poor rural communities in the United States and abroad.</p> <p>Civic discourse at the time of the initial vote to raise the general revenue tax to fund this project was heavily focused on cost concerns rather than benefits. This HIA was presented gave proponents of the bus system information regarding benefits, which helped to bolster support for the project.</p>
<b>Key Challenges &amp; Solutions</b>	<p>Generally speaking, although the study outlined many potential benefits that bus services could bring to the area, a key challenge was that planning and implementing public transportation in rural areas such as southern Dona Ana County can face difficulties that are less prevalent in urban areas, such as:</p> <ul style="list-style-type: none"> <li>No existing public transportation services</li> <li>Long travel distances between destinations (20-40mi one way)</li> <li>High rates of poverty and lack of social services</li> <li>Difficulty matching scheduling to desired destinations at appropriate times (for example times that are appropriate across different uses, such as for travel to work, school, shopping, and health care)</li> </ul>
<b>Communication &amp; Engagement Tools</b>	<p>Study itself was used as an engagement tool to inform the South Central Regional Transit District (SCRTD) of New Mexico and Dona Ana County and community stakeholders about the health and related benefits of rural transit services, which helped to shift the discourse away solely focusing on the cost of running the service. Community surveys were distributed in Spanish and English to remove barriers to participation for non-English speaking residents.</p>

Southern New Mexico Transportation Matters: A Health Impact Assessment in Rural New Mexico	
<b>Reference</b>	Del Rio, Michelle, William Hargrove, Joe Tomaka, and Marcelo Korc. 2017. "Transportation Matters: A Health Impact Assessment in Rural New Mexico." <i>International Journal of Environmental Research and Public Health</i> 14 (6): 629. doi:10.3390/ijerph14060629.

**Case Study 4: South Central Neighborhoods Transit Health Impact Assessment (SCNTHIA), Phoenix, Arizona (2015)**

South Central Neighborhoods Transit Health Impact Assessment (SCNTHIA)	
<b>Overview &amp; Significance</b>	<p>This case study provides an example of an HIA process that gathered information on expected health outcomes associated with a public transportation project, as well as a detailed list of recommendations on how the project could maximize health benefits.</p> <p>The HIA was conducted by the Maricopa County Department of Public Health, the Arizona Department of Health Services, and the Arizona Alliance for Livable Communities (with the help of key partners) from 2013 to 2015, to examine the connections between public health and an extension of an existing light rail transit (LRT) system in Phoenix.</p> <p>The City of Phoenix and Valley Metro proposed to extend the existing LRT to connect South Central and South Phoenix neighborhoods. This extension would be part of a larger planning effort to introduce a high-capacity transit corridor connecting South and Central Phoenix with downtown and the existing LRT. The specific focus of this HIA was in the South Central neighborhood of Phoenix, with comparisons to the wider Maricopa County area, State of Arizona, and the United States (where data was available).</p>
<b>How Can Public Transportation Agencies Use This?</b>	<p>This case study highlights the potential health benefits of public transportation projects and provides clear recommendations on how health benefits can be maximized. However, it is also valuable in that it demonstrates how a community-driven process, that involves a panel of community members from scoping to recommendations, can assist agencies in understanding the key health issues in their local area and how investment in public transportation can create health benefits.</p>

