



Economic and Health Benefits of Bicycling and Walking

State of Colorado

REPORT



Report

October 6, 2016

Economic and Health Benefits of Bicycling and Walking

Prepared for

Colorado Office of Economic Development and International Trade
1625 Broadway, Suite 2700
Denver, Colorado 80202

Prepared by

BBC Research & Consulting
1999 Broadway, Suite 2200
Denver, Colorado 80202-9750
303.321.2547 fax 303.399.0448
www.bbcresearch.com
bbc@bbcresearch.com



Table of Contents

I. Introduction and Summary of Statewide Results

Background.....	I-1
Study Objectives.....	I-2
Summary of Statewide Results.....	I-3
Structure of the Report	I-8

II. Literature Review

Documenting the Benefits of Bicycling and Walking.....	II-1
Overview of Bicycling and Walking	II-2
Other Community Benefits of Bicycling and Walking.....	II-3

III. Methodology

Bicycling and Walking Activity and Public Opinion.....	III-1
Economic Benefit Analysis.....	III-3
Health Benefit Analysis.....	III-8

IV. Bicycling & Walking Behaviors and Opinion

Bicycling Behavior.....	IV-1
Walking Behavior.....	IV-7
Public Opinion	IV-11

V. Economic and Health Benefits

Economic and Health Benefits of Bicycling and Walking in Colorado.....	V-1
Household Spending.....	V-2
Bicycle Retail and Manufacturing.....	V-4
Tourism.....	V-5
Health Benefit Analysis Results	V-8

Appendices

- A. Bicycling Infographic
- B. Walking Infographic

SECTION I.

Introduction and Summary of Statewide Results

SECTION I.

Introduction and Summary of Statewide Results

To better understand the economic and health benefits of bicycling and walking in Colorado, the Colorado Office of Economic Development and International Trade, Colorado Department of Public Health and the Environment, Colorado Department of Transportation (CDOT), and the Colorado Pedals Project commissioned BBC Research & Consulting and Alta Planning & Design ("the study team") to conduct a study of bicycling and walking behavior statewide and the economic and health benefits of such activity.

Background

Colorado ranks as one of the healthiest states in the country, boasting one of the nation's highest rates of physical activity and lowest rates of obesity.¹ Compared to the country as a whole, Colorado residents have 50 percent greater access to parks and recreation facilities, such as trails, bikeways, and multi-use paths, which make it convenient and affordable to get outside and exercise.² The state has invested heavily in bicycle and pedestrian infrastructure over the past several decades creating over 5,000 miles of trails in an effort to encourage residents to be physically active. The State Transportation Commission plans to continue its commitment to active transportation by seeking dedicated funding for bicycle and pedestrian infrastructure including crossing signal improvements, cross walks and sidewalk improvements, trails and safe connections. In 2015, Governor John Hickenlooper announced the Colorado Pedals Project, a four year initiative to expand and elevate bicycle and pedestrian infrastructure and programs with the goal of becoming the "healthiest state in the nation."

The ability to measure the economic and health benefits of past and proposed investments in bicycle and pedestrian infrastructure is critical in order to inform policy makers and stakeholders in their decisions about where and how best to dedicate resources.

¹ Center for Disease Control and Prevention. 2010. *State Indicator Report on Physical Activity, 2010*. Center for Disease Control and Prevention. Washington D.C.: U.S. Department of Health and Human Services. Retrieved April 28, 2016. (https://www.cdc.gov/physicalactivity/downloads/PA_State_Indicator_Report_2010.pdf)

² Colorado (59 percent) trails behind only Hawaii (67 percent) and Minnesota (60 percent) in the percent of its population living within half a mile of a park: <http://www.ephracking.cdc.gov>

Study Objectives

The study objectives include:

- Estimating statewide bicycling and walking behavior and public opinion related to bicycling and walking infrastructure and accessibility;
- Estimating the statewide economic benefit of bicycling and walking;
- Estimating the statewide health benefit of bicycling and walking.

The study team's methodology is based on a comprehensive review of economic benefits and impact studies on bicycling and walking. While numerous studies have been completed on this topic, the majority rely on secondary data to estimate statewide bicycling and walking rates and the economic impacts of such activity with secondary data. Given the detailed scope of our study, the study team was unable to rely on secondary data sources alone. Instead, the study team used secondary data for some estimates and calculated all other estimates using primary data collected in a survey of Colorado residents. Through this hybrid approach, the study team was able to present a current and accurate estimate of bicycling and walking activity and the impact of that activity on the Colorado economy.

The following components were included in the calculation of the economic benefits for the State of Colorado:

- Household spending on bicycles and related goods and services;
- Household spending on walking and related equipment;
- Household spending on bicycle-related events, races, and tourism;
- Revenues from bicycle retail and manufacturing businesses;
- Spending related to major professional bicycling events;
- Health benefits from bicycling and walking;

The study team's approach provides a reasonable estimate of the benefits of bicycling and walking statewide and avoids double counting by precise calculation of each component of the model. Section III of this report provides a detailed description of the methodology employed in the study. Infographics that detail key findings of this report are in Appendix A.

Summary of Statewide Results

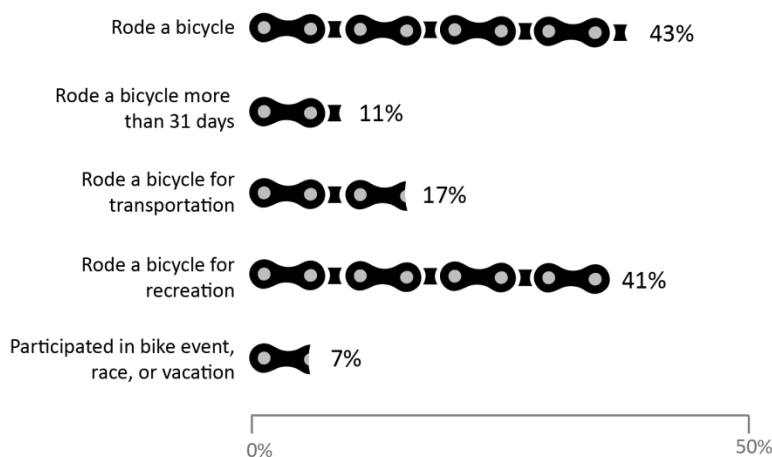
The key statewide results are related to bicycling and walking behavior and the total economic and health benefits.

Bicycling and walking behavior. Colorado is one of the most physically active states in the country, but little data exists on the current rates of bicycling and walking statewide. The study team used a survey of Colorado residents to understand different types of bicycling and walking activity in the state. This analysis establishes benchmark rates of bicycling and walking for comparison to future rates, related U.S. rates, and provides a summary of different facets of those activities. For bicycling and walking, results are summarized separately below.

Bicycling behavior. The study team calculated a variety of estimates related to bicycling in Colorado that help describe that activity statewide. Figure I-1 presents a summary of key data points from the study team's bicycle behavior analysis. Further detail can be found in Section IV – Bicycling and Walking Behavior and Opinion. About 43 percent of Colorado residents 18 or older reported that they rode a bicycle in the last year. This percentage is approximately 48 percent higher than comparable nationwide averages.³ The study team also calculated how frequent Colorado residents bicycle. Of Colorado residents, 11 percent reported riding a bicycle more than 31 days in the last year. The rate of transportation and recreation bicycling was also estimated. Approximately 17 percent of Colorado residents used a bicycle for transportation, including riding a bicycle to commute to and from work or school; run errands; shop; get to and from social and leisure activities; or for a non-racing job. About 41 percent of Colorado residents took a recreational bike ride, including riding a bicycle for exercise, competition, enjoying nature, or fun. In addition, about 7 percent of Colorado residents reported participating in a bicycle event, race, or vacation.

Figure I-1.
Percentage of Colorado
residents that participated
in various bicycling
behaviors in the last year

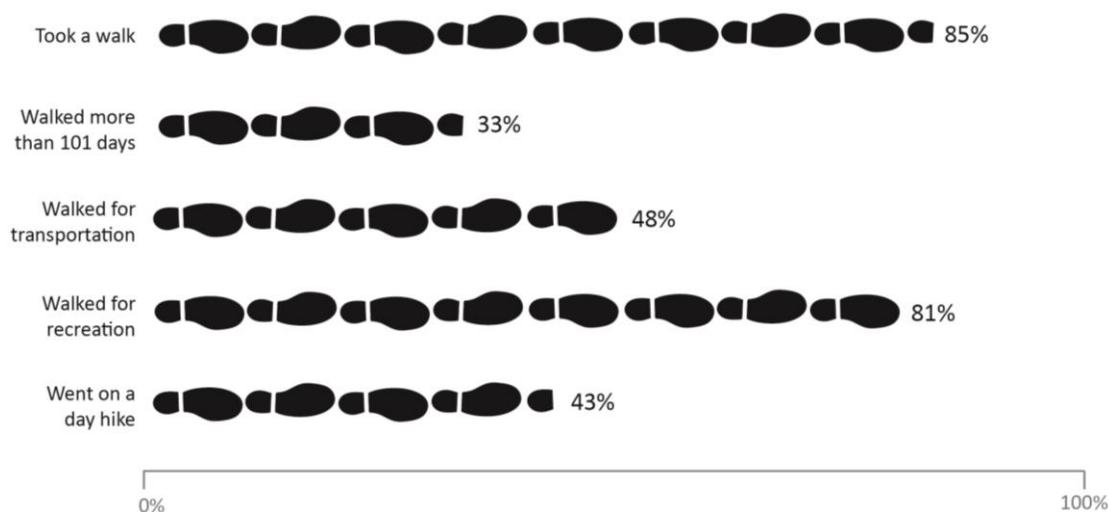
Source:
BBC Research & Consulting and Alta
Planning and Design.



³ PeopleForBikes. 2015. U.S. Bicycling Participation Benchmarking Study Report. PeopleForBikes. Boulder, CO. Retrieved April 27, 2016. (<http://www.peopleforbikes.org/resources/entry/u.s.-bicycling-participation-benchmarking-report>).

Walking behavior. Using the resident survey data, the study team calculated a variety of estimates related to walking in Colorado that summarize that activity statewide. Figure I-2 presents a summary of key data points from the study team’s walking behavior analysis. More details related to these analyses can be found in Section IV – Bicycling and Walking Behavior and Opinion. About 85 percent of Colorado residents 18 or older reported that they took a walk in the last year. The study team also calculated how frequent Colorado residents walk. One-third of Colorado residents took a walk on more than 31 days in the last year. Transportation and recreation walking rates were also calculated. Approximately 48 percent of Colorado residents reported walking for transportation, including walking to commute to and from work or school; run errands; shop; or get to and from social and leisure activities. About 81 percent of Colorado residents reported taking a recreational walk, including day hiking, a walk for exercise, or a walk for fun. In addition, 43 percent of Colorado residents reported taking a day hike.

Figure I-2.
Percentage of Colorado residents that participated in various walking behaviors in the last year



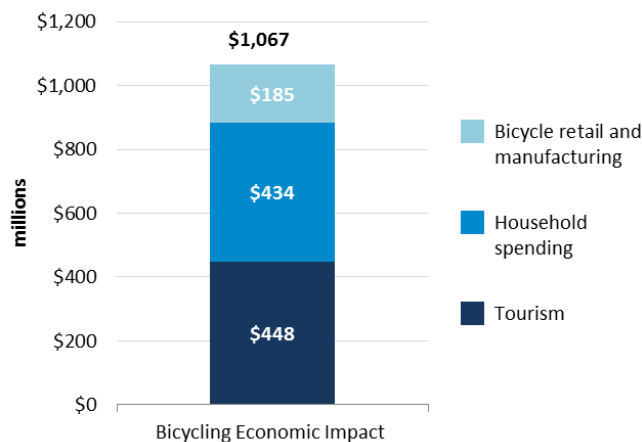
Source: BBC Research & Consulting and Alta Planning and Design.

Economic and Health benefits of Bicycling and Walking in Colorado. With such a large portion of the state population participating in bicycling and walking, there are substantial economic and health benefits generated from that activity. The total economic and health benefits of bicycling estimated for the State of Colorado is approximately \$1.6 billion. The total economic and health benefits of walking calculated for the State of Colorado is approximately \$3.2 billion. Additional details regarding these estimates are provided below.

Economic benefits. There are a variety of economic impacts that are generated from bicycling and walking in Colorado, including in-state household spending on equipment, goods, and events, exports from Colorado businesses, and tourism. Using data from primary and secondary data collection, the study team calculated separate estimates of the total economic impact of bicycling and walking and each of these components listed above. Those estimates are reported in Figures I-3 and I-4 below.

Figure I-3.
Estimates of the economic impact of bicycling (in \$ millions)

Source:
 BBC Research & Consulting and Alta Planning and Design.

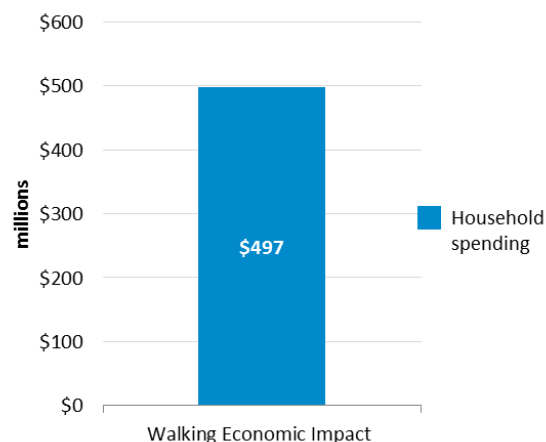


Economic benefits of bicycling (excluding health). Excluding health benefits, bicycling has an estimated \$1.1 billion impact on the Colorado economy. Household spending in-state on bicycles; bicycle goods, equipment, and accessories; and the costs related to participating in bicycle events, races, and vacations contributes an estimated \$434 million. Bicycle retail and manufacturing exports contributes another \$185 million to the Colorado economy. Bicycle tourism by out-of-state visitors contributes \$448 million.

Economic benefits of walking (excluding health). Walking has an estimated \$497 million economic impact on the Colorado economy. Household spending in-state on walking-related equipment and the costs related to day hiking accounts for the entire economic impact. That estimate is reported

Figure I-4.
Estimates of the economic impact of walking (in \$ millions)

Source:
 BBC Research & Consulting and Alta Planning and Design.

