



FREE PUBLIC TRANSIT

Promotes Health and Economic Equity in Colorado

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Colorado's overreliance on cars has made the state's transportation sector the largest source of carbon emissions and a public health threat¹

By investing in accessible and robust public transportation systems, city and state governments can reduce air pollution and carbon emissions while also improving the health and economic security of their residents- especially children, older adults, individuals with low incomes, and people of color.

Free fare programs create more equitable public transit systems by reducing the cost burden on riders with lower incomes. Increasing access to transportation promotes health and economic mobility for Colorado families.

In 2022, Colorado launched the Zero Fare for Better Air Program, which made services from Colorado's Regional Transportation District (RTD) free during

the month of August, 2022. In this research, the Colorado Fiscal Institute (CFI) examines the impact of this program on air pollution in the Front Range area.

CFI also lays out findings from our transportation equity survey, which sought to better understand Coloradans' current relationship with public transportation and the barriers that they face when accessing it. Our work builds on other important examinations of public transportation interventions, some of which are highlighted in this report, including RTD's own analysis of ridership during the Zero Fare program and examinations of other similar programs.

CFI finds:

The Zero Fare for Better Air program has the potential to reduce air pollution

Our analysis shows that after the implementation of the program, Denver and Jefferson Counties' levels of NO₂ pollution decreased by more than seven percent. In Weld county, it decreased by about four percent.

Making public transit free will incentivize more Coloradans to use public transportation and do so more frequently, expanding public transit ridership

Our transportation equity survey found that most Coloradans currently use their cars as their main mode of transportation and the majority of them spend less than 30 minutes a day driving. These short trips are a considerable source of air pollution that can be easily replaced by alternative modes of transportation such as biking, walking, and public transit if the necessary infrastructure is in place.

Travel time, reliability, and cost are identified as the top three barriers to public transportation use by our survey respondents; and a lack of walkable, bikeable roads force people to use cars for very short trips.

65 percent of survey respondents are willing to take public transit more if it is made free, and this figure is higher among low and middle income respondents (those who make under \$80,000 a year). Making public transit free would eliminate the cost burden on riders with lower incomes and create a more equitable transportation system. To sustain and build on the improvements that are possible through the Zero Fare for Better Air program, Coloradans also need a more reliable public transportation system that offers reasonable travel times and accessible transit services to more communities.

FREE PUBLIC TRANSIT IMPROVES HEALTH AND ECONOMIC SECURITY OF COLORADANS

Air Quality and Health Effects

Air quality is a major health and environmental concern in Colorado, particularly during the hot summer months, when ozone levels peak. Large areas of Colorado – from the northern Front Range to Denver – experience “ozone nonattainment,” which means that the level of ozone pollution contaminating the air we breathe exceeds federal safety standards. In the summer of 2021, Colorado recorded some of the worst air quality in the world, and in September of 2022, the Environmental Protection Agency (EPA) reclassified several counties of the Front Range from “Serious” levels of dangerous ozone pollution to “Severe.”

In the US, the transportation sector is responsible for over 55 percent of NOx total emissions inventory, less than 10 percent of VOCs emissions, and less than 10 percent of PM2.5 and PM10 emissions.² NOx and VOCs are the two major components of ozone

molecules, which form ground-level ozone pollution most drastically during the warm summer months.

Ozone pollution increases respiratory diseases such as asthma and chronic bronchitis as well as the risk of stroke, diabetes, and other diseases³. In 2010, high ozone levels contributed to over one million premature deaths⁴. Ground-level ozone also exacerbates cardiovascular disease, heart attacks, preterm births, and Alzheimer’s disease^{5,6,7}. Children, older people, and those who work outdoors are more likely to be negatively impacted by ozone pollution. Moreover, low-income people and communities of color are more likely to live in areas that are more exposed to ozone pollution (e.g. in cities and along highways).

Fortunately, investments in affordable, reliable public transportation can help address these environmental, health, and equity issues.

BENEFITS OF FREE PUBLIC TRANSIT

Public transit emits 84 percent less carbon than traveling by car⁸. Expanding public transit use and reducing personal vehicle use — especially for short, local, or one-way trips — provides Colorado with a significant opportunity to address our severe ozone problem.

Improved access to public transportation can reduce both the short and long-term health effects of air pollution, which are not evenly distributed across Colorado communities. Children and older Coloradans are particularly vulnerable to pollution. Additionally, people who work outside are more frequently exposed to air pollution and face a higher risk of health complications. Furthermore, air pollution disproportionately affects people with low incomes because they are more likely to live near industrial areas, which contain major emission sources that worsen local air quality.

Economic Outcomes

The negative health effects of air pollution are also costly to state and local governments. In 2020, the Colorado Fiscal Institute found that eliminating pollutants from one of Commerce City's oil refineries could

save the state between \$15.7 and \$35.4 million and help Adams County retain between \$5.6 million and \$12.7 million — all through related health and economic benefits⁹. Additionally, air pollution causes a wide range of serious environmental impacts. According to the USDA, ozone pollution does more damage to plants — including crops — than all other air pollutants combined, which imposes significant costs to the state¹⁰.

High-quality and affordable public transit systems also help people with low income find and keep jobs, conduct essential household trips — such as to the grocery store or doctor's office — and participate in activities that support local economies. Without access to affordable public transit, residents with low incomes begin to ration essential trips, which limits out-of-home activities that improve health as well as economic security and mobility¹¹. Women, especially single mothers, are particularly vulnerable to these health and economic costs since they are more likely to manage household needs¹².

Findings from Other Transit Programs: Free Fare Increases Efficiency, Reliability, and Ridership

Free fare public transit has been implemented in some capacity in several cities across the United States. Research shows that during fare free periods, ridership increases and the efficiency and reliability of public transportation improves.

