Disability, Transportation, Activity Performance, and Neighborhood Features in California: Analyzing Data from a Survey

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A Research Report from the Pacific Southwest Region University Transportation Center

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16. Abstract
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Contents

About the Pacific Southwest Region University Transportation Center

The Pacific Southwest Region (PSR) University Transportation Center (UTC) is the Region 9 University Transportation Center funded under the United States Department of Transportation's University Transportation Centers Program. Established in 2016, the Pacific Southwest Region UTC is led by the University of Southern California and includes seven partners: Long Beach State University; University of California, Davis; University of California, Irvine; University of California, Los Angeles; University of Hawaii; Northern Arizona University; and Pima Community College.

The Pacific Southwest Region UTC conducts an integrated, multidisciplinary program of research, education and technology transfer aimed at *improving the mobility of people and goods throughout the region.* Our program is organized around four themes: 1) technology to address transportation problems and improve mobility; 2) improving mobility for vulnerable populations; 3) Improving resilience and protecting the environment; and 4) managing mobility in high growth areas.

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Disclosure

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Abstract

This study aims to investigate the relationship between disability and the present and expected extent of activity engagement and trips by different modes, along with socioeconomic characteristics and neighborhood type. Data were collected through an online survey and analyzed using descriptive and regression analysis. Most people with disabilities in California use public transport and paratransit less than once per month. Individuals with vision, mental, or other driving-preventing disabilities are more likely to use taxis and ride-hailing services, while those with cognitive disabilities are more likely to rely on relatives or friends for rides. People with physical disabilities are less likely to make trips overall and use most modes of transportation. Women are more consistently likely to travel with relatives and friends in private cars and are less likely to use transit and hire modes. People who identify as Black or African American are less likely to drive their own vehicles and are more likely to use public transit and hire modes. Urban residents have a higher propensity to travel by public transit, for-hire modes, walking, and as passengers in relatives' or friends' vehicles. In sum, this study provides detailed travel patterns for individuals with various types of disabilities. The insights gained will inform policy and planning efforts aimed at inclusive transportation in California and other states.

Executive Summary

People with disabilities, one of the largest minority groups of the world, experience different mobility challenges which shape travel behavior and mobility pattern. Existing research about the mobility and travel pattern of people with disabilities highlights the problems they experience to travel by different transport modes with a view to resolving the mode specific problems. However, little research has been conducted to explore the nexus of decision regarding trips by people with disabilities and their desire to travel by different modes. This study explores the association between disability, and present and expected extent of trips and trips by different modes along with socioeconomic characteristics and neighborhood type. For this research goal, an online survey is performed, which produces a sample of 1,896 respondents with 807 among them (43%) being people with disabilities from California. The survey asks about disability and disability type, socioeconomic status, location of residence, and the frequencies with which respondents perform trips and use different transportation modes, along with the desires to use those modes more often than in comparison to current respective frequency. Descriptive statistical analyses and logistic regression are applied for data analysis.

The study reveals that people with disabilities rarely travel by public transportation and paratransit. Most of the people with disabilities in California use these modes less than once per month. Even if they are using public transportation at that rate, the pattern is more persistent in the urban areas. People with disabilities only report unmet demand for public transit at higher rates than people without disabilities when they belong to low-income group. Policymakers should still consider improving the human service, vehicle design, stop design, operational characteristics, infrastructure, and land use patterns that may increase public transit ridership among people with disabilities.

Many people with disabilities do not have driving licenses and own a vehicle, rather depend on other modes, though not as often as people without disabilities who drive. People with vision, mental, or other driving-preventing disabilities are more likely to use taxis and ride hailing services instead of driving. Meanwhile, people with cognitive disabilities are more likely to rely on relatives or friends for rides. People with physical disabilities are less likely to make trips overall as well as make less frequent trips by using most modes. Policymakers should prioritize improvements relevant to people with these specific types of disabilities to ensure transport equity.

In comparison to the current frequency of trips, people with and without disabilities want to make more frequent trips for activities like visiting people, doing groceries, and going to parks. This unmet travel demand is reflected among around 30-40% of respondents irrespective of having disability. Although higher income helps people without disabilities, but not as much people with disabilities to meet these unmet travel needs. This suggests that people with disabilities, despite having a higher income, experience mobility challenges in availing various transportation modes and making trips outside of the home.