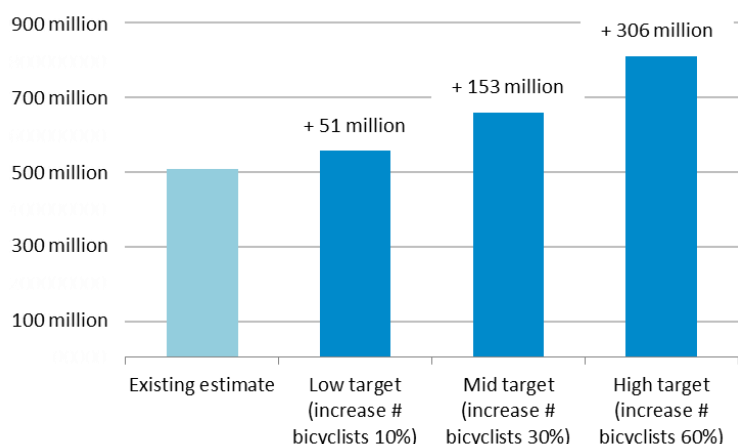


Health benefits. Bicycling and walking in Colorado helps to keep kids and adults active and helps to decrease the prevalence of health conditions such as heart disease, diabetes, and other chronic illnesses. The World Health Organization's (WHO's) Health Economic Assessment Tool (HEAT) allows states and other municipalities to measure changes in all-cause mortality based on existing and targeted travel behavior data. This analysis used Colorado-specific data from the National Household Travel Survey to analyze the existing health benefits from walking and bicycling in Colorado, as well as the potential increase in health benefits if the number of

Coloradans bicycling or walking on a regular basis increased by 10 percent (low target), 30 percent (mid target), and 60 percent (high target).

Health benefits of bicycling in Colorado. Based on estimates from the HEAT model, bicycling in Colorado currently helps prevent about 50 deaths per year.⁴ This translates into about \$511 million in annual health benefits from bicycling. That is, if Coloradans stopped bicycling and did not replace the activity with another form of exercise, the resulting cost in terms of the loss of human life would be approximately \$511 million. According to 2009 National Household Travel Survey, 462,000 Colorado Residents are bicyclists. A 10 percent increase in the number of people bicycling—46,000 additional bicyclists—could result in approximately \$51 million in additional health benefits. In addition, a 60 increase percent—277,000 additional bicyclists—could result in \$306 million in additional health benefits. Figure I-5 presents those results.

Figure I-5.
Estimated mean annual health benefits from bicycling

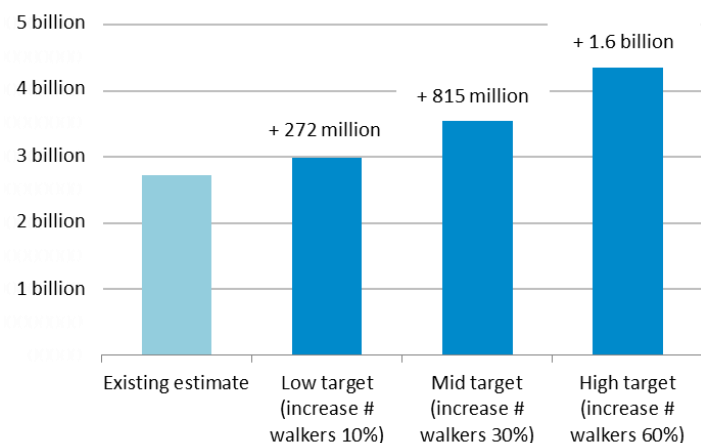


Source: BBC Research & Consulting and Alta Planning and Design from WHO HEAT bicycling output.

Health benefits of walking in Colorado. Walking in Colorado currently helps prevent about 285 deaths per year. This translates into about \$2.7 billion in annual health benefits from walking. That is, if Coloradans stopped walking and did not replace the activity with another form of exercise, the resulting cost in terms of the loss of human life would be approximately \$2.7 billion. According to 2009 National Household Travel Survey, approximately two million Colorado Residents are walkers. A 10 percent increase in the number of people walking—195,000 additional walkers— could result in approximately \$272 million in additional health benefits. In addition, a 60 percent increase—1.2 million additional walkers—could result in \$1.6 billion in additional health benefits. Figure I-6 presents those results.

⁴ The World Health Organization's Health Economic Assessment Tool does not take into account the negative health impacts of road traffic accidents involving bicyclists. For more information, please see pages 5 and 6 in the methodology and user guide. (http://www.euro.who.int/_data/assets/pdf_file/0010/256168/ECONOMIC-ASSESSMENT-OF-TRANSPORT-INFRASTRUCTURE-AND-POLICIES.pdf).

Figure I-6.
Estimated mean annual health benefits from walking

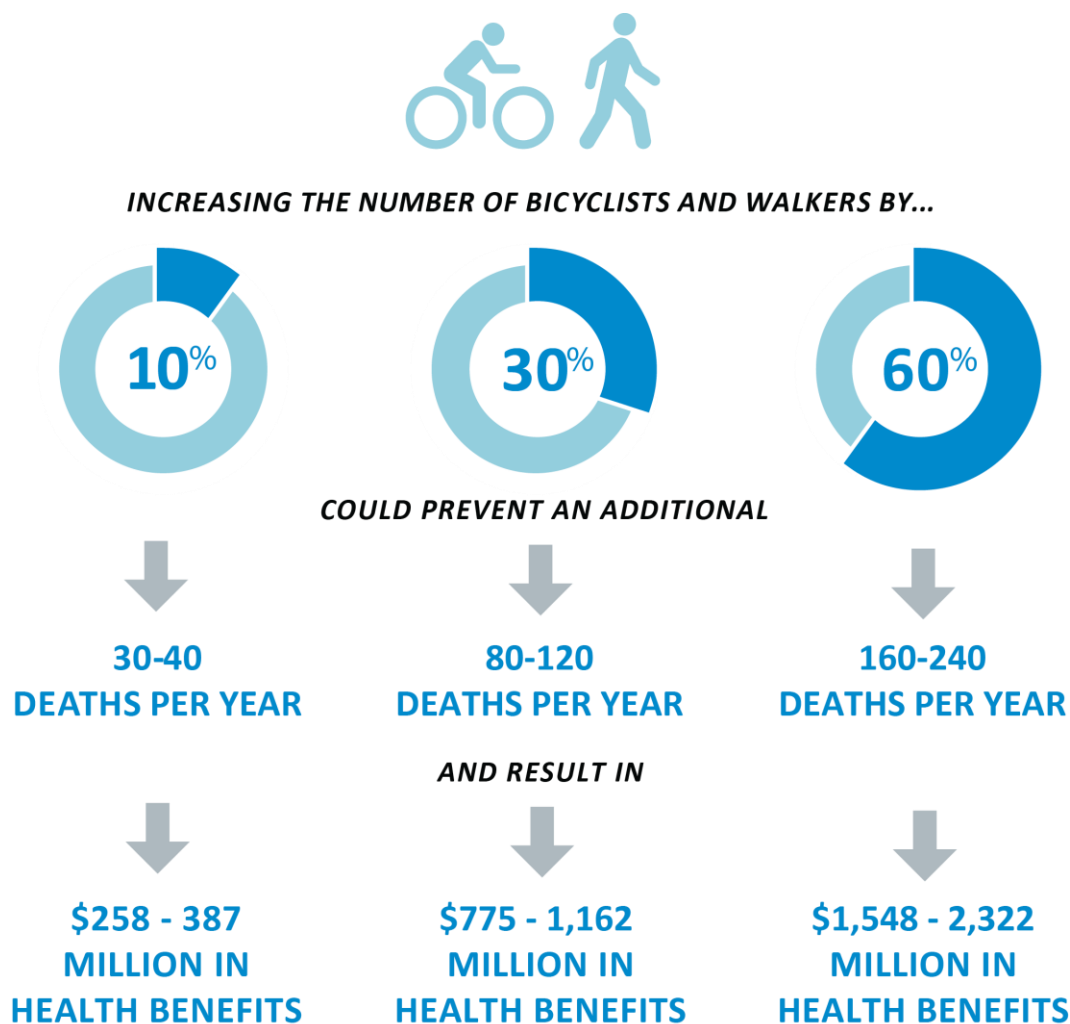


Source: BBC Research & Consulting and Alta Planning and Design from WHO HEAT walking output.

In total, current levels of bicycling and walking in Colorado produce approximately \$3.2 billion in annual health benefits.

Reduced mortality benefits of bicycling and walking. Current levels of bicycling and walking in Colorado help prevent 335 deaths per year. Increasing the number of people that bicycle or walk regularly by 10 percent could help prevent up to an additional 40 deaths per year, and an increase by 60 percent could help prevent up to an additional 240 deaths per year. Figure I-7 summarizes the potential reduced mortality and related health benefits associated with increases in bicycling and walking in Colorado.

Figure I-7.
Reduced mortality benefits from target levels of bicycling and walking in Colorado



Source: BBC Research & Consulting and Alta Planning and Design from WHO HEAT output.

Structure of the Report

This report includes five chapters, including this introduction. Section II provides a literature review of topics related to the economic and health benefits of bicycling and walking. Section III explains the methodology used for the study. Section IV describes the findings of the bicycling and walking behavior and public opinion analysis. Section V summarizes the economic and health benefits of bicycling and walking in Colorado. The report includes two infographics that present statewide results for bicycling and walking separately.

SECTION II.

Literature Review

SECTION II.

Literature Review

This section provides an overview of the types of community benefits derived from bicycling and walking and outlines methods used in other studies to document those impacts. The study team has reviewed numerous studies regarding the economic and health benefits of bicycling and walking and used that information to develop the methodology for the 2016 study of economic and health benefits from bicycling and walking. Section II provides:

- A discussion of the main reasons for documenting the community benefits of bicycling and walking;
- A brief overview of the methods used in this study to document health and economic benefits (which will be expanded on in Section III); and
- A review of studies with unique or interesting approaches to analyzing the benefits of bicycling and walking and results from those studies.

Information from the literature review can help provide a foundation of existing information on the economic and health impacts of bicycling and walking for the State's evaluation of bicycling and walking impacts. This review can also assist in the interpretation of the results from the primary and secondary research conducted as a part of the study.

Documenting the Benefits of Bicycling and Walking

While many policymakers, agencies, and organizations emphasize the social and community impacts related to increased physical activity through bicycling and walking, it is often challenging to quantify economic and health impacts directly related to programs and investments in this area. The majority of current bicycling and walking infrastructure and programs are supported by government funding and, as a result, it is important to understand the benefits that may result from those investments. According to the Journal of Physical Activity and Health, the "use of economic arguments to advocate [for] investments into policies that have a comparatively greater potential to result in health benefits is a promising strategy to win the support of other sectors."¹ Studies quantifying the community benefits of bicycling and walking serve numerous purposes by providing detailed information on:

- The relative importance of local bicycling and walking businesses;
- Resident participation in bicycling and walking;

¹ Cavill, N., Kahlmeier, S., Rutter, H., Racioppi, F., & Oja, P. (2009). Corrigendum to "Economic analyses of transport infrastructure and policies including health effects related to cycling and walking: A systematic review" [Transport Policy 15(5) (2008) 291–304]. Transport Policy, 16(1), 46. doi:10.1016/j.tranpol.2009.03.002

- The role of bicycling and walking in local tourism; and
- The health benefits accrued by residents who bike and walk.

As noted in many of the studies reviewed, the economic and health benefits are complimentary, and providing an analysis of both of these types of impacts is important for stakeholders to appropriately understand the current benefits of bicycling and walking as well as the potential return on future investment in bicycling and walking infrastructure and programs.

Overview of Benefits of Bicycling and Walking

Numerous organizations have conducted studies of the benefits of bicycling and walking. There is wide variation in the quality, scope, and methods used for these studies. Based on the study team's review of these studies, discussions with key stakeholders, and the needs of the state, the study team chose to document the following impacts related to bicycling and walking:

- **Household spending on bicycling and walking.** A number of state and local studies provide estimates of household spending by residents on goods and services related to bicycling and walking. This includes retail purchases (e.g. bicycles, walking gear, and other accessories) and expenditures related to trips for bicycling, walking, or day hiking.
- **Out-of-state spending at bicycle retailers and manufacturers.** While resident spending captures a piece of the economic impacts related to bicycling and walking, many studies also attempt to document exports from bicycle retailers and manufactures to other states. This provides a more complete analysis of the role of bicycling in a specific economy.
- **Tourism related spending.** Many studies of bicycling impacts estimate the role of bicycling in the overall tourism economy. The use of bicycles by out-of-state visitors may ranges from using a bicycle for transportation in a resort community to participating in one of the many bicycle-related events in the state. Large events such as the USA Pro Challenge have also been documented in these types of studies.
- **Health benefits.** The overall impact of bicycling or walking on the health of residents is a substantial benefit for many communities. Many recent studies have used a variety of methods to calculate these impacts.

Section III provides an overview of the specific research methods used by the study team to document these benefits.

Other Community Benefits of Bicycling and Walking

While the benefits discussed above provide a broad overview of the benefits of bicycling and walking, the study team believes that it was appropriate to highlight a few studies that used innovative or creative approaches to document the impacts of bicycling and walking. The study team organized these studies into the following categories:

- Health benefits;
- Fiscal and economic benefits; and
- Localized real estate and business location benefits.

Health benefits. The following studies highlight the relationship between walking and bicycling and community health in the following ways:

- The link between active travel and health conditions;
- The relationship between bicycling and walking investment and injury prevention;
- Uses of the WHO HEAT model.

The link between active travel and health conditions. In the United States, obesity and diabetes are serious public health concerns.² Research has shown that adults that use active transportation (i.e., walking and bicycling for transportation) had lower obesity rate.³ In addition, use of active transportation was also associated with lower rates of diabetes.⁴ Such results underscore how active transportation could help ameliorate these health concerns.

Bicycling and walking investment and injury prevention. Investment in bicycling and walking infrastructure and Safe Routes to School (SRTS) programs has been shown to have straight forward health benefits in cost savings and injury prevention. According to the Smart Growth Coalition's 2015 report, investments in three dozen complete streets infrastructure redesigns resulted in savings of \$18.1 million dollars from reduced collisions and less severe collisions. If complete streets were applied to more roadways across the United States, the savings from averted or less severe crashes could be in the hundreds of millions.⁵ In addition, investments in

² Smart Growth America, Complete Streets Coalition. *Smart Growth America: Safer Streets, Stronger Economies*. March 2015

³ John Pucher, Ralph Buehler, David R. Bassett, and Andrew L. Dannenberg. Walking and Cycling to Health: A Comparative Analysis of City, State, and International Data. *American Journal of Public Health*: October 2010, Vol. 100, No. 10, pp. 1986-1992. doi: 10.2105/AJPH.2009.189324

⁴ John Pucher, Ralph Buehler, David R. Bassett, and Andrew L. Dannenberg. Walking and Cycling to Health: A Comparative Analysis of City, State, and International Data. *American Journal of Public Health*: October 2010, Vol. 100, No. 10, pp. 1986-1992. doi: 10.2105/AJPH.2009.189324

⁵ Smart Growth America, Complete Streets Coalition. *Smart Growth America: Safer Streets, Stronger Economies*. March 2015

Safe Routes to School programs have also shown reductions in bicycle injury rates for children and adults.⁶

Uses of the WHO HEAT model. The World Health Organization's Health Economic Assessment Tool (HEAT) is an important tool used for assessing health impacts across the world. In Austria the Czech Republic, and New Zealand, the HEAT model results demonstrated that their citizen's participation in bicycling and walking reduces mortality, saves money, and provides an annual benefit to the economy.⁷

Fiscal and economic impacts. Health impacts related to bicycling and walking are not the only factors that contributes positive economic impacts. Bicycling and walking can provide other positive economic impacts to cities and communities, including municipal revenue impacts, cost effectiveness of bicycle infrastructure, and trail-specific impacts.