In June 2014, Longmont, Colorado implemented a pilot program that funded free fares on city buses. About a month after the free fare program was implemented, transit boardings increased 72 percent, and by the second month, boardings had increased 83 percent¹³. After 18 months of free fare, daily bus boardings had increased by more than 300 percent – all without any overcrowding, additional buses, or additional routes¹⁴. Boulder County, which contains Longmont, estimates that 43 percent of the riders were new¹⁵.

In December 2015, Boulder County surveyed bus riders to understand the impact that the free fare program had on riders and their families.

Approximately 72 percent of riders agreed that transportation poses a challenge for them and their families. Most of these riders also agreed that the biggest barriers to accessing transportation were the high costs of car ownership and public transit fares. About 40 percent of respondents who identified transportation as a challenge did not use public transit prior to the free fare program because they could not afford to pay the high fares. Instead, these respondents were forced to find less efficient travel options. However, after the implementation of free fares, every respondent who previously could not afford to use public transit reported riding multiple times each week¹⁶.

In 2022, Salt Lake City ran a month-long free fare program called “Free Fare February.” Ridership increased, and more than one in five survey respondents identified as new riders. Furthermore, more than half of all respondents indicated that they were using public transit because it was free, and 72 percent of new riders indicated that they used public transit during February because it was free. Additionally, 89 percent of new riders said they were either very likely or somewhat likely to ride more frequently if public transit were free¹⁷. Boston also ran a fare-free

BENEFITS OF FREE PUBLIC TRANSIT

pilot program for the city's Route 28, which has one of Massachusetts Bay Transportation Authority's (MBTA) highest ridership rates. 97 percent of Route 28 riders are "transit critical," which includes people with low-incomes, people of color, older folks, people with disabilities, and people who live in households with access to few — relative to household size — or no vehicles¹⁸.

After the start of the free fare pilot program, ridership on Route 28 increased 38 percent, with 15 percent of survey respondents indicating that they were new riders¹⁹. Riders who were interviewed during the pilot program placed a high value on travel time savings, and the vast majority

of interviewees indicated that buses seemed more reliable during the free fare program. Overall, researchers estimate that the decrease in dwell time and travel time for free fare riders translates to savings of 4.8 hours per weekday compared to paid fare routes.

In 2019 King County, which contains Seattle, ran a study in which a random group of people with low incomes were offered six months of free public transit²⁰. During the study, public transit ridership increased significantly amongst those who were given free fares by about 350 percent²¹.



COLORADO'S ZERO FARE PROGRAM INCREASES PUBLIC TRANSIT RIDERSHIP AND IMPROVES AIR QUALITY

Ridership

Detailed analysis from Colorado's Regional Transportation District (RTD) finds that overall ridership across RTD transit services increased 22 percent from July 2022 to August 2022, with bus services experiencing the largest increase of 23 percent^{22, 23}. RTD's transit services were able to absorb these increases in ridership without widespread overcrowding, and much of the growth in ridership achieved in August was sustained into September 2022 when fare collection resumed.²⁴

During the month of free fare, ridership also increased across all of RTD's paratransit services, which includes Access-a-Ride, Access-a-Cab, and the Access-on-Demand service provided through Uber. The use of the Uber-based Access-on-Demand service grew most dramatically, with 170 percent more boardings in August 2022 compared to the aggregated monthly average across January to July of 2022. Additionally, Access-a-Ride boardings increased 24 percent,

and ridership across Access-a-Cab services increased 11 percent²⁵. These significant increases in RTD's paratransit ridership support that there is a considerable need to make these services more affordable and accessible.

A survey commissioned by RTD finds that 55 percent of respondents increased their use of public transit during the free-fare month. Notably, respondents who reported having their own vehicle or access to personal transportation as a passenger were more likely to indicate increased use of RTD services during August compared to respondents who did not have access to a personal vehicle. This supports the claim that free fare programs are effective in expanding public transit ridership by motivating those who would typically drive a personal vehicle to opt instead for public transportation.

RTD’s survey confirms that cost-savings and environmental concerns were two prominent motivating factors for riders when choosing to take public transit. The majority of respondents agreed that they were satisfied with RTD services, and 54 percent indicated that their level of satisfaction with RTD services increased as a result of the free fare period.

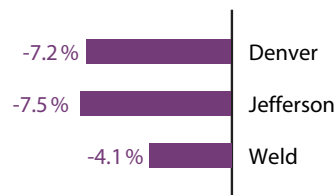
RTD’s final analysis of the Zero Fare for Better Air (ZFBA) program finds that better planning for the free fare month could yield significant cost savings in the future that were not leveraged in 2022 due to a lack of advanced notice. For instance, the printing costs for physical tickets and the contract costs for services that RTD employs could be modified to achieve greater cost-savings during future free fare periods.

Air Quality

CFI’s research builds on RTD’s analysis by estimating the impact of the Zero Fare program on air quality in the Front Range region of Colorado.

Overall, we found that the program has reduced NO2 pollution by more than seven percent in Denver and

Jefferson Counties, and by about four percent in Weld county. Denver and Weld counties have a larger proportion of Hispanic residents, as well as a larger share of the population who live in poverty compared to the state average²⁵. Improvement in air quality means health cost savings for these communities.



→ See details about CFI’s statistical analysis in the appendix on page 20

CFI’s statistical analysis shows that we cannot establish statistically significant reductions in Weld county. This is likely because the intervention period of just one month is too short making it difficult to distinguish the impact from other variations in the data. Despite this limitation, the findings still show declines in NO2 pollution across counties indicating the Zero Fare program is likely to improve air quality if implemented for longer periods of time.

CFI'S TRANSPORTATION SURVEY EXPOSES OPPORTUNITIES FOR IMPROVING RACIAL AND ECONOMIC EQUITY

CFI surveyed 160 Coloradans using email and some in-person surveys. Overall, travel time, reliability, and cost are the major barriers to public transit for our survey respondents. Most Coloradans rely on cars as their main mode of transportation and the majority spend less than 30 minutes a day driving. Likewise, a lack of walkable and bikeable roads force people to use cars even for very short trips.