People with disabilities expect to use private vehicles at a significantly higher frequency than the current extent of their use in comparison to people without disabilities. Such unmet demand is prevalent among 20% of the respondents irrespective of disability status. These findings suggest policymakers should highlight more inclusive vehicle design for private vehicles. People with and without disabilities

consistently report unmet demand for active modes at even higher rates (over 50%) than for private vehicles, suggesting the need for more and better active mode infrastructure, including sidewalks and protected bike lanes, that is congenial to active mode users.

Women are more consistent to travel with relatives and friends in private car at higher frequency, and less likely to travel by public transit, for-hire modes and active transportation in comparison to man. Additionally, women seem to be consistently less likely to go to activity locations: places of worship, sports fields, and bars. People with Black or African American racial identity are less likely than people with White or Caucasian racial identity to drive their own vehicles, and more likely to use public transit and hire modes.

The study reports living in an urban area makes people more likely to travel by public transit modes, for-hire modes, walking, and riding as a passenger in a relative's or friend's vehicle. People from suburban neighborhoods, compared to rural neighborhoods, have higher propensity to use ride hailing services, walk, and own private vehicle.

Introduction

With the growth of emerging technology such as ride hailing, e-bike, and autonomous and electric vehicles, shared mobility such as bike sharing, carpooling, dedicated infrastructure for the public transport and active transportation has brought about many changes in the transportation in California with promise of sustainable transportation system (Cal-ITP, 2023; Safe Routes Partnership, 2020; Schaller, 2018). However, suburbanization of poverty in major coastal metropolitan areas in California may hinder the progress towards sustainable transportation (Cooke and Denton, 2015; Kneebone and Garrs, 2007). Meanwhile, people with disabilities, a transportation disadvantaged group, inclusive of people experiencing difficulty in hearing, vision, cognition, or even indoor mobility, face wide range of problems to make trips for work and other purposes because of mode specific problems oriented to transportation in the United States (Flynn et al, 2023). With the increase in academic and public awareness of social and mobility injustices as well as inequity in transportation is questioning how successful has been disability mobility right protection policies like the 1990 Americans with Disabilities Act (ADA) and consequently, transportation equity has appeared for people with disabilities as an emerging issue (Capozzi, 2011; Kavaanagh, 2019; Surico, 2020). People with disability are also more likely to be financially backward, so the areas in California experiencing a suburbanization of poverty can lead to a "suburbanization of disability" over time. Consequently, these areas can worsen the situation of current immobility of people with disabilities and negatively impact achieving the goal of sustainable and inclusive transportation which can lead to further worsening of poverty and socioeconomic exclusion (Jeekel, 2019; Lucas, 2012; Martens, 2018). However, the overall impacts of these phenomena on the mobility and travel behavior of people with disabilities has not been scrutinized comprehensively.

Besides, little research currently exists pertaining to the relationship of decision to make a trip to perform an activity and desires for transportation modes, particularly of people with disabilities. Existing research on mobility of people with disabilities is mostly focused on public transportation use (Bezayak et al., 2017; Grise et al., 2019). While National Household Travel Survey (NHTS, 2022) reports that people with disability are more dependent on driving car and carpooling than using other modes, there is little study focusing on why they are depending more on car and not using alternative modes (Firestine, 2024). Similarly, NHTS 2022 reports that trip frequency of both work and non-work trips is lower among people with disabilities than people without disabilities. However, rarely any study has addressed the dynamics of people with disabilities travelling less (Firestine, 2024). While literature reveals that multimodal transportation system helps to flourish transit ridership (e.g., better walking infrastructure encourages more people to walk to transit stations and travel by bus), little research is done to understand the multimodal travel behavior of people with disabilities too (Hampshire and Gaites, 2012; Stillwater et al., 2009).