Municipal Revenue Impacts. Health impacts are not the only factor that drives positive economic impacts with bicycling and walking. Through infrastructure and program investment, communities can receive direct economic impacts from bicycling and walking through additional city income, sales -tax revenues, and private investment due to trails and bike lanes.

Cost Effectiveness of Bicycle Infrastructure. Standard pedestrian and bicycle infrastructure projects and facilities highlighted in this paper are extremely low-cost in comparison to new roadway projects. New roadway projects can cost tens of millions of dollars to construct, depending on location and type of road. Standard pedestrian and bicycle infrastructure projects and facilities highlighted in this paper are extremely low-cost in comparison. Costs for pedestrian and bicycle safety infrastructure vary greatly from city to city, but are still significantly less expensive than roadway projects and benefit all road users.⁸

Trail-specific Impacts. Bicycle and Pedestrian investment through trails can generate sales tax or private investment. Rails to Trails, a national advocacy organization has examined the impacts of numerous trail investments in trails throughout the United States. Recent findings include:

- A review of economic activity related to investment in the Ohio to Erie trail which documents an increase in tourism in local economies and private investment of over \$110 million along the route of the trail.⁹
- A study of the Down East Sunrise trail in Maine that reports over \$60 million in annual activity related to bicycling along the trail.¹⁰

⁶ Dimaggio, C., Brady, J., & Li, G. (2015). Association of the Safe Routes to School program with school-age pedestrian and bicyclist injury risk in Texas. *Inj. Epidemiol. Injury Epidemiology*, 2(1). doi:10.1186/s40621-015-0038-3

⁷ Schweizer, C., Racioppi, F., Kahlmeier, S., Cavill, N., Foster, C., Kelly, P., . . . Rutter, H. (2015). A67 The Health Economic Assessment Tools (HEAT) for Walking and Cycling: Supporting the integration of active mobility in healthy and sustainable transport solutions. *Journal of Transport & Health*, 2(2). doi:10.1016/j.jth.2015.04.555

⁸ Bushell, Max A.; Poole, Bryan W; Rodriguez, Daniel A.; Zegeer, Charles V. Costs for Pedestrian and Bicyclist Infrastructure Improvements. UNC Highway Safety Research Center. October 2013

⁹ Rails to Trails. *Rails to Trails Conservancy Story Bank: Ohio. Rails to Trails* (<http://www.railstotrails.org/resourcehandler.ashx?id=4639>), October 21, 2014.

Similar impacts have been documented in Colorado. In the months following the opening of the Mineral Belt Trail an 11.6-mile former rail-trail, Leadville reported a 19 percent increase in sales tax revenues.¹¹

Real estate and location-specific business Impacts. Studies have also shown that bicycle and pedestrian infrastructure increases property values and spurs development. Bicycle and walking infrastructure and trail-oriented development have contributed to increases in real estate values and new development activity.

Bike infrastructure and property values. Communities that offer bike sharing programs or robust walking and bicycling infrastructure have seen an increases in property values. Property values of multi-family and single-family homes within a half mile of a Bixi Bike sharing station in Montreal have increased.¹² Hedonic regression analyses have also demonstrated neighborhoods adjacent to bicycle and walking trails have higher property values.¹³ Such research lend support to the proximate principle by providing empirical evidence that the value of bicycling and walking trails or bike share programs is captured, at least partially, in the value of the homes in adjacent neighborhoods.¹⁴

Protected bike lanes and retail visibility. Protected bike lanes increase retail visibility and sales volume. Cyclists shop often and spend as much or more than those arriving by automobile. An additional benefit is that business owners can fit 10 cyclist customers in a parking space, as opposed to one automobile customer.¹⁵

Trail-oriented development. Developers and homebuilders are beginning to build home developments around new and existing bicycle and walking trails due to consumer demand for bikeable and walkable neighborhoods. Two examples of trail-oriented development include:

- **Montour Trail, PA.** The Montour Trail in Pennsylvania showed that the trail was used as branding for several new adjacent developments, including “The Waterfront” a \$300 million commercial and residential development along the Montour Trail (Searns, Flink, Olka 2001).¹⁶

¹⁰ Rails to Trails. *Rails to Trails Conservancy Story Bank: Maine. Rails to Trails* (<http://www.railstotrails.org/resourcehandler.ashx?id=4637>), August 6, 2014.

¹¹ Arapahoe County. *Arapahoe County Open Space Master Plan, Appendix G – Open Space Benefits* June 20, 2010

¹² Urban Land Institute: Active Transportation and Real Estate: The Next Frontier. Washington, D.C.: the Urban Land Institute, 2016.

¹³ Nicholls, Sarah; Crompton, John L.; The Impact of Greenways on Property Values. *Journal of Leisure Research*, 2005, Vol 37, No 3, pp. 321-341

¹⁴ Crompton, John L.; Perceptions of How the Presence of Greenway Trails Affects the Value of Proximate Properties. *Journal of Park and Recreation Research Administration*. Fall 2001. Vol 19, No 3, pp. 114-132

¹⁵ Urban Land Institute: Active Transportation and Real Estate: The Next Frontier. Washington, D.C.: the Urban Land Institute, 2016.

¹⁶ Flink, C. A., Olka, K., & Searns, R. M. (2001). *Trails for the twenty-first century: Planning, design, and management manual for multi-use trails*. Washington, DC: Island Press.

- **Douglas County, CO.** Douglas County's Shea Homes' Plum Creek Development intends to use the riparian corridor of the High Line Canal and the adjacent Chatfield State Park as a selling point and an extra amenity for future homeowners.¹⁷

Consumer demand for trail-oriented development is not just driven by quality of life. Homes that are located in neighborhoods with the above-average levels of walkability command a premium of about \$4,000 to \$34,000 over houses in neighborhoods with just average levels of walkability.¹⁸

¹⁷ Cossit, Krysta. Shea Homes, a NEW Roxborough Neighborhood. *Roxorough Living*: April 7, 2015

¹⁸ Cortright, Joe. How Walkability Raises Home Values in U.S. Cities. *Ceos for Cities*. August 2009.

SECTION III.

Methodology

SECTION III.

Methodology

This section details the methodology used to estimate statewide bicycling and walking rates and calculate the economic and health benefits of bicycling and walking in Colorado.

Bicycling and Walking Activity and Public Opinion

The study team completed the following research tasks related to measuring bicycling and walking activity and public opinion:

- Resident survey;
- Bicycling and walking rates; and
- Public opinion.

Details related to the methodology for each research task are explained below.

Resident survey. The study team conducted a survey of Colorado resident to collect information related to their bicycling and walking behavior and opinions regarding bicycling and walking infrastructure. To complete the resident survey, the study team developed a survey instrument and executed that survey.

Survey development. The study team developed a resident survey by reviewing relevant survey instruments and soliciting stakeholder feedback. The study team reviewed relevant survey instruments related to walking and bicycling, including PeopleForBikes's U.S. Bicycling Participation Survey; the Outdoor Industry Association Economic Survey Questionnaire; and transportation surveys completed for the Michigan Department of Transportation and the Colorado Department of Transportation. Through this review, the study team identified a core set of questions that can be used to benchmark walking and bicycling rates statewide and compare to related U.S. rates.

The survey instrument was also reviewed by a team of project stakeholders that represented the Colorado Office of Economic Development and International Trade, the Colorado Department of Public Health and Environment, the Colorado Department of Transportation, the Colorado Pedals Project, and Bicycle Colorado. Project stakeholders reviewed the survey instrument and suggested revisions to the project team. Based on this review, the study team added in relevant public opinion questions related to bicycling and walking as requested by project stakeholders.

Survey execution. The study team fielded responses to the survey online via the following means:

- Randomly selected online panel of Colorado residents;
- Post cards mailed to a random selection of Colorado residents; and
- Outreach to bicycling and walking advocacy organizations.

Over 2,255 Colorado residents responded to the survey. For statewide estimates of activity rates and household spending, the study team used responses collected from the online panel, as the panel provides a representative sample of Colorado residents. Data collected via other means besides the panel was included in the public opinion analyses. The survey data collected provides information on a range of bicycling and walking topics in Colorado, including:

- Rates of bicycling and walking;
- Demographics of bicyclists and walkers;
- Household spending on bicycling and walking; and
- Public opinion regarding bicycling and walking infrastructure.

Bicycling and walking rates. The study team conducted a detailed review of bicycling and walking behavior in the state using data collected from the online panel of the resident survey. Each Colorado resident surveyed reported the number of days they participated in bicycling and walking in the last year and their weekly recreation and transportation bicycling and walking. Using this information, the study team summarized bicycling and walking statewide, described who bicycles and walks by various demographic categories, and presented a review of recreation and transportation bicycling and walking activity.

There is tremendous utility in a descriptive overview of bicycling and walking rates. These rate analyses establish a variety of activity benchmarks that can be used for future comparison and to contextualize the current economic and health benefit calculations. The study team also describes group disparities in bicycling or walking rates, which is useful for identifying populations that could be the target of public health or transportation infrastructure interventions. In addition, the study team's description of transportation bicycling and walking provides information regarding the percentage of Colorado residents that have used active transportation in the last year—a statistic missing from primary and secondary mode share discussions, which often focus on commuting.

Public Opinion. The study team conducted an assessment of public opinion related to bicycling and walking infrastructure and the accessibility of their community for bicycling using data from all survey respondents. Each Colorado resident rated their overall satisfaction with bicycling and walking infrastructure and the bicycle accessibility of their community as well as a number of subcomponents related to each core question. For example, each respondent was asked to rate their overall satisfaction with bicycle infrastructure and a number of related bicycle infrastructure subcomponents, including the availability of bicycling parking; the number and conditions of bike lanes and trails; and the availability of trip facilities. Using this information,

the study team presented the average rating for each component and subcomponent that was rated.

The study team employed survey weights to ensure that results of the public opinion measurement would be representative of the Colorado population. Survey weights were developed based on the number of days the respondent reported bicycling in the last year. Three survey weights were developed for infrequent (i.e., reported bicycling 0 to 10 days), moderate (i.e., reported bicycling 11 to 30 days) and frequent cyclists (i.e., reported bicycling 31 days or more) for data collected from all sources. This weighting strategy helps to mitigate any bias introduced by oversampling frequent walkers and bicyclists via survey data collected through outreach to bicycling and walking advocacy organizations and ensures representative results for the public opinion analyses.

Assessing public opinion regarding bicycling and walking infrastructure and bicycling accessibility provides a variety of benefits. Average ratings of Colorado resident's satisfaction with bicycling and walking infrastructure help policymakers understand generally how that infrastructure is performing and identify where gaps in the infrastructure exist. The study team also identifies those subcomponents of bicycling and walking infrastructure that were the lowest rated, which can be used to inform future decisions on investment in bicycling and walking infrastructure. Likewise, understanding Colorado resident's views on bicycling accessibility in their community and various subcomponents of community bicycling accessibility gives policymakers insight into how bicycle accessible Colorado is and where residents identify barriers to accessing bicycling.

Economic Benefit Analysis

The study team's economic benefit approach avoids double counting and provides a precise estimate of the total economic benefits of bicycling and walking in the state. With this approach as a guide, the study team identified core economic data points related to bicycling and walking to be included in the economic benefits model. The economic benefits model includes the following categories:

- Household spending;
- Bicycling retail and manufacturing; and
- Tourism.

Each category is composed of a number of sub-components. For example, the tourism portion includes the costs related to out-of-state tourists participating in bicycling in Colorado. The total economic impact is the sum of the three categorized benefits. Calculations used to estimate the benefits of each component are described as follows:

Household spending. The study team estimated total household spending on a variety of bicycle- and walking-related expenditures in Colorado using survey data collected in the online panel of the resident survey. Separate estimates of total household spending were calculated for bicycling and walking.

Bicycling-related household spending. The study team calculated total household spending on bicycling purchases in Colorado and separately for each subcategory of bicycling spending, which included bicycle purchases; bicycle equipment, goods, and maintenance purchases; and bicycle events, races, and vacations costs. The survey asked each respondent to separately report the total their household spent on bicycle purchases in Colorado; on bicycle goods, equipment, and maintenance purchases in Colorado; the number of days they participated in bicycle events, races, and vacations in Colorado, and the daily costs of lodging (e.g., hotels, campgrounds, cottages), food (e.g., groceries, restaurants), non-bicycle entertainment and recreation (e.g., amusement parks, movies, shopping, souvenirs), transportation (e.g., gas, parking, bus, or train fare), and registration fees related to those events. Using survey data collected via these questions, the study team calculated the average in-state annual household spending on bicycling and for each subcategory of purchases discussed above in.¹

Each average in-state annual household spending estimate was examined for the influence of outliers. The study team examined the survey responses of all average annual household spending estimates that were over 2.5 standard deviations from the mean. Many of these cases included data entry error in their responses or contained unrealistic reported spending. The study team excluded these cases from our average household spending estimates. In addition, all resulting estimates were compared to the Bureau of Labor Statistics' Consumer Expenditure Survey spending profile to ensure that the study team's estimates were realistic given total consumer spending.

To calculate estimates of total in-state household spending on all bicycling-related purchases and separately for bicycles, bicycle goods, equipment, and maintenance, and bicycle events, races, and vacations, the study team multiplied the estimated average in-state annual household spending for each item by the American Community Survey's 2010-2014 estimate of the number of Colorado households (1,998,314).

Walking-related household spending. The study team calculated total household spending on walking purchases in Colorado and separately for each subcategory of walking spending, which included walking equipment purchases and day hiking costs. The survey asked each respondent to separately report the total their household spent on walking equipment in Colorado; the number of days they participated in day hiking in Colorado, and the daily costs of food (e.g., groceries, restaurants), transportation (e.g., gas, parking, bus, or train fare), and park access (e.g., park entry fee or park pass) related to day hiking. Using survey data collected via these questions, the study team calculated the average in-state annual household spending on walking

¹ To produce the average annual household spending on bicycle events, races, and vacations, the study team first estimated the total spent on bicycling events, races, and vacations in the past year. This estimate was calculated by multiplying the total spent on food, lodging, transportation, non-bicycling entertainment, and registration fees by the number of days the respondent reported participating in bicycling events, races, and vacations in the last year.

and for each subcategory of purchases discussed above.² The study team used a similar approach for analyzing outliers in household spending related to walking as it used in the bicycling-related household spending analysis; excluding all cases with reported spending over 2.5 standard deviations from the mean.