Despite these barriers, 65 percent of survey respondents say they would use public transit more if it were free, and this figure is higher among

respondents with low and moderate incomes (those who earn under \$80,000 a year). People with low and moderate incomes are also more likely to take public transportation, so expanding transit infrastructure and making it more affordable will benefit these groups most.

Reliability of public transit also has important equity implications because people who earn lower incomes are more likely to have in-person jobs with irregular working hours, and accessible, reliable public transit helps workers get to and from their job more easily.

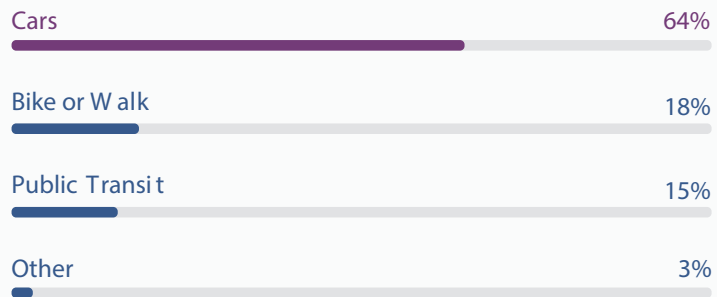
→ *Find demographics breakdown of survey participants on page 23*

MODES OF TRANSPORTATION

Free or more affordable public transportation expands transportation equity and promotes economic mobility while also improving air quality and providing other health and environmental benefits.

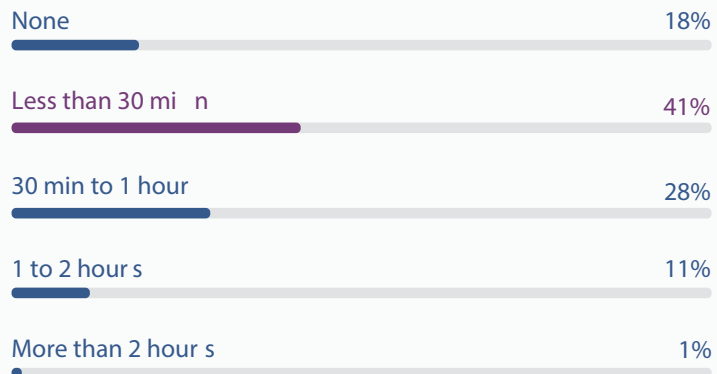
PRIMARY MODES OF TRANSPORTATION

1. Cars are the main mode of transportation for 64 percent of survey respondents.



DAILY TIME SPENT DRIVING A CAR

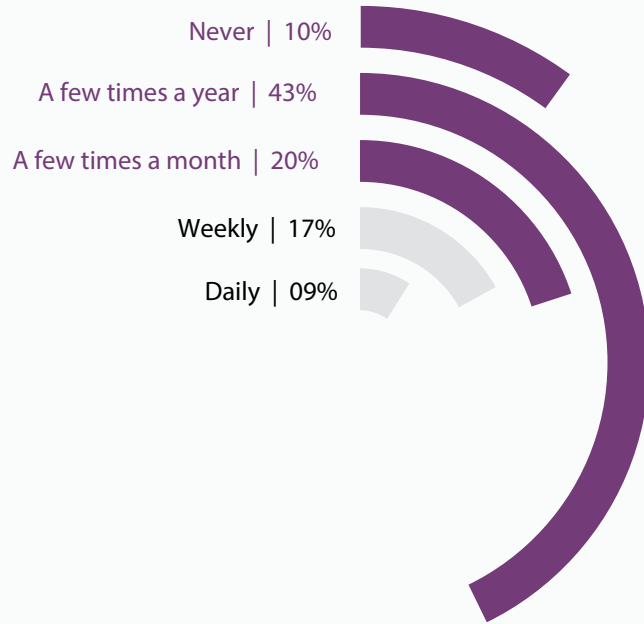
2. Most people drive their cars for less than 30 minutes a day.



CFI SURVEY: MODES OF TRANSPORTATION

3. 73 percent of respondents use public transportation a few times a month or less.

PUBLIC TRANSIT USAGE



4. Respondents with incomes lower than \$50,000 a year were more likely to use public transportation.

PUBLIC TRANSIT USAGE BY INCOME LEVELS

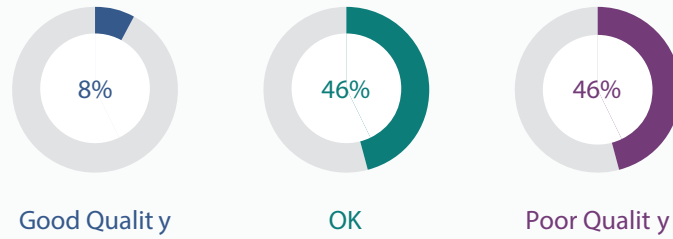


● Public Transit ● Bike / Walk ● Own / Family Car ● Other

PUBLIC PERCEPTIONS OF PUBLIC TRANSIT

PUBLIC TRANSIT QUALITY RATINGS

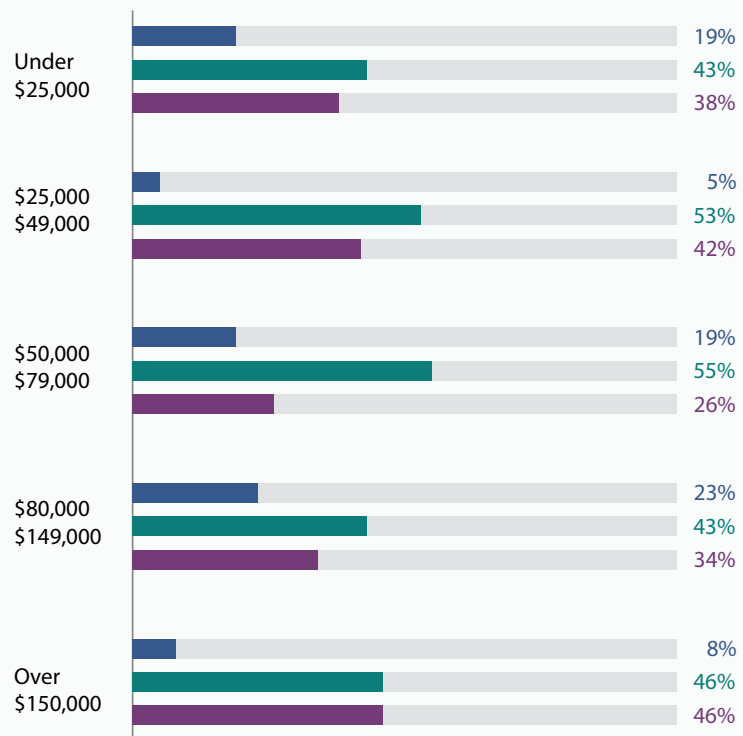
1. Only eight percent of respondents give the system a positive rating of