This project aims to fill these knowledge gaps by understanding the dynamics of trip frequency to perform different activities and trip frequency by different transport modes. We focus on trips to perform activities such as trips to shopping centers, medical facilities, restaurants, bars, concert halls, sport fields, parks. The project covers analysis of trip frequency of driving car and driven by car, carsharing, ride hailing, active transportation, public transportation including paratransit. Based on trip frequency by different modes, the projects also explore the multimodal travel behavior of people with disabilities. Statistical models have been developed to describe the trip frequency for different purposes and trip frequency by different modes as well as multimodality. Along with socioeconomic characteristics, characteristics of the area of residence (urban/rural/suburban), regions of California have been used as predictors to understand influence of neighborhood and geographic characteristics on the travel behavior of people with disabilities. This project also reports unmet travel demand of people with disabilities for trips in general and trips specific to various modes. To perform the study, 1,896 respondents have been surveyed from a pool of people with and without disabilities living in California, from which 807 (43%) respondents were with disabilities. Surveying significantly large number of cases (particularly people with disabilities) helped us draw robust conclusions while controlling for socioeconomic factors and local characteristics to understand the influence of disability on travel behavior.

As the project aims to identify understand the dynamics of travel behavior and unmet travel demand, this report identifies the transportation disadvantaged groups who are travelling less by in terms of trips and their use of transportation modes which can be used as a basis of undertaking policy interventions for the improvement of mobility of transportation disadvantaged groups. Similarly, the research findings can also help to understand multimodal mobility in respect of trip frequency by different modes of transportation which will be helpful for policymakers to promote multimodal transportation system for people with disabilities. Similarly, understanding the impact of local characteristics on travel behavior will help to understand the requirements to improve transportation systems for people with disabilities based on local characteristics.

Literature Review

We recommend that readers interested in a somewhat broader survey of the literature about qualitative and quantitative studies of the travel behavior of people with disabilities consult the literature review of the report by Flynn et al (Flynn et al, 2023). The current literature review focuses on more recent works and on works that apply regression models to quantitative data about the travel behavior of people with disabilities.

Park et al (Park et al, 2023) have conducted a systematic review of the travel behavior of people with disabilities in the US, finding lesser frequency of travel, lesser use of private vehicular modes compared to public or active transportation modes, and greater incidence of barriers to travel, among people with disabilities compared to people without disabilities. Shen et al (Shen et al, 2023) have conducted a similar literature review with similar findings. Levine & Karner (Levine & Karner, 2023) have pointed to a need for more research about the travel behavior of people with disabilities that go beyond mere compliance with the ADA, consider disabilities beyond physical disabilities, address data gaps, and ensure that characteristics associated with disability are accounted for in place-based accessibility measures. Venkataram et al have argued for a more holistic consideration of problems with different transportation modes facing people with disabilities (Venkataram et al, 2023) and used these concepts to review such problems, finding similarities among modes that have similar expectations to each other about the extent of involvement of the mode user as well as about whether a first-/last-mile connection is required (Venkataram et al, 2024).

There have not been many studies applying regression techniques beyond showing mere descriptive statistics, including discrete choice modeling, to quantitative data about the travel behavior of people with disabilities. Examples are as follows.

Gu has applied binary logistic regression to data from the China Family Panel Studies in 2016, 2018, and 2020, finding that among people at least 45 years old, constituting around 42,000 respondents across the aforementioned 3 waves of that study, the likelihood of being unable to use public transit independently in China increases with older age, female gender, and larger family size, and decreases with being married, having more education, receiving a pension, and living in an urban area (Gu, 2024); Gu also notes that not all people with disabilities face problems using public transit.

Desai et al have conducted a cross-sectional study of over 300 middle-aged adults between the ages of 45-65 in Missouri who have had physical disabilities for at least 5 years, specifically considering transportation mode choices as well as neighborhood types, finding from a multivariate analysis of covariance as well as multilinear regression that middle-aged adults with long-term physical disabilities who use paratransit were more likely to engage in social activities outside of the home than their peers who use private vehicular modes, while neighborhood type does not have a significant effect on the likelihood of engaging in such social activities (Desai et al, 2023).