To calculate estimates of total in-state household spending on all walking-related purchases and separately for walking equipment and day hiking, the study team multiplied the estimated average in-state annual household spending for each item by the American Community Survey's 2010-2014 estimate of the number of Colorado households (1,998,314).

Bicycle retail and manufacturing. The study team calculated an estimate of Colorado bicycle retail and manufacturing sales to out of state consumers using data collected via a bicycle business survey and information from a variety of business lists including business intelligence service Dun & Bradstreet and lists of bicycle related businesses from PeopleForBikes.

Business survey. In our resident survey, the study team collected data related to Colorado resident's in-state purchases of bicycles, bicycle gear, and bicycle maintenance at bicycle retail and manufacturing businesses in the state. However, this data does not provide us information related to purchases at Colorado Bicycle retail and manufacturing businesses by out-of-state consumers. To collect out-of-state sales data, the study team attempted to complete online surveys with more than 1,000 Colorado-based bicycle retail and manufacturing businesses.³ The survey asked each business to report their total number of employees, their total sales revenue in the last year, and the percentage of that revenue that came from out-of-state sales. 74 businesses completed the survey. Using this data, the study team calculated the total sales to out-of-state consumers for each respondent and an average percentage of out-of-state sales for all Colorado bicycle businesses.

Dun & Bradstreet. Dun & Bradstreet is a business intelligence service that provides information, including sales revenue and number of employees, on establishments doing business in a variety of industries. The study team collected lists of businesses classified in bicycle-specific Standard Industry Classification (SIC) Codes, including bicycle frame and component manufacturing; bicycle inner tube manufacturing; bicycle tire manufacturing; bicycle lamp manufacturing; sale of bicycles, bicycle parts, bicycle equipment, and bicycle supplies; and bicycle repair services. The study team incorporated all businesses listed in our Dun & Bradstreet lists that did not complete a survey into our bicycle business survey results. To calculate an estimate of the total out-of-state sales for each business, the study team multiplied their reported revenue by the average percentage of out-of-state sales reported in the bicycle business survey (48.6%).

² To produce the average annual household spending on dayhiking, the study team first estimated the total spent on day hiking in the past year. This estimate was calculated by multiplying the total spent on food, lodging, transportation, non-bicycling entertainment, and registration fees by the number of days the respondent reported participating in bicycling events, races, and vacations in the last year.

³ The study team developed its Colorado bicycle retail and manufacturing businesses list via web search, lists from PeopleForBikes, and Dun & Bradstreet business intelligence lists of businesses classified as doing business in bicycle-related industries. Special thanks to PeopleForBikes and Bicycle Colorado for their assistance with distributing the survey and encouraging organizations to respond.

Businesses from other sources. BBC collected lists of businesses from a variety of websites and from PeopleForBikes, a national nonprofit organization headquartered in Boulder, Colorado dedicated to improving bike riding throughout the country. For businesses on these lists that answered the bike business survey, BBC used the out-of-state revenue reported in the survey. For a number of businesses compiled in this process, BBC did not have any revenue information. Given this situation BBC considered a number of options ranging from excluding these businesses from the analysis (which would likely underrepresent the total revenues from bicycle-related retailers and manufactures) to using an average of the existing revenue data (which might overestimate the total revenues from retailers and manufacturers given that higher revenue businesses are typically more likely to respond to a survey and have revenue data in Dun & Bradstreet). After considering these options, BBC chose to estimate the revenue for these businesses using the average revenue reported by the lowest quartile of businesses where BBC had revenue (approximately \$60,000 of annual revenue). BBC then multiplied this estimated revenue by the average percentage of out-of-state sales reported in the bicycle business survey.

Tourism. The study team calculated an estimate of the total economic impact of out-of-state bicycle tourism in Colorado and the US Pro Challenge using data from the 2015 Longwoods International Colorado Tourism Report and an economic impact study of the US Pro Challenge—a major professional bicycle race that was held in the state between 2012 and 2015. Separate estimates were calculated for each category of tourism.

Longwoods International Colorado Tourism Report. The Longwoods International report presents information related to out-of-state visits to Colorado in 2015, including:

- Number of marketable overnight leisure trip visits;
- Proportion of trips from in-state visitors;
- Proportion of visitors that reported bicycling on overnight leisure trip;
- Average length of overnight leisure trip stay;
- Average travel party size; and
- Average expenditures per person on a marketable overnight leisure trip.

The study team used this information to calculate an estimate of the total economic impact of one day of expenditures made by visitors that reported participating in bicycling on their vacation. To produce this estimate the study team had to calculate two intermediary estimates: the total number of out-of-state visitors that participated in bicycling and the average per person expenditures for one day of a marketable leisure trip. The study team calculated the total number of out-of-state visitors that participated in bicycling in 2015 via the following steps:

1. **Total out-of-state visitors.** BBC calculated the total number of out-of-state visits (11,970,000) by multiplying the total number of marketable overnight leisure trip visits reported by the Longwoods study (17.1 million) by the proportion of those visits made by out-of-state residents (70%).

2. **Number of out-of-state bicycle related trips.** Based on data from the Longwoods survey, BBC estimated the total number of bicycle-related out-of-state visits (778,050) by multiplying the number of out of state visits by the four-year average of the proportion that reported participating in bicycling (6.5%).
3. **Number of out-of-state visitors who bicycled.** An estimate of the total number of out-of-state visitors that participated in bicycling (2,256,345) was calculated by multiplying the total number of out-of-state bicycle visits by the average travel party size (2.9).
4. **Average daily expenditures.** The study team also calculated the average per person expenditures (\$93.92) for one day of a marketable overnight leisure trip by dividing the average expenditures per person (\$479) on a marketable overnight leisure trip by the average length of stay (5.1 days).
5. **Number of tourism days attributable to bicycling.** The majority of out-of-state visitors who rode a bike during their visit likely participated in other activities during their stay. As a result, including the total trip expenditures for these individuals would likely overstate the impact of bicycle-related tourism on the state. After talking with representatives in mountain resorts and bicycle industry experts in the state, BBC estimated that the vast majority of visitors who bike only did so for one day, and that the average number of days that visitors used a bicycle was 1.5 days.
6. **Total economic impact from out-of-state visitors who rode bikes.** Using the estimate of the number of days attributable to bicycling (1.5), the average spending per-person-per-day (\$93.92), and the number of out-of-state bicycle visitors (2,256,345), BBC calculated the total expenditures by out-of-state tourists who participated in bicycling (\$317,879,193).

USA Pro Cycling Challenge. The study team also included the results from Sponsorship Science's economic impact study of the 2014 USA Pro Cycling Challenge. The report estimated the total economic impact of expenditures made by out-of-state race spectators at the seven day event from August 18, 2014 through August 24, 2014. The study team will be reporting the results of the study in its economic impact model to show the benefit of a major professional bike race on the Colorado economy. A new professional biking event with a different format will take the place of the USA Pro Cycling Challenge in 2017.

Government investment. The study team considered including annual capital and program investment made by state and local governments in the analysis. Based on discussions with state agencies, it was determined that it is not possible to calculate the total investment in walking and bicycling at a state level. While some municipalities track annual capital expenditures, the total investment by local governments across the state is minimal when compared with the other benefits included in the study. For example, one of the largest cities in Colorado reported \$2.2 million in capital investment for one year. This is an area where the state could improve data collection in order to have a better understanding of the magnitude of economic activity related to investments in bicycling and walking.

Health Benefit Analysis

The World Health Organization (WHO) developed the Health Economic Assessment Tool (HEAT) to analyze the health-related benefits of walking and bicycling. HEAT was first published in 2007 and last updated in 2014. HEAT allows governments and agencies to input basic travel behavior data about a selected study area and to quantify the health benefits of current and future levels of bicycling and walking.

Background. Implementation of HEAT was steered by a core project group representing an interdisciplinary range of professional backgrounds, including health and epidemiology; health economics; and transportation economics, practice, advocacy, policy, and implementation perspectives. Close coordination also took place with the Transport, Health and Environment Pan-European Programme (THE PEP) and HEPA Europe, which is the European network for the promotion of health-enhancing physical activity.

HEAT can be used in a number of different situations, including:

- Evaluating reduced mortality for past and/or current levels of bicycling or walking within a specific campus, city, state, or country;
- Planning new bicycling and walking infrastructure; and
- Providing input into more comprehensive economic analyses or prospective health impact assessments, such as estimating the mortality benefits from achieving targets set to increase bicycling or walking or from the results of an intervention program.

HEAT estimates the relative risk of death for bicyclists and walkers from any cause (i.e. all-cause mortality), compared to the risk of death for people who do not bicycle or walk regularly. The webtool applies those relative risks to the amount of bicycling and walking entered by the user, assuming a linear relationship between physical activity and mortality. For example, the relative risk of death from any cause for a bicycle commuter who bicycles 100 minutes per week year-round is 10 percent lower than the risk of death for a non-bicyclist. If the bicyclist increases the amount of time spent bicycling, the protective benefit increases up to a certain limit. To avoid inflated values on the upper end of the range, the risk reduction built into HEAT is capped at about a 45 percent risk reduction for bicycling and 30 percent for walking.

After identifying the reduced risk of mortality that a population might incur from specific levels of bicycling and walking, HEAT compares this to an estimate of the number of adults who would normally be expected to die in any given year in the study population. Finally, the webtool produces an estimate of the discounted economic savings from this calculated reduction in deaths over a specified evaluation period.

Limitations. There are a number of situations where using HEAT would not be appropriate. Before using HEAT, the following items should be considered:

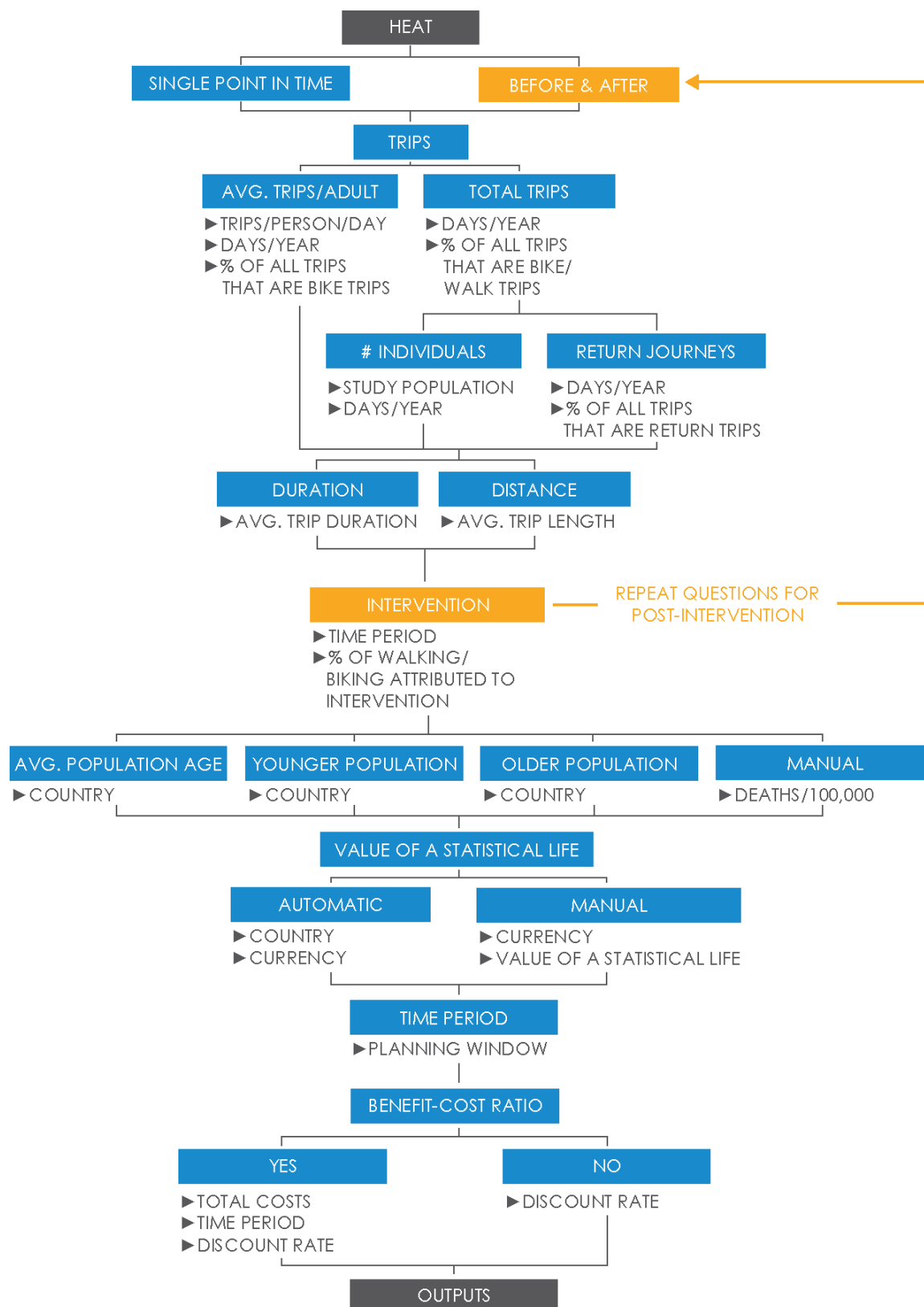
- The analysis is appropriate for groups of people but not individuals;
- The analysis is calibrated to account for adults between the ages of 20 and 74 years old but is not calibrated for children, young adults, or seniors;

- The analysis aims to study groups with average levels of physical activity and not unusually sedentary or active groups;
- The analysis studies habitual behavior, such as commuting or regular leisure-time activities but not one-day events or competitions; and
- The outputs should be understood as order of magnitude estimates instead of precise estimates.

HEAT's focus on average all-cause mortality indirectly accounts for health conditions across large population segments. However, this high-level view excludes details about morbidity, age, traffic injuries, air pollution, and sex that may provide insights into the root cause of mortality prevented by increased levels of bicycling and walking.

Model inputs. Assessments in HEAT can be carried out with two main types of data—data from a single point in time or “before and after” data. The former is used when assessing the status quo, such as evaluating current levels of bicycling and walking in a city. The latter is used when assessing the impact of an intervention or hypothetical scenario. The study team used single point in time data to evaluate the health benefits associated with existing and potential increased levels of bicycling and walking in the state of Colorado. The study team used before and after data to evaluate the health benefits associated with potential increased levels of bicycling and walking in the state. Figure III-1 presents the necessary data inputs for carrying out both types of HEAT analysis.

Figure III-1.
HEAT input model



The health analysis has several data inputs related to daily trip activity, including:

- Total trips per person per day (including bicycling, walking, and all other trip types);
- Days per year that those trips are made;
- Percentage of those trips that are bicycling and walking trips (i.e., mode share); and
- Average distance of bicycling and walking trips.

Figure III-2 presents those data inputs for the Colorado HEAT health benefits analysis.