South Central Neighborhoods Transit Health Impact Assessment (SCNTHIA)	
Health Impacts Studied	<p>While the health impacts on all residents were considered, the HIA focused on the unique needs of pregnant women; families with children or youth with special health care needs; and adults with chronic conditions (including developmental, physical, and sensory disabilities). A community advisory group consisting of dedicated local residents and representatives of local organizations—the Insight Committee—provided guidance for the health impact assessment (HIA).</p> <p>Using a Social Determinants of Health model, the Insight Committee (IC) found that the transit corridor’s greatest impacts to the health of the community came through six critical “pathways to health”. IC members participated in a facilitated “Tree Exercise”, where they listed several disease outcomes prevalent in their community. IC members then identified diseases and health conditions, resulting behaviors and practices, and the social, economic, and political determinants that influence the behaviors they described. The outcomes of this exercise resulted in the identification of 6 pathways, which guided the study’s research questions and methods. These pathways included:</p> <ul style="list-style-type: none"> <li>•</li> <li>• <b>Landscape/Shade/Security</b> - An environment supportive of healthy living needs to be safe and inviting for the public. The intense Arizona sun and the urban heat island affect in Phoenix limit active living.</li> <li>• <b>Transportation Costs</b> - A major transit project may alter transportation costs. Examine the impact on cost and its relationship to health.</li> <li>• <b>Business and Employment</b> - Equitable opportunity to good jobs is a key factor of prosperity and health. Explore how changing transportation opportunities might impact income, health insurance, and health care.</li> <li>• <b>Housing</b> - A healthy family needs quality and safe housing within their budget. Major transit projects can influence housing conditions and social cohesion among residents.</li> <li>• <b>Access to healthy food, safe places to play, and health care</b> - Increasing transit options can improve access and public health.</li> <li>• <b>Active Transportation</b> -How the environment supports walking, cycling, and access to transit, collectively known as Active Transportation, affects physical activity and health.</li> </ul> <p>The SCNTHIA project team classified the following sub-groups as priority populations, those who would be most affected by the proposed transit project:</p> <ul style="list-style-type: none"> <li>• Families with children/youth with special health care needs</li> <li>• Adults with chronic conditions (including developmental, physical, and sensory disabilities)</li> <li>• Pregnant women</li> </ul>

<b>South Central Neighborhoods Transit Health Impact Assessment (SCNTHIA)</b>	
<b>Methodology, Tools &amp; Approaches</b>	<p>This study uses a Social Determinants of Health model and a HIA. Multiple assessment methodologies led to a comprehensive understanding of issues / opportunities, as well as recommendations. Methods included:</p> <ul style="list-style-type: none"> <li>• Literature review</li> <li>• Epidemiologic reviews of multiple data sources/secondary data review</li> <li>• Focus groups</li> <li>• Key informant interviews</li> <li>• Surveys</li> <li>• Walkability assessments</li> </ul> <p>These methodologies were selected to capitalize on the most current and accurate data sources and to incorporate the voice of the community. Data tools that were utilized ranged from those familiar to public health to ones that have never before been accessed by MCDDPH public health epidemiologists. Examples of the latter include Valley Metro studies and data from City of Phoenix departments including injury data. Four focus groups with each of the three target population groups were conducted, in addition to 20 key informant interviews and 300 surveys collected at community events, by organizations in the study area and via the Internet. Findings were returned to the IC for review and then used to develop and report on recommendations.</p> <p>The study includes recommendations for each pathway along with a timeframe for consideration, and the agency responsible for its implementation.</p>
<b>Outcome</b>	<p>This HIA clearly sets out the potential health benefits of the project and recommendations on how it could be improved, informed by the community-driven input of the Insight Committee. This locally specific evidence could be used to drive greater awareness of the health benefits of the projects as well as how it could maximize health benefits; however, the extent to which the HIA has informed infrastructure and funding decisions made on this project is unknown, which underscores the important of evaluation and storytelling when communicating results.</p>
<b>Key Challenges &amp; Solutions</b>	<p>There were two health impact pathways that were ultimately omitted from the HIA, due to varying reasons:</p> <ul style="list-style-type: none"> <li>• Air quality: This was omitted due to the substantial resources associated with complex air quality modelling</li> <li>• Crime: This was omitted as crime data was not available at a sufficient spatial resolution to identify crime taking place in proximity to the light rail line</li> <li>• In addition, the following impacts were also not analyzed:                             <ul style="list-style-type: none"> <li>• Full economic analysis of the LRT (separate analysis and data required)</li> <li>• Property value and housing costs (Separate analysis and data required)</li> <li>• Racial and ethnic equity impacts (distribution of impact/benefits)</li> </ul> </li> </ul>
<b>Communication &amp; Engagement Tools</b>	<p>The community-driven nature of this HIA was enabled by the use of an Insight Committee, which was made up of multiple community groups. This committee was involved throughout the entire process, from the scoping of the HIA, through to taking the lead on developing recommendations. It appears that this approach helped to ensure that the HIA was appropriate to the local context by enabling it to focus on and respond to issues of most concern to the local community.</p> <p>The recommendations at the end of the report are easy to understand and reference for the public as well as planning officials.</p>