Eisenberg et al (Eisenberg et al, 2024) have analyzed data from the 2017 National Household Travel Survey (NHTS) in the US, applying binary logistic regression to the question of whether people with travel-limiting disabilities (as defined in the 2017 NHTS) use active travel modes (walking or using a wheelchair or medical scooter). They have found that 85% of people with travel-limiting disabilities in the US do not use active travel modes, and those who do come disproportionately from marginalized ethnic backgrounds and do not have car access within their households.

Ong et al (Ong et al, 2024) have applied binary logistic regression to data from a study of Transportation Network Company (TNC) trips in Metro Vancouver in Canada, finding different attributes among people with versus without disabilities that explain whether a person is more or less likely to replace a public transit trip or a taxi trip with a TNC trip. People with various disabilities were included based on using a wheelchair or medical scooter or using paratransit or a wheelchair-accessible taxi service (which are not restricted to people who use wheelchairs).

Zhang et al (Zhang et al, 2023) have applied multilevel linear regression to data from taxi companies serving paratransit trips using wheelchair-accessible vehicles in Toronto in Canada to explore factors, including time of day, day of the week, season in the year, trip purpose, neighborhood characteristics, and whether the trip occurred during the lockdown for the recent COVID19 pandemic, that may affect wait times for rides as well as ride times in the vehicle.

Mohiuddin et al (Mohiuddin et al, 2024) have applied an integrated choice and latent variable regression model, which involves a multinomial logistic regression model combined with structural equations, to understand the mode choices of people with disabilities and the problems that different modes pose to them in the city of Dhaka in Bangladesh.

Cochran and Chatman (Cochran & Chatman, 2021) have applied binary logistic regression to data from the 2017 NHTS to show that disability, income, age, paratransit use, smartphone use, and metropolitan area size can all affect the likelihood of a person using taxi or TNC services.

Gebresselassie (Gebresselassie, 2023) has applied binary logistic regression to data from a survey about the use of TNC services by adults across the US who use wheelchairs, finding that wheelchair type as well as private vehicle access influence the likelihood of using TNC services.

Methods

Our analyses in this report are based on a survey conducted online in California in 2022 involving adults with as well as without disabilities. We refer readers to the report by Flynn et al for more details about the survey methodology and for descriptive statistics about the respondent demographics (Flynn et al, 2023). Notably, the survey included 1,896 responses, of which 807 (43%) were with disabilities. The survey included seven questions (that did not explicitly use the words “disability” or “disabled”) to capture respondents’ experiences with disability. These questions were of having trouble walking, lifting things, or climbing stairs, having trouble seeing even with glasses or identifying as blind or low vision, having trouble hearing even with hearing aids or identifying as deaf, having trouble concentrating, remembering, or learning things, having trouble speaking even in one’s first language, having trouble being in many everyday situations because of fear, anxiety, or other mental stress, or being unable to drive due to epilepsy or another medical condition. These questions implicitly defined 7 forms of disability (of which respondents could report having any number, including none), which in this report we refer to as respectively as physical, vision, hearing, cognitive, communication, and mental disabilities, and other disabilities that prevent driving. In some analyses, we will present these forms of disabilities explicitly, while in others, we report respondents as broadly having a disability in a binary way if they report experiencing at least one of these forms of disability. The survey did not ask about whether these experiences with disability were in the past versus the present, were expected to be temporary versus permanent (if in the present),or were from birth versus acquired later (if permanent).

The main analyses presented in this report will involve discrete choice models examining the ways in which the frequency of performing a certain activity outside of the home, the frequency of using a certain transportation mode, and some other characteristic relevant to transportation are associated with sociodemographic and geographic variables, as well as disability. In particular, we use binomial logistic regression (also known as binary logistic regression) for dependent variables that can take one of two values, multinomial logistic regression for dependent variables that can take one of more than two categorical values, and ordinal logistic regression for dependent variables that can take one of more than two values that can be represented by numbers in an ordered way (like frequencies of performing an activity or using a mode, reduced from a continuum to a few possible value ranges in the survey).