Figure III-2.
Daily trip activity data inputs

Daily Activity Data Inputs	Bicycling	Walking
Total trips/person/day	4	4
Days/year	365	365
Activity mode share	2.3 %	9.7 %
Average trip length (miles)	3.9	0.6

Note: HEAT only allows whole numbers for the total trips/person/day input.

Because the study team chose the average total trips/person/day input, the assumed number of days per year was set to 365 days.

Source: Total trips/person/day, activity mode share, and average trip length numbers were obtained from the Colorado Transportation by the Numbers report from the 2009 National Household Travel Survey by the U.S. Department of Transportation:
<https://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/colorado.pdf>.

The study team estimated the study population (i.e., the existing number of bicyclists and walkers) by multiplying the population of Colorado by the average number of trips taken per person per day (including trips conducted by means other than bicycling and walking) and the bicycle or walk all trip purpose mode share (i.e., percentage of total trips that are taken via bicycling or walking). In addition, the study team evaluated potential increased target levels of bicycling and walking. Three target levels were input into HEAT in addition to the existing conditions.^{4,5}:

- **Low Target:** 10 percent increase in bicycle and pedestrian mode share (i.e., an increase to 2.5 percent bicycle mode share and 10.7 percent pedestrian mode share).⁶
- **Mid Target:** 30 percent increase in bicycle and pedestrian mode share (i.e., an increase to 3 percent bicycle mode share and 12.6 percent pedestrian mode share).⁷

⁴ All target values assume Colorado's total population is held constant.

⁵ Because the number of bicyclists and walkers was chosen as the independent variable, 100 percent of the increased number of bicyclists and walkers are attributed to the intervention in the HEAT analysis.

⁶ The low target is based on the mode share target in the U.S. Department of Health and Human Services' Healthy People 2020 Initiative <<https://www.healthypeople.gov/>>

⁷ The mid target is based on the 50th percentile increase of state-level increases in bicycle mode share between 2000 (U.S. Census) and 2013 (American Community Survey). The target is rounded to the nearest tens place.

- **High Target:** 60 percent increase in bicycle and pedestrian mode share (i.e., an increase to 3.7 percent bicycle mode share and 15.5 percent pedestrian mode share).⁸

WHO strongly recommends that calculations are carried out with low and high estimates of the main variables in order to gain a better understanding of the possible ranges of results.⁹ In accordance with WHO's recommendation, the existing number of bicyclists and walkers in Colorado is shown across a range of low, mid, and high estimates.^{10,11}

Figure III-4 presents the input data values for the estimated existing and potential future increased number of bicyclists and walkers. Figure III-4 also presents the low, mid, and high estimates for each of those scenarios.

Figure III-4.
Estimated number of bicyclists and walkers in Colorado

Number of Bicyclists and Walkers in Colorado	Low Estimate	Mid Estimate	High Estimate
Number of bicyclists			
Existing	370,000	462,000	554,000
Low Target (10% increase)	407,000	508,000	609,000
Mid Target (30% increase)	481,000	601,000	720,000
High Target (60% increase)	592,000	739,000	886,000
Number of walkers			
Existing	1,560,000	1,950,000	2,340,000
Low Target (10% increase)	1,716,000	2,145,000	2,574,000
Mid Target (30% increase)	2,028,000	2,535,000	3,042,000
High Target (60% increase)	2,496,000	3,120,000	3,744,000

Note: The mid estimate for the number of existing bicyclists was calculated by multiplying Colorado's population (4,843,211) * total trips per person per day (4.15) * Colorado bike mode share (2.3%).

The mid estimate for the number of existing walkers was calculated by multiplying Colorado's population (4,843,211) * total trips per person per day (4.15) * Colorado walk mode share (9.7%).

Source: Alta Planning & Design from 2005-2009 ACS 5yr and 2009 National Household Travel Survey.

The HEAT model also includes several additional data inputs, including:

- Deaths per 100,000 people in Colorado;
- Value of a statistical life;
- Evaluation period; and
- Discount rate.

⁸ The high target is based on the 75th percentile increase of state-level increases in bicycle mode share between 2000 (U.S. Census) and 2013 (American Community Survey). The target is rounded to the nearest tens place.

⁹ Kahlmeier S, et al. Health economic assessment tools (HEAT) for walking and for cycling. 2014. World Health Organization.

¹⁰ Low estimates represent 80 percent of the mid estimates and are rounded to the nearest thousand.

¹¹ High estimates represent 120 percent of the mid estimates and are rounded to the nearest thousand.

Figure III-5 presents those data inputs for the Colorado HEAT health benefits analysis.

Figure III-5.
Additional data inputs to Colorado health benefit analysis

Source:

Deaths/100,000 was obtained from Centers for Disease Control and Prevention (1999-2014).

Value of a statistical life, evaluation period, and discount rate were obtained from the 2015 TIGER Benefit-Cost Analysis Resource Guide from the U.S. Department of Transportation.

https://www.transportation.gov/sites/dot.gov/files/docs/Tiger_Benefit-Cost_Analysis_%28BCA%29_Resource_Guide_1.pdf

Additional Data Inputs	Bicycling
Deaths/100,000	664
Value of a statistical life	\$ 9,604,000
Evaluation period (years)	20
Discount rate	3.0 %

Deaths per 100,000 people in Colorado. The HEAT analysis requires a mortality rate to estimate potential health benefits associated with bicycling and walking. HEAT's default value is the European average, but it allows for the user to input a local mortality rate. The Centers for Disease Control and Prevention lists Colorado's mortality rate as 664/100,000.¹²

Value of a statistical life. To conduct an economic analysis of health benefits, it is necessary to select a method for valuing health (or life). The preferred method used in HEAT is a *standard value of a statistical life*, which is how much an individual would be willing to pay in monetary terms to reduce their annual risk of dying. There can be substantial variation among populations about how to value reducing one's annual risk of dying, but the U.S. Department of Transportation recommends \$9.65 million in 2016 inflation-adjusted dollars.¹³

Evaluation period. HEAT allows users to manually adjust the evaluation period to account for various types of interventions, because some bicycling and walking interventions may take several years to build up to their full-level of anticipated benefits. WHO states that it is important to recognize that delays exist between increases in physical activity and measurable benefits to health. For example, if a new bikeway is built and it is estimated to take five years before the number of daily users of the bikeway reaches a steady state (i.e. when the demand for the bikeway levels off), then it would be appropriate to set the evaluation period to five years. A time horizon of 20 years is the U.S. Department of Transportation's default value for assessing the economic benefits of transportation projects for the U.S. population.¹⁴

Discount rate. The total benefits found from a HEAT analysis must be discounted over the entire evaluation period to account for changes in the value of money over time. The U.S. Department of Transportation recommends applying a three percent discount rate to transportation infrastructure projects in which the funding for the project would otherwise be distributed to another project that creates a public good.¹⁵

¹² Deaths per 100,000 people in Colorado. Centers for Disease Control and Prevention (1999-2014): <http://kff.org/other/state-indicator/death-rate-per-100000/>

¹³ TIGER Benefit-Cost Analysis (BCA) Resource Guide. 2015. U.S. Department of Transportation. https://www.transportation.gov/sites/dot.gov/files/docs/Tiger_Benefit-Cost_Analysis_%28BCA%29_Resource_Guide_1.pdf

¹⁴ Ibid.

¹⁵ Ibid.

SECTION IV.

Bicycling & Walking Behaviors and Opinion

SECTION IV.

Bicycling & Walking Behaviors and Opinion

The Colorado Resident survey provided information on bicycling and walking in Colorado, including:

- Overall rate of bicycling;
- Demographics of bicyclists;
- Overview of recreation and transportation bicycling;
- Overall rate of walking;
- Demographics of walkers;
- Overview of recreation and transportation walking; and
- Public opinion regarding bicycle and walking infrastructure and bicycling accessibility.

In this section, the study team will first report bicycle behavior results before turning to discussions of statewide walking behavior and public opinion results.

Bicycling Behavior

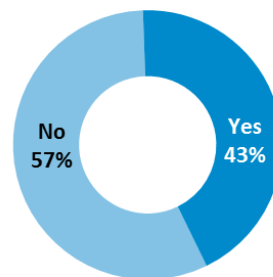
The study team analyzed the Colorado Bicycling and Walking Survey to summarize the degree of biking in the state, describe the demographic background of bicyclists, and explain types of bicycling behavior in Colorado.

Bicycling in Colorado. As displayed in Figure IV-1, the study team estimates that approximately 43 percent of Colorado residents 18 or older rode a bike in the past year. A report released by PeopleForBikes estimated that 29 percent of the United States population 18 or older rode a bicycle at least one day last year.¹ The bicycling rate in Colorado is 48 percent higher than in the United States.

¹ PeopleForBikes. 2015. U.S. Bicycling Participation Benchmarking Study Report. PeopleForBikes. Boulder, CO. Retrieved April 27, 2016. (<http://www.peopleforbikes.org/resources/entry/u.s.-bicycling-participation-benchmarking-report>).

Figure IV-1.
Percentage of Colorado residents who rode a bicycle in the last year

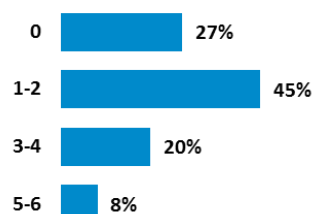
Source:
 BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.



Bicycle ownership. Figure IV-2 presents the number of bicycles owned by Colorado residents. About a quarter of Colorado residents own 3 or more bicycles. Approximately 45 percent of Colorado residents own 1 or 2 bicycles, and a quarter of Colorado residents do not own a bicycle.

Figure IV-2.
Number of bicycles owned

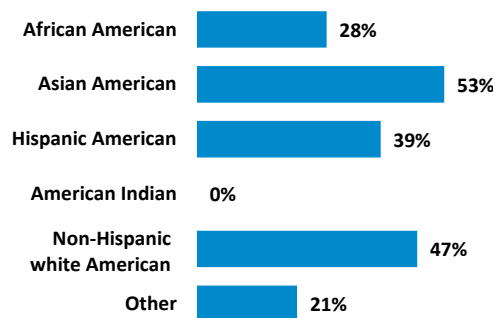
Source:
 BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.



Race/ethnicity. Figure IV-3 presents the percentage of each race/ethnicity that rode a bicycle in the last year. Approximately half of Asian Americans and non-Hispanic white Americans reported cycling in the last year. Conversely, about 38 percent of Hispanic Americans, 21 percent of African Americans, and 0 percent of American Indians surveyed reported riding a bicycle last year.

Figure IV-3.
Percentage of Colorado residents who rode a bicycle in the last year by race/ethnicity

Source:
 BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.

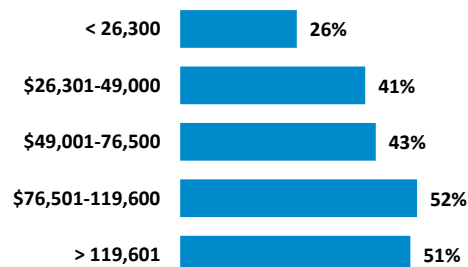


Income. Figure IV-4 below reports the percentage of Colorado residents that rode a bicycle last year by income. About 50 percent of Colorado residents with yearly incomes greater than \$76,500 reported riding in the last year. Conversely, approximately a quarter of Colorado residents with yearly incomes less than \$26,300 reported riding a bicycle.

Figure IV-4.
Percentage of Colorado residents who rode a bicycle in the last year by income

Note:
Income groups are State of Colorado income quintiles.

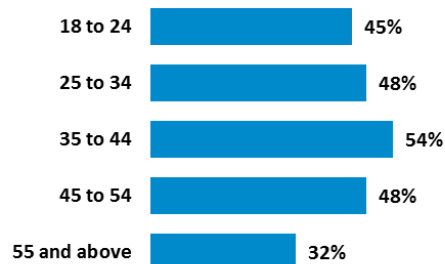
Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.



Age. As shown in Figure IV-5, approximately half of Colorado residents between the ages of 25 and 54 years old rode a bicycle last year. In addition, about a third of Colorado residents over the age of 55 reported bicycling in the last year. The PeopleForBike's benchmarking report presented U.S. bicycling rates for the same age groups reported below.² Colorado residents for every age group from above age 25 have substantially higher percentages of people who reported bicycling in the last year than the U.S. as a whole.

Figure IV-5.
Percentage of Colorado residents who rode a bicycle in the last year by age

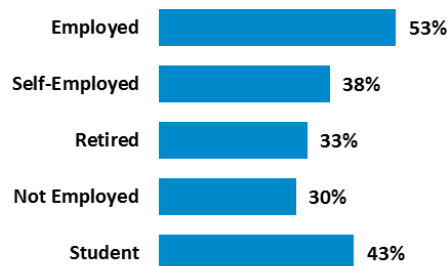
Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.



Employment status. Figure IV-6 presents the percentage of Colorado residents who rode a bicycle last year by employment status. The study team estimates that approximately half of employed Colorado residents reported riding a bicycle in the last year. Conversely, about a third of not employed and retired Colorado residents reported riding a bicycle—the lowest bicycle ridership rates of any employment status.

Figure IV-6.
Percentage of Colorado residents who rode a bicycle in the last year by employment status

Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.

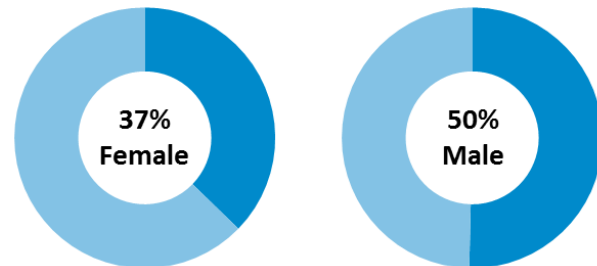


² Ibid.

Gender. As reported in Figure IV-7, the study team estimates that half of men rode a bicycle in the last year. Conversely, approximately 37 percent of women reported riding a bicycle in the last year.

Figure IV-7.
Percentage of Colorado residents who rode a bicycle in the last year by gender

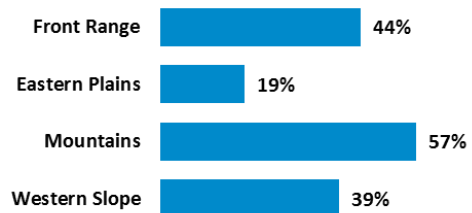
Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.



Region. Figure IV-8 reports the percentage of Colorado residents who rode a bicycle in the last year by region. The Front Range and Mountain regions had the highest ridership rates, while the Eastern plains had the lowest ridership rates.

Figure IV-8.
Percentage of Colorado residents who rode a bicycle in the last year by region

Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.