PUBLIC TRANSIT QUALITY RATINGS BY INCOME LEVEL

2. Respondents' views on the quality of public transit do not vary significantly across income levels.

- Good quality
- OK
- Poor quality



CFI SURVEY: BARRIERS TO ACCESSING PUBLIC TRANSIT

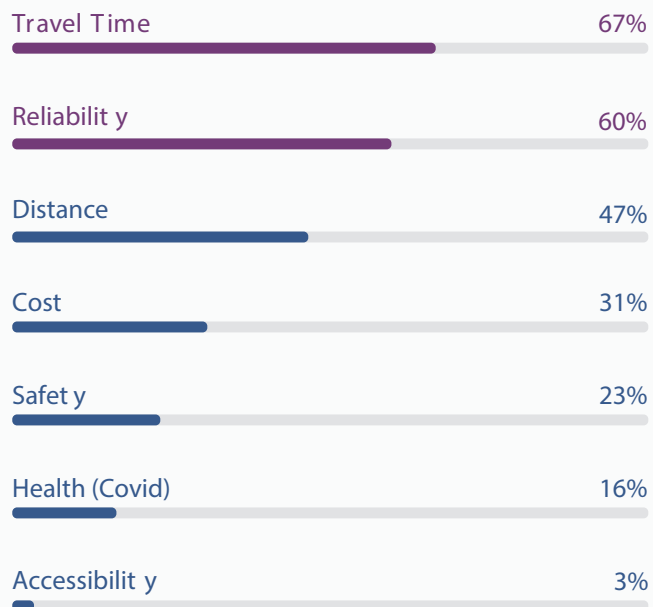
BARRIERS TO ACCESSING PUBLIC TRANSIT

Survey respondents identified four major barriers to taking public transportation: travel time, reliability, the distance of the bus or train station from home or work, and costs.

These findings have important equity implications given the impact of free public transit on riders with low incomes. Since riders with lower incomes are most sensitive to the costs, more likely to work in person, and more likely to rely more on public transportation, they would experience the greatest savings from the program. Thus, in addition to increasing ridership and likely improving air quality, RTD's Zero Fare program would eliminate the cost burden on riders with lower incomes and create a more equitable transportation system.

BARRIERS TO PUBLIC TRANSIT

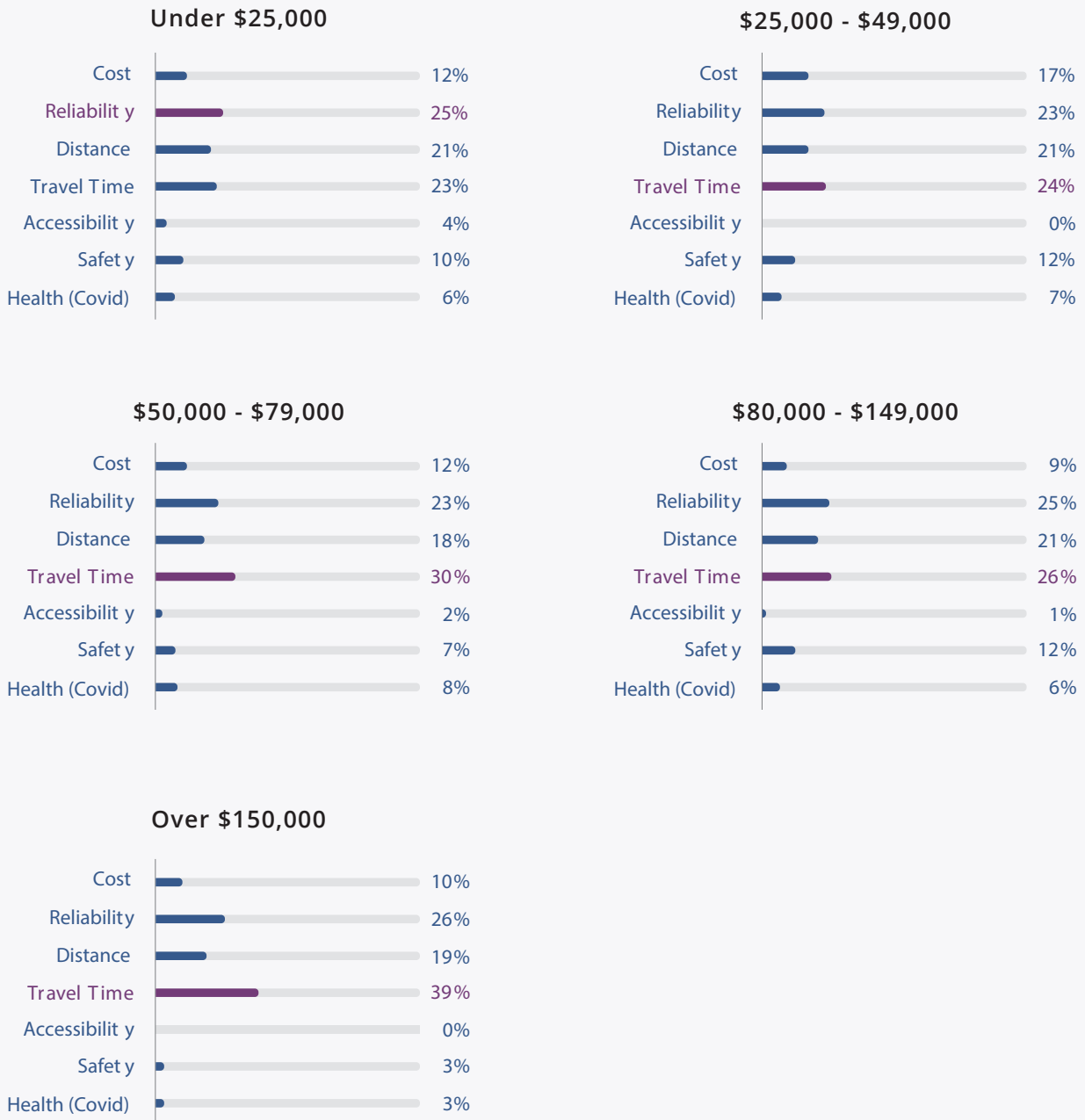
1. Respondents identify travel time as the greatest barrier to their use of public transit followed by service reliability and the distance of access points from their home and destinations.