South Central Neighborhoods Transit Health Impact Assessment (SCNTHIA)	
Reference	<i>South Central Neighborhoods Transit Health Impact Assessment</i> . Arizona Department of Health Services, 2015. maricopa-cnty-ph-2015-scnthia-report.pdf (pewtrusts.org)

**Case Study 5: The Rails & Health Study in Portland, Oregon (2019, 2022)**

The Rails & Health Study in Portland, Oregon	
<b>Overview &amp; Significance</b>	<p>Three reports combine to create this case study, which assesses and documents how a new transportation option (i.e., MAX LRT expansion between Portland and Milwaukie, OR) can alter physical activity, health, and health care costs over time. These studies provide valuable data and contribute unique methods for conducting this sort of analysis, the description of which is included in this paper.</p> <p>A group of researchers partnered with health care provider Kaiser Permanente to conduct the studies, including Urban Design 4 Health, Inc., Centre for Health Research, Kaiser Permanente Northwest, Oregon, Health &amp; Community Design Lab, Schools of Population and Public Health and Community and Regional Planning, University of British Columbia, Seattle Children’s Research Institute and the University of Washington, WA, Center for Research &amp; Evaluation, Kaiser Permanente Southern California, Oregon Health &amp; Science University, School of Public Health.</p> <p>The first is a prospective study by Frank et al. following 3036 adults exposed to a new LRT line and a similar cohort of adults who do not live close to the new line. Saelens et al. examined the effect of transit use on levels of physical activity, as well as healthcare costs. Wali et al. examined the impact of LRT on health care costs after controlling for mode-specific objectively assessed moderate-to-vigorous physical activity (MVPA), participant-level neighborhood environmental measures, demographics, attitudinal predispositions, and residential choices.</p>
<b>How Can Public Transportation Agencies Use This?</b>	<p>The information generated from this case study could be helpful for project decision-making, by providing evidence that is based on the tracking of individual-level outcomes. While the level of detail and effort required to deploy this type of study is likely far beyond the capacity of public agencies to conduct by themselves, it demonstrates how partnerships with research and healthcare organizations can enable this type of more in-depth research to be undertaken.</p> <p>Notwithstanding this, the reported results provide evidence of the health benefits that could accrue through investment in LRT and may therefore be transferable to similar projects elsewhere. It is noted that cost-benefit tools currently used to justify transportation investments do not account for the health impacts and costs they incur, resulting in decisions that promote roadway improvements over transit and non-motorized investments. Internalizing these costs within the transportation investment process has the potential to better estimate the collective societal impacts of these major investments.</p>

The Rails & Health Study in Portland, Oregon	
<b>Health Impacts Studied</b>	<p>The studies evaluate changes in physical activity, health and health care utilization, and costs over time among Kaiser Permanente Northwest (KPNW) members. The Frank et al study examines four outcome measures: medical care costs, body mass index, blood pressure, and laboratory data for the overall cohort. In a subsample of the study population, Wali et al. collected direct measures of travel-related behavior, including levels of physical activity, to document mechanisms responsible for observed changes in health outcomes and costs. The Saelens et al study examined health care costs.</p>
<b>Methodology, Tools &amp; Approaches</b>	<p>All studies use members of Kaiser Permanente Northwest (KPNW) as their study participants. Wali et al. and Saelens et al. used statistical analyses to (1) examine the effects of opening a new LRT line on chronic disease indicators, health care utilization, and health care costs and (2) evaluate the degree to which observed effects of the LRT line on health measures and costs are mediated by changes in total and transportation-associated physical activity. In general, the approach taken is a natural experiment, examining how outcomes differ based on exposure to the new LRT line.</p> <p>In the Frank et al study, individual-level data was extracted from KPNW medical records. This was complemented by a survey of participants, which captured data on factors including demographics, travel patterns, physical activity (PA), and perceived neighborhood walkability. Data on the characteristics of the built environment (both baseline and after LRT construction) was also collected.</p> <p>Participants in Saelens et al. participated in a self-directed survey on personal travel and activity habits, but healthcare costs were taken directly from a standardized medical care costing model developed at KPNW to account for all services, procedures, and products received by the individual, and translating those services into dollar amounts:</p> <ul style="list-style-type: none"> <li>• <b>Outpatient costs</b> were calculated based on Medicare relative value units for procedures provided as part of an outpatient visit.</li> <li>• <b>Medication costs</b> were calculated by approximate retail costs, with additional external pharmacy dispense data captured via pharmacy claims.</li> <li>• <b>Inpatient costs</b> were estimated based on the stay’s assigned diagnosis-related group (DRG), calculated by summing: a base cost derived from Medicare’s DRG reimbursement, a professional per-diem multiplied by length of stay, and an additional adjustment for unusually long lengths of stays when applicable.</li> </ul> <p>Wali et al. used five individual-level data streams:</p> <ul style="list-style-type: none"> <li>• Health care cost data obtained from the KPNW Electronic Medical Records (EMR)</li> <li>• MVPA measures collected through GPS and accelerometers</li> <li>• Travel diary data obtained from a modified version of 2009 National Household Travel Survey (NHTS)</li> <li>• Transportation and neighborhood perception survey to collect detailed information on demographics, perceived built environment, perceived crime, residential choices, travel in a typical week, social cohesion, travel preferences and attitudes</li> <li>• Objectively assessed measures of the built environment surrounding a participant’s main residential address created using Pedestrian-enhanced walkable road network</li> </ul>