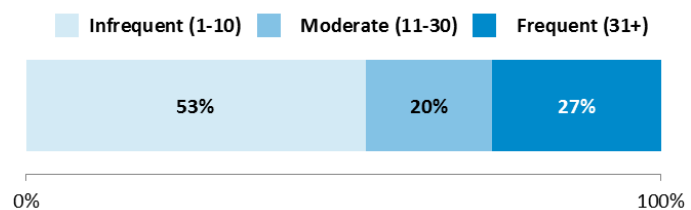


Frequency of bicycling. Figure IV-9 reports the frequency of bicycle riding in days by Colorado bicyclists. Approximately a quarter of all bicyclists rode a bicycle more than 31 days last year. About 53 percent of all bicyclists reported riding less than ten days last year.

Figure IV-9.
Percentage of bicyclists reporting infrequent, moderate, or frequent riding

Notes:
Sample includes Colorado residents 18 or older that reported riding a bicycling in the last year.

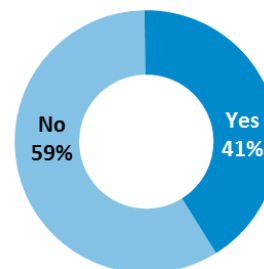
Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.



Recreational bicycling. Figure IV-10 reports the percentage of Colorado residents who took a recreational bike ride – like riding a bicycle for exercise, competition, enjoying nature, or fun – in the last year. The study team estimates that approximately 41 percent of Colorado residents took a recreational bicycle ride last year.

Figure IV-10.
Percentage of Colorado residents who took a recreational bike ride in the last year

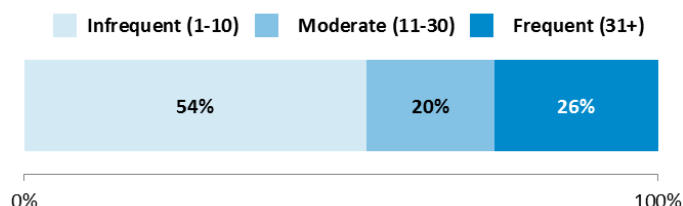
Source:
BBC Research & Consulting from 2016 Colorado
Bicycling and Walking Survey.



Recreational bicyclists riding frequency. Figure IV-11 reports the bicycling frequency in days of Colorado residents that took a recreational bike ride in the last year. About 54 percent of all recreational bicyclists rode 10 or fewer days last year. Approximately a quarter of recreational bicyclists rode more than 31 days last year.

Figure IV-11.
Riding frequency (in days) of recreational cyclists

Notes:
Sample includes Colorado residents 18 or older that reported taking a recreational bike ride in the last year.



Source:
BBC Research & Consulting from 2016 Colorado
Bicycling and Walking Survey.

Average distance of recreational ride. As shown in Figure IV-12, the study team estimates that the mean weekly distance of recreational riding is 19.3 miles, and the median weekly distance of recreational riding is 7.5 miles.

Figure IV-12.
Average weekly recreational ride distance

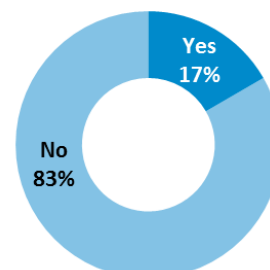
Source:
BBC Research & Consulting from 2016 Colorado
Bicycling and Walking Survey.



Transportation bicycling. Figure IV-13 reports the percentage of Colorado residents that reported taking a transportation bicycle ride—like riding a bicycle to commute to and from work or school; run errands; shop; get to and from social and leisure activities; or for a non-racing job—in the last year. The study team estimates that approximately 17 percent of Colorado residents took a bike ride for transportation last year.

Figure IV-13.
Percentage of Colorado residents who took a bike ride for transportation in the last year

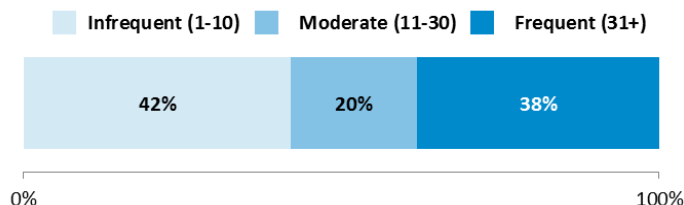
Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.



Transportation bicyclists riding frequency. Figure IV-14 reports the bicycling frequency in days of Colorado residents that took a transportation bike ride in the last year. About 38 percent of transportation bicyclists reported riding more than 31 days last year. Approximately 42 percent of transportation bicyclists reported riding fewer than 10 days last year.

Figure IV-14.
Riding frequency (in days) of transportation bicyclists

Notes:
Sample includes Colorado residents 18 or older that reported taking a transportation bike ride in the last year.



Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.

Average distance of transportation ride. As shown in Figure IV-15, the mean weekly distance of transportation riding is 12.5 miles, and the median weekly distance of transportation riding is 10 miles.

Figure 15.
Average weekly transportation riding distance

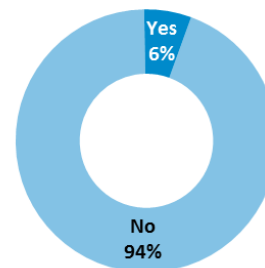
Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.



Safety training. As shown in Figure IV-16, the study team estimates that approximately 6 percent of Colorado residents have participated in a bicycle safety class in the last five years.

Figure IV-16.
Participated in safety training

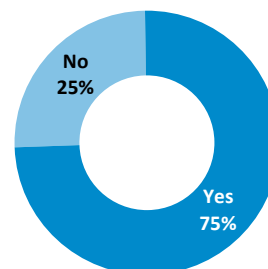
Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.



Children's bicycling. As shown in Figure IV-17, approximately 75 percent of Colorado residents with children ages 3 to 17 in their household reported that their children rode a bicycle in the last year.

Figure IV-17.
Children bicycled in last year

Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.



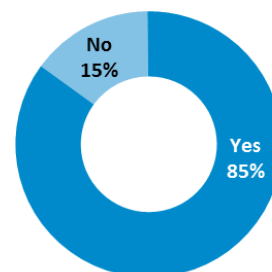
Walking Behavior

The study team analyzed the Colorado resident survey to summarize the degree of walking in the state, describe the demographics of walkers, and explain types of walking behavior.

Walking in Colorado. As displayed in Figure IV-18, the study team estimates that approximately 85 percent of Colorado residents took a walk in the past year.

Figure IV-18.
Percentage of Colorado residents who took a walk in the last year

Source:
BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.



Race/ethnicity. Figure IV-19 presents the percentage of Colorado residents who took a walk in the last year by race/ethnicity. More than 80 percent of Asian Americans, Hispanic Americans, American Indians, and non-Hispanic white Americans have taken a walk in the last year. Conversely, 67 percent of African Americans took a walk last year.

Figure IV-19.
Percentage of Colorado residents who took a walk in the last year by race/ethnicity

Source:
BBC Research & Consulting from 2016 Colorado
Bicycling and Walking Survey.



Income. Figure IV-20 presents the percentage of Colorado residents who took a walk in the last year by income. Over 90 percent of Colorado residents with incomes greater than \$76,000 reported taking a walk last year. Conversely, 78 percent of Colorado residents with incomes less than \$49,000 took a walk last year.

Figure IV-20.
Percentage of Colorado residents who took a walk in the last year by income

Note:
Income groups are State of Colorado income quintiles.

Source:
BBC Research & Consulting from 2016 Colorado
Bicycling and Walking Survey.



Age. As shown in figure IV-21, More than 80 percent of Colorado residents of all age groups took a walk in the last year.

Figure IV-21.
Percentage of Colorado residents who took a walk in the last year by age

Source:
BBC Research & Consulting from 2016 Colorado
Bicycling and Walking Survey.



Employment Status. As shown in figure IV-22, approximately 90 percent of employed and self-employed Colorado residents took a walk in the last year. Conversely, about 78 percent of not employed Colorado residents took a walk last year.

Figure IV-22.
Percentage of Colorado residents who took a walk in the last year by employment status

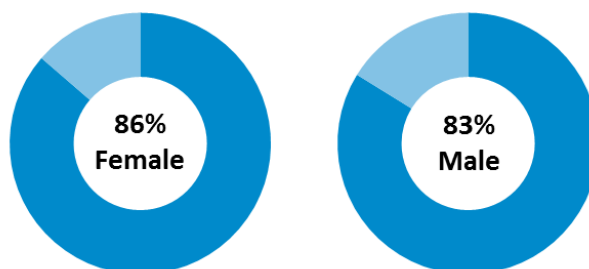


Source:

BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.

Employment Status. As shown in figure IV-23, the study team estimates that 83 percent of men and 86 percent of women reported taking a walk in the last year.

Figure IV-23.
Percentage of Colorado residents who took a walk in the last year by gender



Source:

BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.

Region. As shown in figure IV-24, the study team estimates that about 85 percent of Colorado residents in the Front Range, Mountain, and Western Slope regions took a walk in the last year. Conversely, approximately 78 percent of Colorado residents in the Eastern Plains region took a walk last year.

Figure IV-24.
Percentage of Colorado residents who took a walk in the last year by region

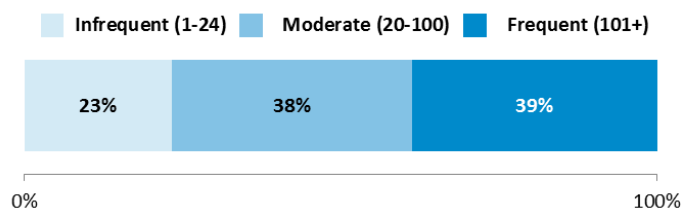


Source:

BBC Research & Consulting from 2016 Colorado Bicycling and Walking Survey.

Frequency of walking. Figure IV-25 reported the frequency of walking in days by Colorado walkers. Approximately 39 percent of Colorado walkers reported walking more than 101 days last year. About 23 percent of Colorado walkers reported walking less than 24 times last year.

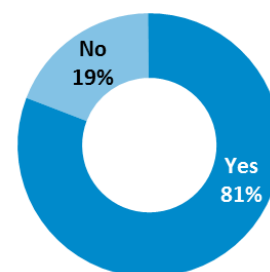
Figure IV-25.
Percentage of residents reporting infrequent, moderate, or frequent walking



Source:
BBC Research & Consulting from 2016 Colorado
Bicycling and Walking Survey.

Recreational walking. Figure IV-26 reports the percentage of Colorado residents that reported taking a recreational walk—like a day hike, a walk for exercise, or a walk for fun—in the last year. The study team estimates that 81 percent of Colorado residents took a recreational walk in the last year.

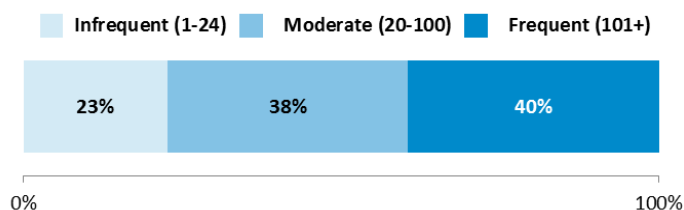
Figure IV-26.
Percentage of Colorado residents who took a recreational walk in the last year



Source:
BBC Research & Consulting from 2016 Colorado
Bicycling and Walking Survey.

Recreational walkers walking frequency. Figure IV-27 reports the walking frequency in days of Colorado residents that took a recreational walk in the last year. About 40 percent of recreational walkers reported walking more than 101 days last year. Approximately 23 percent of recreational walkers reported walking less than 24 days last year.

Figure IV-27.
Walking frequency of recreational walkers

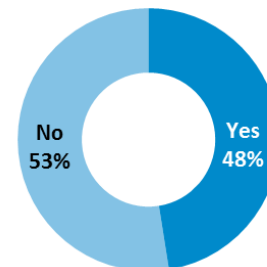


Source:
BBC Research & Consulting from 2016 Colorado
Bicycling and Walking Survey.

Transportation walking. Figure IV-28 reports the percentage of Colorado residents who took a walk for transportation—like walking to commute to and from work or school; run errands; shop; or get to and from social and leisure activities—in the last year. Approximately 48 percent of Colorado residents have taken a transportation walk in the last year.

Figure IV-28.
Percentage of Colorado residents who took a walk for transportation in the last year

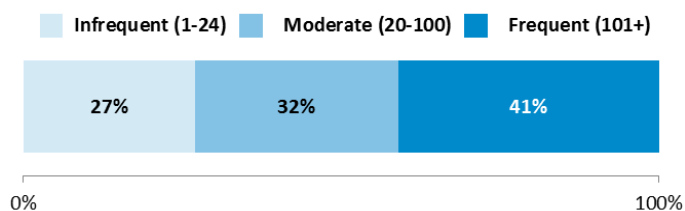
Source:
BBC Research & Consulting from 2016 Colorado
Bicycling and Walking Survey.



Transportation walkers walking frequency. Figure IV-29 reports the walking frequency in days of Colorado residents that took a transportation walk in the last year. Approximately 41 percent of transportation walkers reported walking more than 101 days in the last year. About a quarter of recreational walkers reported walking less than 24 days in the last year.

Figure IV-29.
Walking frequency of transportation walkers

Source:
BBC Research & Consulting from 2016 Colorado
Bicycling and Walking Survey.



Public Opinion

In the Colorado Bicycling and Walking Survey, Colorado Residents were asked to rate their satisfaction with bicycling and walking infrastructure and the bicycle accessibility of their community. The study team estimated the average rating for each question to measure Colorado Residents' willingness to recommend existing bicycling and walking infrastructure and community bicycling accessibility to a friend. To interpret the results of these net promoter questions, the study team used Satmetrix's net promoter score guidelines.³ An average score of 9 or 10 would demonstrate that Colorado Residents are supporters; they are extremely satisfied and exhibit a willingness to recommend to others. An average score of 7 or 8 would demonstrate that Colorado Residents are passive; they are satisfied but unenthusiastic about recommending to others. An average score of 0 to 6 would demonstrate that Colorado Residents are detractors; they are unsatisfied and would not recommend to others.