CFI SURVEY: BARRIERS TO ACCESSING PUBLIC TRANSIT

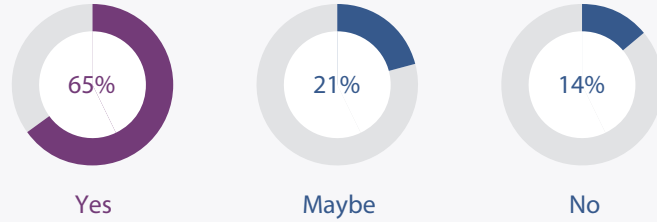
2. Respondents with higher incomes, who are more likely to have fully remote or hybrid work schedules, identify travel time as the greatest barrier. As would be expected, cost is a greater barrier for those earning less than \$80,000 a year. Only 23 percent of respondents with incomes below \$80,000 reported working fully remote. Contrarily, low and moderate income people are more likely to have in-person work with irregular schedules making reliable transportation vital.

BARRIERS TO PUBLIC TRANSIT - BY INCOME LEVEL



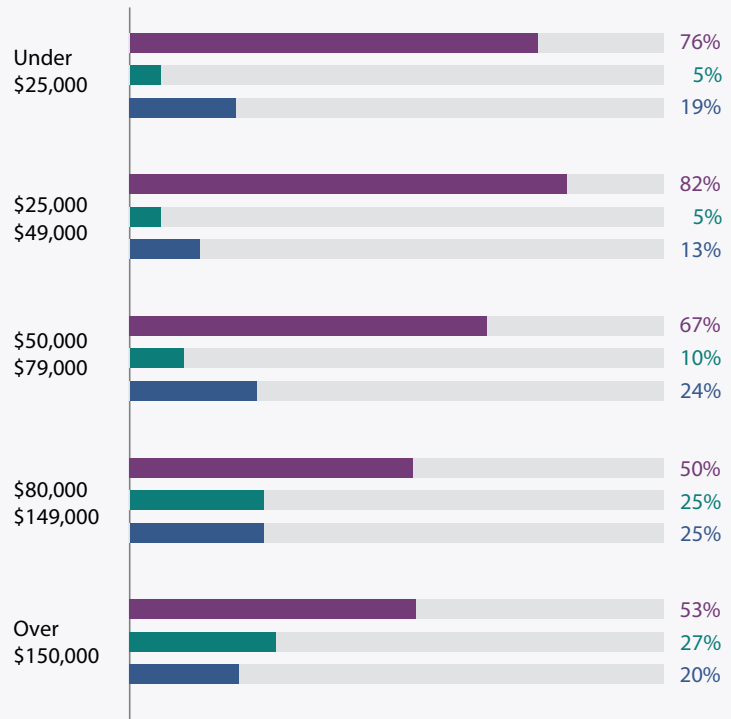
PUBLIC TRANSIT USAGE WOULD INCREASE IF FREE

1. When asked if they would use public transportation more if it becomes free, 65 percent of all respondents answered "yes."



2. Respondents who earn less than \$80,000 a year are more likely to report that their public transit usage would increase if fare were free compared to respondents with higher incomes.

PUBLIC TRANSIT USAGE WOULD INCREASE IF FREE - BY INCOME LEVEL



- Yes
- Maybe
- No

CFI's findings support previous analyses that have shown that free public transportation programs like Colorado's Zero Fare for Better Air Program can expand public transit ridership, improve air quality and health, and advance economic equity.

Over the long-term, these improvements to Coloradans' health and economic stability can help lower other costs, making it easier to make forward-looking investments in the state's public transportation system and other infrastructure.

In the future, we hope to see a sustainable and progressive funding method established that supports free and robust public transit year-round. Additionally, our research shows that in order to provide Coloradans with the quality of public transportation

services that we deserve, we must invest in our transit infrastructure – including building and enhancing bus stops, expanding routes, increasing route frequency, hiring new drivers and operators, and improving workers' wages and benefits.

In order to fund these important and needed investments, Coloradans need to come together to fix our state's broken and unfair tax and revenue system, which starts with repealing TABOR.

CFI recommends:

Investing in a sustainable and progressive funding source

Funding for the Zero Fare for Better Air program is included in Governor Polis's State Budget Proposal for fiscal year 2023-24. However, future investments are needed to make the program permanent. In order to do so, Colorado lawmakers must identify a revenue source that is robust, sustainable, and progressive – meaning that the costs do not fall disproportionately on people with low incomes.

Currently, the major source of state funding for the Colorado Department of Transportation is the 22-cent state gas tax, which has not been increased since 1991. Compared to gas taxes in other states, Colorado's tax ranks 42nd lowest. RTD's primary funding source is the one percent sales-and-use tax levied within the district's boundaries. Sales taxes are regressive funding mechanisms because they place the largest cost burden on those who earn the lowest incomes. Colorado lawmakers must identify a revenue source that is robust, sustainable, and progressive, meaning that the costs do not fall disproportionately on people with low incomes.