The Rails & Health Study in Portland, Oregon	
<b>Outcome</b>	<ul style="list-style-type: none"> <li>• The Frank et al study functions as a baseline, for the results of future studies to be compared against. The prospective study does not discuss key findings or recommendations.</li> <li>•</li> <li>• The Saelens et al study suggests that individuals may experience \$5500 in medical savings from higher physical activity and lower obesity rates associated with transit. The study found that transit users did have lower health care costs than those not using transit.</li> <li>•</li> <li>• Wali et al. found the following:             <ul style="list-style-type: none"> <li>• There is no significant effect on average healthcare costs post-LRT opening, but the study may need to be undertaken over a longer period of time</li> <li>• Walkability and access to rail stations reduced healthcare costs at varying rates across individuals</li> </ul> </li> </ul> <p>Residential choice and predisposed attitude are important proxies for self-selection into areas promoting active travel</p>
<b>Key Challenges &amp; Solutions</b>	<p>The study by Saelens et al. notes that given its cross-sectional design, the presence, direction, and magnitude of a causal relationship between transit use and health care costs is unknown. For example, it is unclear through the data whether transit users tend to be more “able-bodied” and therefore able to access and take transit at all. Transit use is likely not the only mechanism associated with reduced healthcare costs, but it is acknowledged as essential to create the land use patterns and levels of walkability associated with active living.</p> <p>Saelens et al. also note that the study does not consider transit use across a wide variety of transit user types or alternatively, across a wide variety of income brackets. The sample of population studied that opted into the online were primarily well-educated, generally healthy, relatively racially homogenous, and were all members in a private managed care organization from a single metropolitan area.</p>
<b>Communication &amp; Engagement Tools</b>	Not applicable.
<b>Reference</b>	<p>Frank, L. D., Kuntz, J. L., Chapman, J. E., Fox, E. H., Dickerson, J. F., Meenan, R. T., Saelens, B. E., Young, D. R., Boone-Heinonen, J., &amp; Fortmann, S. P. (2019). The Health and economic effects of light rail lines: design, methods, and protocol for a natural experiment. <i>BMC public health</i>, 19(1), 200. <a href="https://doi.org/10.1186/s12889-019-6518-6">https://doi.org/10.1186/s12889-019-6518-6</a></p> <p>Saelens, Brian E., Richard T. Meenan, Erin M. Keast, Lawrence D. Frank, Deborah R. Young, Jennifer L. Kuntz, John F. Dickerson, and Stephen P. Fortmann. 2022. “Transit Use and Health Care Costs: A Cross-Sectional Analysis.” <i>Journal of Transport &amp; Health</i> 24: 101294. <a href="https://doi.org/10.1016/j.jth.2021.101294">https://doi.org/10.1016/j.jth.2021.101294</a>.</p> <p>Wali, Behram, Frank, Lawrence D., Young, Deborah R., Meenan, Richard T., Saelens, Brian E., Dickerson, John F., Fortmann, Stephen P., “Causal evaluation of the health effects of light rail line: A natural experiment,” <i>Journal of Transport &amp; Health</i> 24 (2022): doi:10.1016/j.jth.2021.101292.</p>