Satisfaction with bicycling infrastructure. Figure IV-30 reports Colorado resident's satisfaction with bicycling infrastructure overall and their rating of various components of bicycling infrastructure, including the condition of bike lanes and trails; the number of bike lanes and trails; the presence of clear signs and maps; the quality of connections between bike lanes,

³ For more information about net promoter scores, please visit Satmetrix's website. (<https://www.netpromoter.com/know/>)

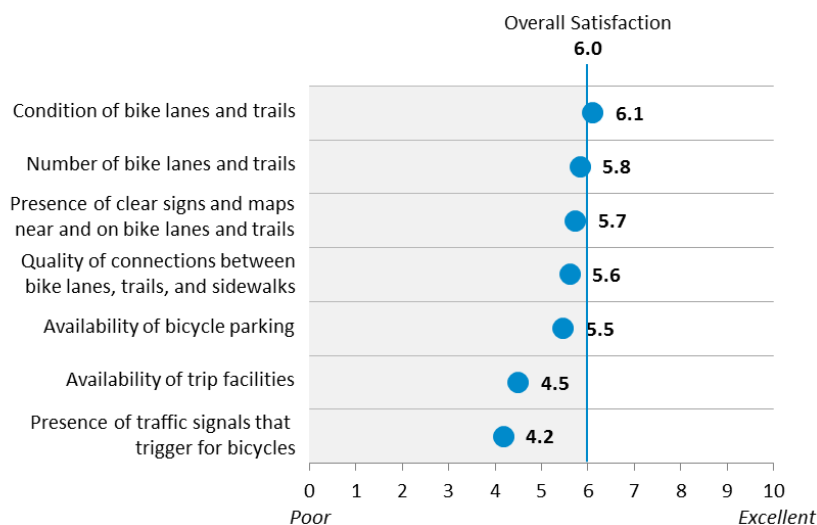
trails, and sidewalks; the availability of bicycle parking, the availability of trip facilities, and the presence of traffic signals that trigger for bicycles. The study team estimates that Colorado resident's average bicycle satisfaction rating was a 6. An average score of 6 demonstrates that, on average, Colorado residents are detractors; they are unsatisfied with the state's bicycle infrastructure and would not recommend it to others.

In addition, the study team identified the lowest and highest rated components of bicycle infrastructure in the state. The presence of bicycle-friendly traffic signals and the availability of trip facilities (i.e., bathrooms; water fountains; and lockers and showers) and bicycle parking were the lowest rated components of bicycle infrastructure. Conversely, the number and condition of bike lanes and trails and the presence of clear signs and maps near bike lanes and trails were the highest rated components. However, with all components rated a 6 or lower, these scores demonstrate that Colorado residents are unsatisfied with the presence, availability, and conditions of bicycle lanes and trails as well as vital support infrastructure.

Figure IV-30.
Satisfaction with
bicycling infrastructure

Source:

BBC Research & Consulting from
2016 Colorado Bicycling and
Walking Survey.



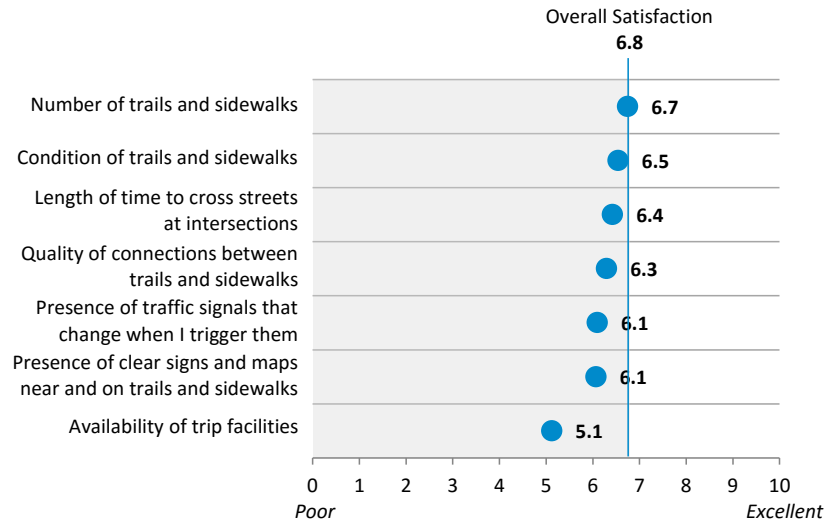
Satisfaction with walking infrastructure. Figure IV-31 below presents Colorado resident's satisfaction with walking infrastructure overall and their rating of various components of walking infrastructure, including the number of bike lanes and trails; condition of bike lanes and trails; the presence of clear signs and maps; the quality of connections between bike lanes, trails, and sidewalks; the availability of bicycle parking; the availability of trip facilities; and the presence of traffic signals that trigger for bicycles. The study team estimates that Colorado resident's average walking infrastructure satisfaction rating was a 6.8. An average score of approximately 7 demonstrates that Colorado residents are passive; they are satisfied with the state's walking infrastructure but are unenthusiastic about recommending it to others.

In addition, the study team identified the highest and lowest rated components of walking infrastructure. The availability of trip facilities, presence of clear signs and maps, and pedestrian-friendly traffic signals were the lowest rated components of walking infrastructure. The number and condition of trails and sidewalks were the highest rated components of walking infrastructure. However, with many components rated about a 6 or less, these scores demonstrate that Colorado Residents are unsatisfied with the support infrastructure connected to sidewalks and trails, including the availability of trip facilities; sidewalk and trail

connections; length of time to cross at intersections; pedestrian-friendly traffic signals; and clear signs.

Figure IV-31.
Satisfaction with
walking infrastructure

Source:
BBC Research & Consulting from
2016 Colorado Bicycling and
Walking Survey.

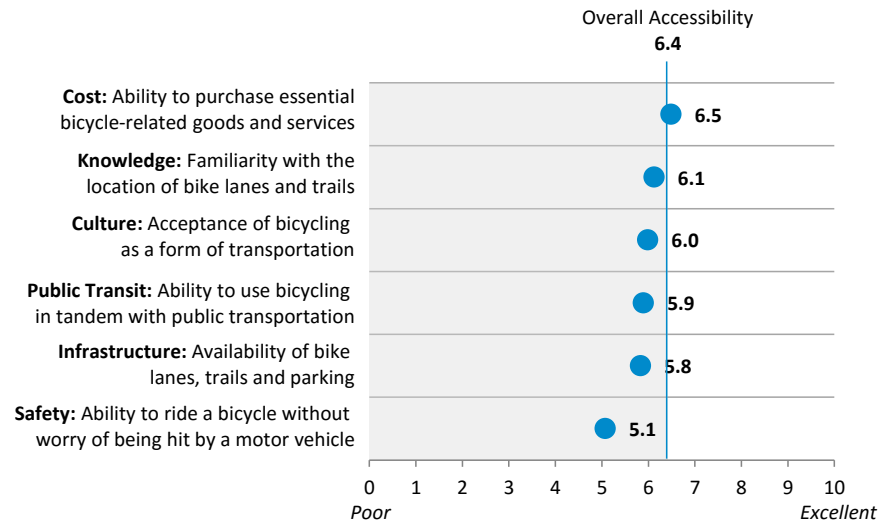


Access to bicycling. Figure IV-32 presents Colorado resident's rating of the accessibility of bicycling in their community overall and their rating of various components of bicycling accessibility, including cost, knowledge, culture, public transit, infrastructure, and safety. The study team estimates that Colorado resident's average bicycling accessibility rating was a 6.4. An average score of about 6 demonstrates that Colorado residents are detractors; they are not satisfied with the bicycle accessibility of their community and would not recommend it to others.

In addition, the study team examined the highest and lowest rated components of community bike accessibility. The ability to ride a bicycle without fear of being hit and the availability of bike lanes, trails, and parking were the lowest rated components of community bicycling accessibility. The ability to purchase essential bicycle-related goods and services was the highest rated component of community bicycling accessibility. However, with most components being rated about a 6 or less, these scores demonstrate that Colorado residents are unsatisfied with many components of bicycle accessibility in their community.

Figure 32.
Access to bicycling
in your community

Source:
BBC Research & Consulting
from 2016 Colorado Bicycling
and Walking Survey.



SECTION V.

Economic and Health Benefits

SECTION V.

Economic and Health Benefits

This section provides details on the economic and health benefits of bicycling and walking in Colorado, which includes the following subsections that detail findings from components of the economic model:

- Economic and health benefits of bicycling and walking in Colorado;
- Household spending;
- Bicycle retail and manufacturing;
- Tourism; and
- Health benefits.

More information on the data sources and methodology can be in Section III – Methodology. The report is accompanied by two infographics that detail the economic and health benefits of bicycling and walking separately.

Economic and Health Benefits of Bicycling and Walking in Colorado

The study team calculated the economic and health benefits of bicycling and walking for the State of Colorado. Separate estimates were produced for bicycling and walking. Figure V-1 presents the total economic impact of bicycling and walking by category.

Figure V-1.
Total bicycling economic and health benefits

Source:
BBC Research & Consulting and Alta Planning and Design.

Total Economic Benefit (millions)	
Bicycling	
Household spending	\$434
Bicycle retail and manufacturing	\$185
Tourism	\$448
Health benefits	\$511
Bicycling total	\$1,577
Walking	
Household spending	\$497
Health benefits	\$2,700
Walking total	\$3,197
Total	\$4,789

The total economic and health benefits of bicycling calculated for the State of Colorado is approximately \$1.6 billion. Of that total, household spending on bicycling comprises \$434 million, bicycle retail and manufacturing sales account for \$185 million, bicycle-related tourism contributes \$448 million, and health benefits accrued from bicycling account for \$511 million.

The total economic and health benefits of walking calculated for the State of Colorado is approximately \$3.2 billion dollars. Of that total, household spending on walking contributes \$497 million and the health benefits accrued from walking account for \$2.7 billion.

Taken together, the total economic and health benefits of bicycling and walking calculated for the state of Colorado is approximately \$4.8 billion.

Household Spending

In the Colorado Bicycling and Walking survey, Colorado residents were asked to report their total household spending on bicycling and walking, including bicycling- and walking- related goods and services purchases and costs related to participating in day hiking; bicycle events or races; and bicycle vacations. Based on this data, the study team calculated average annual household spending estimates for a number of subcategories in bicycle- and walk-related household spending.

Bicycle-related household spending. Based on the Colorado Bicycle and Walking survey, the study team calculated the total average annual spending on bicycling and the average annual household spending of a number of bicycle spending subcategories. The study team estimated that the average annual household spending on bicycling in the State of Colorado was \$217, with a total household spend of approximately \$434 million dollars on bicycling-related goods, services, and events. In addition, the study team calculated the average annual household spending estimates for subcategories of bicycling spending.

Figure V-2.
Bicycle-related household spending

Household spending subcategory	Average annual household spending	Total Economic Benefit (millions)
Bicycle purchases	\$77	\$153
Bicycle-related equipment, clothes, and maintenance	\$103	\$206
Bicycling events and vacations	\$37	\$74
Total	\$217	\$434

Note: Totals may not add due to rounding.

Source: 2016 Colorado Bicycle and Walking Survey.

Bicycle purchases. The study team estimated the average annual household spending on purchases of bicycles in Colorado in the past year using results from the Colorado Bicycling and Walking survey. Based on this analysis, the average annual household spending on bicycle purchases is \$77 for a total of \$153 million across all Colorado households.

Bicycle-related equipment, clothing, and maintenance. The study team calculated the average annual household spending on bicycle-related equipment, clothing, and maintenance. These expenditures include the purchase of bicycle components (e.g., pedals, lights, water bottle cages), clothing (e.g., bicycle jerseys, cycling caps, cycling shoes), and services (e.g., tune-ups, fix a flat tire, build a bike) at Colorado retailers. The estimated average annual household spending on bicycle-related equipment, clothing, and maintenance is \$103. In total, Colorado households spent an estimated \$206 million on bicycle-related goods and services.

Bicycling events and vacations. Using the Colorado Bicycling and Walking survey, the study team estimated the average annual household spending on expenditures related to participating in bicycle events and races or taking a bicycle-oriented vacation in Colorado. These expenditures include the costs of lodging (e.g., hotels, campgrounds, cottages), food (e.g., groceries, restaurants), non-bicycle entertainment and recreation (e.g., amusement parks, movies, shopping, souvenirs), transportation (e.g., gas, parking, bus, or train fare), and registration fees. The estimated average annual household spending on bicycle events is \$37. The 2 million households in Colorado spent an estimated \$74 million on costs related to participating in bicycle events or bicycle-oriented vacations in Colorado.

Walking-related household spending. The study team calculated the total average annual spending on walking and the average annual household spending on a number of walk spending subcategories. The study team estimated that the average annual household spending on walking in the State of Colorado was \$248. Overall annual household spending is estimated to be \$497 million on walking-related equipment and expenses. In addition, the study team calculated the average annual household spending estimates for subcategories of walk spending.

Figure V-3.
Walking-related household spending

Note:
Totals may not add due to rounding.

Source:
2016 Colorado Bicycling and Walking Survey

Household spending subcategory	Average annual household spending	Total Economic Benefit (millions)
Walking-related equipment	\$97	\$193
Day hiking	<u>\$152</u>	<u>\$303</u>
Total	\$248	\$497

Walking-related equipment. The study team calculated the average annual household spending on walking-related equipment, including specialty walking or hiking footwear, orthotic insoles, and clothing. The estimated average annual household spending on walking-related equipment was \$97 with a total for all households in Colorado of \$193 million.

Day hiking. The study team estimated the average annual household spending on expenditures related to day hiking in Colorado using results from the Colorado Bicycling and Walking Survey. These expenditures include food (e.g., groceries, restaurants), transportation (e.g., gas, parking, bus, or train fare), and park access (e.g., park entry fee or park pass). The estimated average annual household spending on day hiking is \$152. Overall, Colorado residents annually spend an estimated \$303 million on day hiking.

Bicycle Retail and Manufacturing

The study team draws from two sources to describe the economic impact of bicycle retail and manufacturing industry on the Colorado economy. Dun & Bradstreet reports information on the revenue and number of employees of bicycle retail and manufacturing businesses. The study team's bicycle business survey asked Colorado bicycle business owners to report on their experiences operating a bicycle business in Colorado, including identifying key industry resources and barriers. Based on this information, the study team describes the economic impact of the bicycle retail and manufacturing industry in Colorado and highlights some of the resources businesses used to start their business and barriers to the industry's growth.

Economic impact. The study team calculated total out-of-state bicycle retail and manufacturing sales in the State of Colorado using Dun & Bradstreet business intelligence data, bicycle business lists from a variety of sources, and a survey with bicycle businesses. This estimate includes any sales of bicycles, equipment, clothing, or services to out-of-state visitors or consumers that live outside Colorado. The study team estimates that the bicycle industry in Colorado sold an estimated \$185 million dollars in goods and services to out-of-state.

Industry resources. Colorado Bicycle retail and manufacturing businesses reported that the state agencies and the bicycle community in Colorado have been helpful resources in starting and growing their business.

Bicycle community. Business owners reported that the Colorado bicycle community has been important to their success. For example:

"Colorado has a strong biking community, which supports new growth. Also, the media is supportive of sharing information about new companies to help them get the word out."

Representative of a bicycle manufacturing business.

State agencies. Business owners reported that Colorado state agencies have been helpful to starting and growing their business. For example:

"Overall, I would have to say that the State of Colorado is very good to deal with in starting a business."

Representative of a bicycle retail business.

"I used our Small Business Development Center to get going and figure out the basics of starting a business."

Representative of a bicycle manufacturing business

Industry barriers. Colorado bicycle retail and manufacturing businesses cite a number of barriers to growing their business, including finding affordable space, internet competition, and lack of support for bicycle infrastructure and bicycle education.

Affordable space. Business owners reported that finding affordable rental space was very difficult for their business. For example:

"The growth of the marijuana industry has made industrial space prohibitively expensive."