Repealing the Taxpayer's Bill Of Right (TABOR)

TABOR – an amendment in Colorado's state constitution – poses a significant obstacle to investing in public services and infrastructure like transportation. Most Coloradans associate TABOR with the state's yearly rebate checks, but TABOR also dictates how the state is allowed to collect revenue – and how much revenue it can retain each fiscal year, which makes funding public necessities so difficult in Colorado.

(continued)
Repealing the
Taxpayer's Bill Of
Right (TABOR)

TABOR uses what is called the Referendum C cap to calculate the amount of revenue that the state is allowed to retain each fiscal year. The formula that determines the revenue cap takes the previous fiscal year's revenue limit and adjusts it by population growth and inflation, which is measured through the Consumer Price Index (CPI).

However, the CPI creates a lag of one to two years between when the market experiences inflation and when the CPI reflects it. That lag in TABOR's revenue cap causes the state to fall behind on funding many programs and services. Additionally, using CPI to determine the rate of inflation means that the state is considering the change in prices of consumer goods to determine the amount of money that the state is allowed to retain. This is problematic because the state is not typically purchasing consumer goods, but the state funds activities such as road building and maintenance, K-12 education, and healthcare – among many other public goods and services. The cost of funding these programs is increasing at a higher rate than the cost of consumer goods, which further exacerbates the lag in the revenue cap.

TABOR has also stripped away the ability of legislators to raise taxes or create new taxes that would bring in additional revenue to the state's General Fund. In order to fund these necessary investments in public transportation, major constitutional fiscal reform is necessary.

1. CFI'S STATISTICAL ANALYSIS SHOWS PRELIMINARY DECLINES IN NO₂ POLLUTION

Methodology

Ground-level ozone is not emitted directly into the air but is created by chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOC). Heat and sunlight act as catalysts in forming ozone molecules, which is why ozone pollution is usually higher during summer months. Since vehicles are a significant source of NO₂ pollution, this research examines the effect of the Free Fare for Better Air program on NO₂ emissions in Colorado.

Randomized controlled trials are widely used as the standard approach for evaluating the effect of a treatment. For example, in a medical experiment, to find out if a medicine is effective in reducing the risk of heart attack, researchers randomly place study subjects (patients) in treatment or control groups. When examining the impact of public policies, it can be very difficult, if not impossible, to conduct randomized controlled trials to learn about their effectiveness.

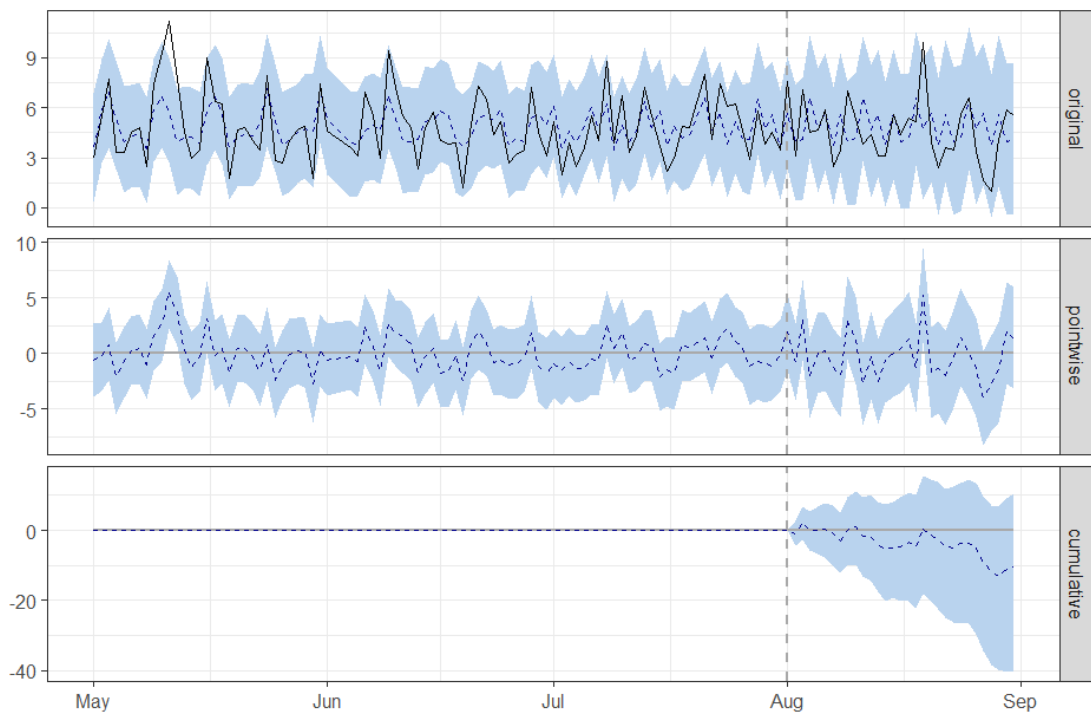
In absence of randomized trials in social sciences, "observational" approaches are used to create a hypothetical control group and build a "counterfactual" scenario that shows us what would have happened in the absence of the policy. This analysis relies on the "synthetic control method" to examine the difference between Colorado's NO₂ pollution levels in the summer of 2022, when the Zero Fare program was administered, and NO₂ pollution across the summers of 2018 - 2021, which serves as the control group.

We assume that ozone pollution levels have similar trajectories in the control (2018 - 2021) and treatment (Zero Fare program) groups in the pre-intervention period (May-July). In order to build the counterfactual scenario (the synthetic region), we use several control variables that contribute to the NO₂ pollution but are not correlated with the implementation of the program: vehicle sales (monthly), temperature (daily), PM_{2.5} (daily) and oil production (monthly)²⁷. We use the Causal Impact R package to visualize the trends²⁸:

APPENDIX

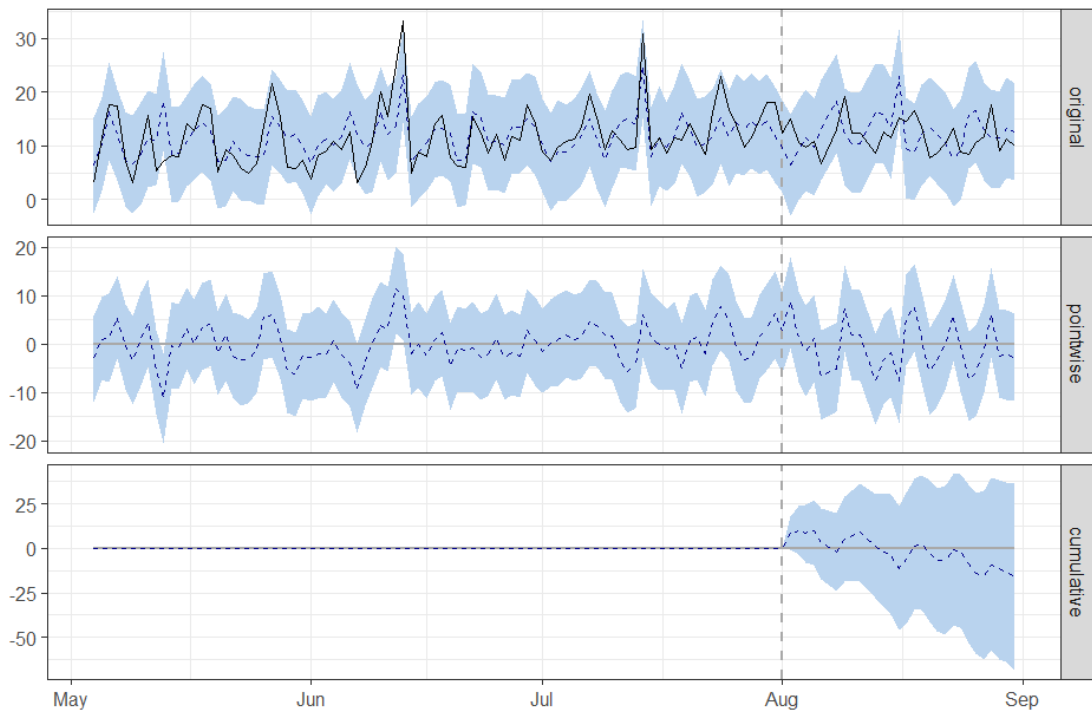
- The first panel (“original”) shows the observed data (solid black line) and fitted data (dashed blue line). The dashed line in the post-treatment period is the counterfactual prediction for the outcome variable.
- The second panel (“pointwise”) shows the pointwise differences between counterfactual predictions and the observed data. This difference is the inferred causal impact of the intervention.
- The third panel (“cumulative”) shows the cumulative effect of intervention by adding up pointwise differences. The shaded area shows the 95 percent credible interval of the impact. The posterior interval widens progressively since the predictive strength of the model decreases as we move away from the intervention date. If the 95 percent credible interval in the third panel crosses the zero line, the cumulative effect is insignificant.