Representative of a bicycle manufacturing business.

"Rental property was hard to find, and we ended up with a smaller place than desired."
Representative of a bicycle retail business.

Internet competition. Business owners reported that it is very hard to compete against internet retail outlets. For example:

"Someone needs to control national and international pricing. We cannot compete with some of these online stores."
Representative of a bicycle retail business.

"The bicycle industry is tough. [It's] going more and more to direct sales on the internet, rather than selling through dealers."
Representative of a bicycle manufacturing business.

Lack of support for bicycle infrastructure and education. Business owners identified that a key to the growth of the state's bicycling community and the future success of their businesses would be more investment in bicycle infrastructure and education. Currently, those business owners identified a lack of adequate investment. For example:

"Low support for bicycle education and infrastructure across the state limits the size of Colorado's bike industry - we're getting by on cycling enthusiasts and tourists."
Representative of a bicycle retail business.

"Invest in more pathways and trails. Ruby Hill is a great example of improving the bicycle environment."
Representative of a bicycle manufacturing business.

Tourism

The study team draws from a variety of sources to describe the economic impact of out-of-state bicycle tourism. Longwoods International's 2015 Colorado Tourism Report presents economic information related to the number of out-of-state visitors, out-of-state visitor spending, and the activities out-of-state visitors participated in. Sponsorship Science's conducted a study of the US Pro Challenge—a professional bicycle race that was staged in Colorado from 2012-2015—to quantify the yearly economic impact of a major professional bicycle race. In addition, the study team conducted interviews with key resort and industry stakeholders to identify ways the state can help the bicycle tourism industry.

Economic impact. The study team calculated an estimate of the total economic impact of out-of-state bicycle tourism in the State of Colorado using data from the 2015 Longwoods International Colorado Tourism Report and a related economic impact study of the 2014 US Pro Challenge. The total economic impact of out-of-state bicycle tourism in Colorado is \$448 million. In addition the study team calculated the total economic impact of two subcomponents of bicycle-related tourism.

Figure V-4.
Tourism economic benefit

Source:
2015 Longwoods International Colorado Tourism Report.
Sponsorship Science. 2014. US Pro Challenge Economic Impact Report.

Tourism subcategory	Total Economic Benefit (millions)
Out-of-state bicycle tourism	\$318
US Pro Challenge	<u>\$130</u>
Total	\$448

Out-of-state bicycle tourism. Using data from the 2015 Longwoods international Colorado Tourism Report, the study team calculated the total expenditures made by out-of-state visitors that reported participating in bicycling during their stay in Colorado.¹ These total expenditures include lodging; food and beverage; and transportation costs. The estimated total economic benefit of out-of-state tourists that bicycled on their vacation is approximately \$318 million.

USA Pro Cycling Challenge. Sponsorship Science conducted an economic impact study of the 2014 US Pro Cycling Challenge. Sponsorship Science estimated that the 2014 US Pro Cycling Challenge generated \$130 million in spending by out-of-state race spectators. The race occurred for five years starting in 2011 with the most recent edition taking place in 2015. While the race was not held in 2016, it is likely that another international road cycling event will take place in 2017.

State assistance for out-of-state bicycle tourism. Resort and industry stakeholders identified that bicycling is growing at a significant rate at resorts and in mountain communities. However, stakeholders identified a number of ways the state could assist the bicycle tourism industry, including changes to state law, trail development and maintenance, mountain bike share programs, and marketing.

State law. Stakeholders identified that there is tremendous potential for future growth in their industry if state law can be changed to clarify a few legal issues. Some respondents made suggestions for legal changes that could better define liability for mountain biking and improve riding conditions for participants and venue owners.

¹ To be sure that the study team did not overestimate the economic impact of bicycling activity, only one day's worth of expenditures was added into this model for each bicycling visitor. Our interviews with resort stakeholders suggest that by and large bicycling is one of many activities that out-of-state visitors participate in while visiting Colorado. Consequently, the study team wanted to reflect that in our tourism calculation.

Trail development and maintenance. Stakeholders identified that trail development and maintenance is important to the future growth of the bicycling tourism industry. Stakeholders reported that the resort communities need more trails and connections between trails. For example:

"We need more trails. We need more connections. We need more acquisitions of open space to make those connections. We need capital to build the trails...There are a lot of communities that still need linkages [to trails]."

Stakeholders also reported that they need more resources to maintain existing mountain bike trails. For example:

"For the county or the valley in general, resources for trail maintenance would be huge for us. We need the help to maintain them [the existing mountain biking trails]. [To know] that we are delivering a good quality product when people do come."

In addition, stakeholders identified that they are having difficulty getting forest service approval for building additional downhill mountain bike trails on public land. For example:

"We haven't been able to get green-lighted on building out more downhill trails...We are ready to pull the trigger in building out bike trails, and we have just been in gridlock on forest service approval."

Mountain bike sharing. Stakeholders mentioned that they have seen an increase in the use of bicycling for transportation in some resort communities. One stakeholder suggested that the state could provide funding to help mountain communities establish bike sharing programs. For example:

"We are one of the only mountain communities with a bike sharing [program]. [At first,] we were really skeptical. Really? You think there are enough people here to really make this a viable business? It has been thriving, and [the business] has been expanding. You see a lot of tourists downloading the app, grabbing a bike, and using it to get from A to B... [The state could provide] funding or grant funding to do more of those types of programs in mountain communities."

Marketing. Stakeholders mentioned that the state could help the bicycle tourism industry by marketing the state as a bicycle destination. For example:

"Where I could see opportunity [for the state to help], is if there is some sort of opportunity to label Colorado as the number one bicycling destination in America... Anyone who is taking that messaging on from a statewide perspective would be complementary to the messaging we are putting out there [at the resort]. That's where I could see [the state] helping, because [the messaging would be] raising the awareness level."

In addition, one stakeholder identified that their resort benefited from the US Pro Challenge. That stakeholder suggested the state could sponsor a professional cycling event that would solidify the state's reputation as a world-class cycling destination. For example:

"I think it's interesting when you start talking about things like the US Pro Challenge. [I wonder if] there some sort of benefit to attracting those types of [professional cycling] events [like the Tour De France] that give a national and international lens and is good for branding for the state? I think there is an element to that. When there was investment in [the US Pro Challenge],... our communities really saw a benefit from that. [The event] had national exposure, and [the event] really raised the profile."

Health Benefit Analysis Results

The Health Economic Assessment Tool (HEAT) produces estimates of the reduction in all-cause mortality and the reduction in the number of deaths resulting from bicycling and walking. It also estimates the following economic health benefits from reduced mortality:

- Annual health benefits;
- Total health benefits over the evaluation period (in this case, 20 years);
- Current value of annual health benefits (time-adjusted using the three percent discount rate); and
- Current value of the total health benefits over the evaluation period (again using the three percent discount rate).

All results are reported for the existing number of bicyclists and walkers in Colorado as well as for the three target increased numbers of bicyclists and walkers outlined in Section III. The study team presents results as ranges to account for the low, mid, and high estimate inputs. The study team also presents the mean of the low, mid, and high estimates. For more information on HEAT model inputs, see Section III.

Health benefits of bicycling in Colorado. Colorado residents who bicycle regularly are estimated to experience on average a 2 percent reduction in all-cause mortality compared to people who do not bicycle regularly. This number remains constant regardless of the total number of bicyclists in the study population, because it refers to each individual's potential reduced mortality risk, not the reduced risk of the population overall. Figure V-5 presents the reduced mortality benefits based on the existing number of bicyclists in Colorado as well as the reduced mortality benefits one would expect from the three target increased numbers of bicyclists in Colorado.

Figure V-5.
Reduced mortality benefits
from bicycling in Colorado

Source:
BBC Research & Consulting and Alta
Planning and Design from WHO HEAT
bicycling output.

Number of Bicyclists in Colorado	Number of Deaths Prevented per Year
Existing	40-60
Low Target (10% increase)	50-70
Mid Target (30% increase)	60-80
High Target (60% increase)	70-100

As presented in Figure V-5, the existing levels of bicycling in Colorado translate into 40 to 60 deaths prevented per year. If the number of Colorado residents who bicycle regularly increased by 10 percent over the next 20 years (low target), HEAT estimates that an additional 10 deaths

would be prevented per year. If the number of Colorado residents bicycling regularly increased by 30 percent over the next 20 years (mid target), HEAT estimates that an additional 20 deaths would be prevented per year. If the number of Colorado residents bicycling regularly increased by 60 percent over the next 20 years (high target), HEAT estimates that an additional 30 to 40 deaths would be prevented per year.

Figure V-6 presents the economic benefits associated with reduced mortality from bicycling. As shown in Figure V-6, the existing levels of bicycling in Colorado translate to \$409 million to \$612 million in economic benefits per year based on the U.S. Department of Transportation's statistical value of a human life. The low target increase in bicyclists resulted in approximately \$123 million to \$184 million in additional annual undiscounted health benefits. The mid target increase in bicyclists resulted in approximately \$245 million to \$367 million in additional annual undiscounted health benefits. The high target increase in bicyclists resulted in approximately \$245 million to \$367 million in additional undiscounted health benefits.

Figure V-6.
Economic health benefits from bicycling in Colorado

Number of Bicyclists in Colorado	Annual Economic Benefits (millions)	Mean Annual Economic Benefits (millions)	Total Economic Benefits (millions)	Mean Total Economic Benefits (millions)
Undiscounted Benefits				
Existing	\$409 - \$612	\$511	\$8,181 - \$12,250	\$10,215
Low Target (10% increase)	\$450 - \$673	\$562	\$9,000 - \$13,466	\$11,232
Mid Target (30% increase)	\$532 - \$796	\$664	\$10,635 - \$15,920	\$13,278
High Target (60% increase)	\$654 - \$980	\$817	\$13,090 - \$19,590	\$16,340
Discounted Benefits				
Existing	\$304 - \$456	\$380	\$6,086 - \$9,112	\$7,599
Low Target (10% increase)	\$335 - \$501	\$418	\$6,694 - \$10,017	\$8,356
Mid Target (30% increase)	\$396 - \$592	\$494	\$7,911 - \$11,842	\$9,877
High Target (60% increase)	\$487 - \$729	\$608	\$9,737 - \$14,573	\$12,155

Note: The total undiscounted benefit and total discounted benefit values are based on a 20-year planning window.

Source: BBC Research & Consulting and Alta Planning and Design from WHO HEAT bicycling output.

Health benefits of walking in Colorado. As with bicycling, Colorado residents who walk regularly are estimated to experience on average a 2 percent reduction in all-cause mortality compared to people who do not walk regularly. Again, this number is the same regardless of the total number of walkers in the study population, because it refers to each individual's potential reduced mortality risk, not the reduced risk of the population overall. Figure V-7 presents the reduced mortality benefits based on the existing number of walkers in Colorado as well as the reduced mortality benefits one would expect from the three target increased numbers of walkers in Colorado.

Figure V-7.
Reduced mortality benefits from walking in Colorado

Source:
BBC Research & Consulting and Alta Planning and Design from WHO HEAT walking output.

Number of Walkers in Colorado	Number of Deaths Prevented per Year
Existing	230-340
Low Target (10% increase)	250-370
Mid Target (30% increase)	290-440
High Target (60% increase)	360-540

As presented in Figure V-7, the existing levels of walking in Colorado translate into 230 to 340 deaths prevented per year. If the number of Colorado residents who walk regularly increased by 10 percent over the next 20 years (low target), HEAT estimates that an additional 20 to 30 deaths would be prevented per year. If the number of Colorado residents who walk regularly increased by 30 percent over the next 20 years (mid target), HEAT estimates that an additional 60 to 100 deaths would be prevented per year. If the number of Colorado residents bicycling regularly increased by 60 percent over the next 20 years (high target), HEAT estimates that an additional 130 to 200 deaths would be prevented per year.

Figure V-8 presents the economic benefits associated with reduced mortality from walking. As shown in Figure V-8, the existing levels of bicycling in Colorado translate to \$2.2 billion to \$3.3 billion in economic benefits per year based on the U.S. Department of Transportation's statistical value of a human life. The low target increase in walkers resulted in approximately \$217 million to \$326 million in additional annual undiscounted health benefits. The mid target increase in walkers resulted in approximately \$652 million to \$978 million in additional annual undiscounted health benefits. The high target increase in bicyclists resulted in approximately \$1.3 billion to \$2.0 billion in additional undiscounted health benefits.

Figure V-8.
Economic health benefits from walking in Colorado

Number of Walkers in Colorado	Annual Economic Benefits (millions)	Mean Annual Economic Benefits (millions)	Total Economic Benefits (millions)	Mean Total Economic Benefits (millions)
Undiscounted Benefits				
Existing	\$2,172 - \$3,258	\$2,715	\$43,445 - \$65,167	\$54,306
Low Target (10% increase)	\$2,389 - \$3,584	\$2,987	\$47,789 - \$71,684	\$59,737
Mid Target (30% increase)	\$2,824 - \$4,236	\$3,530	\$56,478 - \$84,717	\$70,598
High Target (60% increase)	\$3,476 - \$5,213	\$4,344	\$69,512 - \$104,268	\$86,890
Discounted Benefits				
Existing	\$1,616 - \$2,424	\$2,020	\$32,317 - \$48,476	\$40,397
Low Target (10% increase)	\$1,777 - \$2,666	\$2,222	\$35,549 - \$53,324	\$44,437
Mid Target (30% increase)	\$2,101 - \$3,151	\$2,626	\$42,013 - \$63,019	\$52,516
High Target (60% increase)	\$2,585 - \$3,878	\$3,232	\$51,708 - \$77,562	\$64,635

Note: The total economic benefit values are based on a 20-year planning window.

Source: BBC Research & Consulting and Alta Planning and Design from WHO HEAT walking output.

APPENDIX A.

Bicycling Infographic

Biking in Colorado



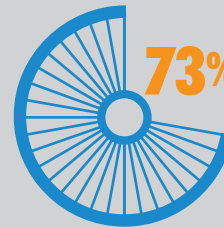
In the past year...

Colorado residents...
that cycled for recreation **41%**
that cycled for transportation **17%**



43%
of Colorado residents took at least one bike ride

CO households spent
\$434 million
on bikes, gear, & events



73% of Colorado residents owned at least one bicycle

7%
of Colorado residents participated in local bike events

1,735,650
tourists participated in bicycling



Out-of-state consumers spent
\$185 million
at Colorado bike businesses



\$510
million in
Health Benefits



Total Impact

\$1.6
BILLION

APPENDIX B.

Walking Infographic

Walking in Colorado



In the past year...

85%

of Colorado residents walked



33%

of Colorado residents walked more than 101 days



Colorado residents...

walked for recreation

81%

walked for transportation

48%



Colorado residents spent

\$500 million

on gear and day hiking



43% of Colorado residents day hiked



\$2.7

billion in
Health Benefits



Total Impact

**\$3.2
BILLION**