JEFFERSON COUNTY

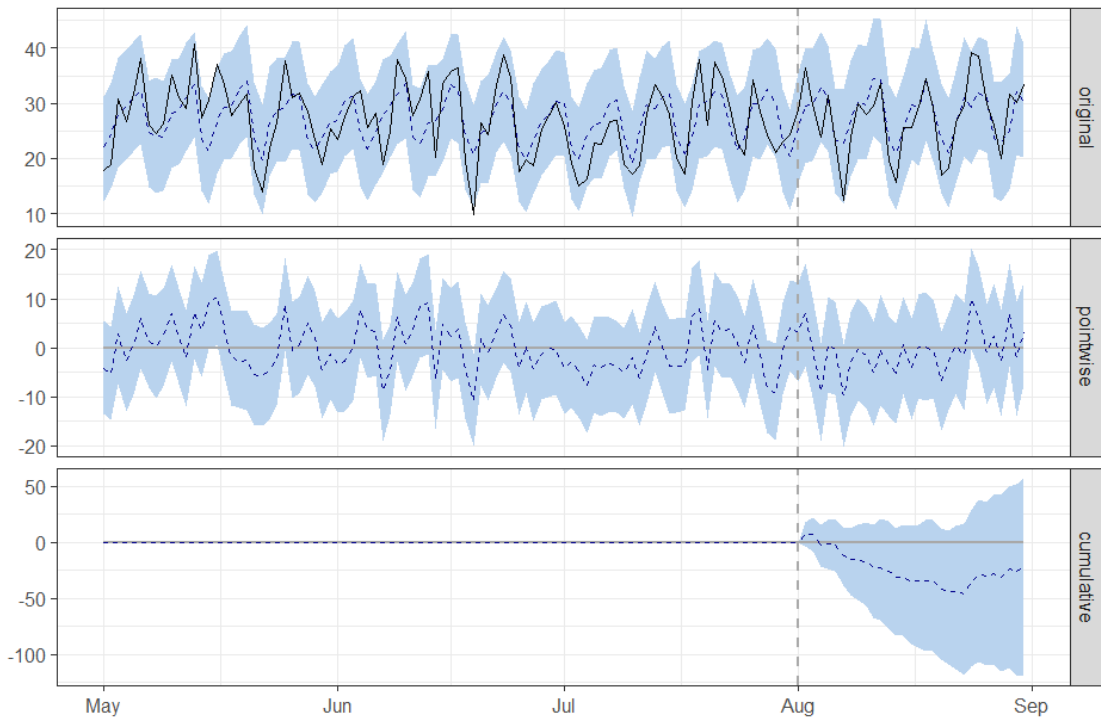


APPENDIX

WELD COUNTY



DENVER COUNTY



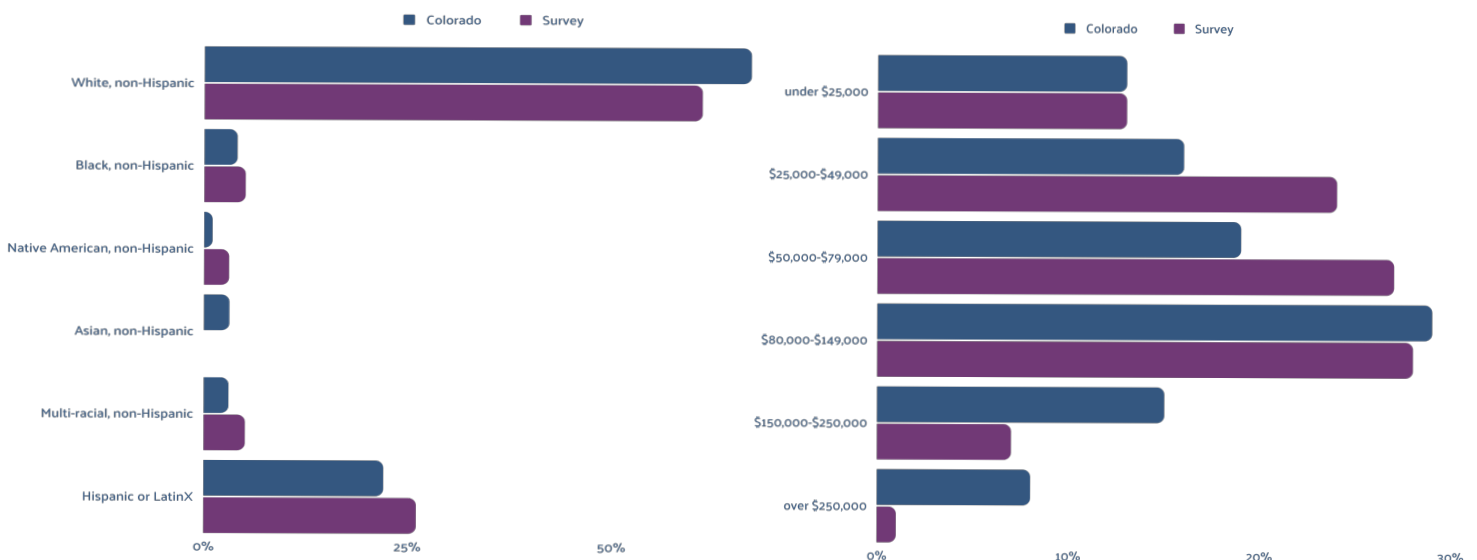
2. DEMOGRAPHIC BREAKDOWN OF SURVEY PARTICIPANTS

Survey respondents are more racially and ethnically diverse than Colorado’s overall population – with the exception of Asian Americans, who are underrepresented in our survey responses.

The proportion of our survey respondents who identify as female (61 percent) are also larger than the proportion of people who identify as female in Colorado’s statewide demographic data²⁹.

Likewise, respondents skew younger; more than half are age 35 or younger. Over half (55 percent) of survey respondents fell within the 19-35 age group – compared to just 25 percent across the Colorado population as a whole. Meanwhile, age groups 1-18 and 66 or older were underrepresented in our survey group³⁰.

Survey respondents with incomes of \$25,000 - \$49,000 and \$50,000 - \$79,000 are overrepresented in this survey compared to the whole of Colorado³¹. Conversely, survey respondents with incomes of \$150,000 - \$250,000 and over \$250,000 are underrepresented in comparison with statewide demographics.



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13. All margins of increase in this Longmont ridership analysis are relative to the same pre-implementation boarding rates derived from the August 2013 average of 575 boardings a day (ibid).
14. ibid
15. New riders are those who transitioned to utilizing public transit since the implementation of free fare. These riders may use public transit as their primary means of transportation or as a supplement to a personal vehicle.

ENDNOTES

16. ibid
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19. ibid
20. In this study, low-income was defined as at or below 200% of the Federal Poverty Level.
21. Brough, R., Freedman, M., & Phillips, D.C. (2022). Experimental evidence on the effects of means-tested public transportation subsidies on travel behavior. *Regional Science and Urban Economics*, Volume 96. <https://doi.org/10.1016/j.regsciurbeco.2022.103803>
22. Regional Transportation District. (2022). Zero-Fare August Impact Analysis: Final Report. <https://www.rtd-denver.com/sites/default/files/files/2022-11/Zero-Fare%20August%20Impact%20Analysis%20Final%20Report%20-%2011.30.2022.pdf>
23. It is important to note that RTD's analysis does not attribute all increases in ridership for August 2022 solely to the ZFBA program because circumstances such as back to school season, sporting events, other seasonal trends, and the continued rebound in ridership since the significant decline due to the COVID pandemic all confound the effect of the free fare month on ridership increases.
24. The weekly average of daily ridership across RTD's transit services dropped only 3.1% from August 2022 to September 2022, when fare collection was reinstated (Regional Transportation District, 2022).
25. Both Access-a-Ride and Access-a-Cab comparisons are made with the same aggregated monthly average across January to July 2022 that the Access-on-Demand comparison uses.
26. United States Census Bureau. (2022). QuickFacts: Weld County, Colorado; Jefferson County, Colorado; Denver County, Colorado; Colorado; United States. <https://www.census.gov/quickfacts/fact/table/weldcountycolorado,jeffersoncountycolorado,denvercountycolorado,CO,US/PST045222>
27. <https://cogcc.state.co.us/data4.html#/production>
28. <https://google.github.io/CausalImpact/CausalImpact.html>
29. The United States Census Bureau still collects binary sex data, so unfortunately, we do not have statewide data that accurately reflects the diversity of sex and gender identity in Colorado. We recognize and respect that there are many people in Colorado who do not identify within the female/male binary.
30. The disproportionately low rate of respondents from the 1-18 year age group is expected because a large percentage of that age group includes young riders who are unlikely to take our survey.
31. Income is measured as annual household earnings.