Binomial logistic regression models express the probability of the dependent variable Y_i for respondent i having a value 1 (labeling the only alternative as 0), with characteristics x_{ji} (where the label j represents different independent variables), as $\ln(P(Y_i = 1)/(1 - P(Y_i = 1))) = \beta_{0} + \sum_{j = 1}^{J} \beta_{j} x_{ji}$. Multinomial logistic regression models express the probability of the dependent variable Y_i for respondent i having a value m (which can take on values in the set $\{1, \ldots, M\}$), assuming that $m \neq M$ (so that $m = M$ is chosen as the pivot value), with characteristics x_{ji}, as $\ln(P(Y_i = m)/P(Y_i = M)) = \beta_{m0} + \sum_{j = 1}^{J} \beta_{mj} x_{ji}$; the pivot value can then be found from the requirement $P(Y_i = M) = 1 - \sum_{m = 1}^{M - 1} P(Y_i = m)$. Ordinal logistic regression models express the probability of the dependent variable Y_i for respondent i having a value n (which can take on values in the set $\{1, \ldots, N\}$), assuming that $n \neq N$, with characteristics x_{ji}, as $\ln(P(Y_i \le n)/(1 - P(Y_i \le n))) = \beta_{0n} - \sum_{j = 1}^{J} \beta_{j} x_{ji}$; this is consistent with the sign convention used in the scientific computing platform R, and as the cumulative probabilities are used in the regression formula, the formula for each probability $P(Y_i = n)$ for each n in the set $\{1, \ldots, N\}$ can be found from the facts that $P(Y_i \le 1) = P(Y_i = 1)$ and $\sum_{n = 1}^{N} P(Y_i = n) = 1$. Regardless of whether the logistic regression is binomial, multinomial, or ordinal, the coefficients can be determined through maximum likelihood estimation. In particular, given the observed values for the independent variables x_{ji} and dependent variables Y_i, if Y_i can generically take on values n in the set $\{1, \ldots, N\}$ and the model specifies the form of $P(Y_i = n)$, then the log-likelihood (which is just a monotonically increasing transformation of the likelihood) can be written as $\ln(L) = \sum_{i = 1}^{I} \sum_{n = 1}^{N} \delta_{Y_i, n} \ln(P(Y_i = n))$, and maximization with respect to the coefficients β can yield the values of exactly those coefficients. Additionally, it is worth noting that regardless of whether the logistic regression is binomial, multinomial, or ordinal, if an independent variable is discrete, then one value for that independent variable must be taken as a reference case (whose information effectively goes into the intercept β_{0}).

We estimate models with the scientific computing platform R, which gives the values and standard errors for all coefficients. These models assume that the standard errors for the coefficients have normal or Student's t distributions (with a large enough number of degrees of freedom that the Student's t distribution can be approximated as a normal distribution). Thus, we report 95% confidence intervals as $(\mu - 1.96\sigma, \mu + 1.96\sigma)$, where μ is the mean value and σ is the standard error of the corresponding coefficient. If the confidence interval crosses 0, then we report no significant difference from 0 ("NS").

When considering models of the frequency of mode use, the frequency of activity performance, and the presence of other characteristics, we use a consistent set of independent variables with the same set of reference categories. In particular, the independent variables that we consider are gender (male, female, other gender identity, or refusal to respond, with male as the reference value), race (White or Caucasian only, Black or African American only, Asian American or Pacific Islander only, Native American only, other racial identity only or two or more racial identities, or refusal to respond, with White or Caucasian only as the reference value, though the survey asks about racial identity in a multiple-choice format), annual household income ($0-49,999, $50,000-99,999, $100,000+, or no response, with $100,000+ as the reference value, though the survey asks about annual household income with more granular brackets), age (18-33, 34-49, 50-65, 66+, or no response, with 66+ as the reference value, though the survey collects age as a continuous variable via birth year), region in California (based on the jurisdictions of the MPOs MTC, SCAG, SACOG, SANDAG, and SJVCOG (which we refer to as the Central Valley and abbreviate as CV), or the rest of California (which we abbreviate as ROC), with SANDAG as the reference category, though this is determined from the survey based on the county corresponding to the address that the respondent provides), the binary variable of experiencing a cost burden for transportation defined as having at least one entity other than the respondent or the respondent's employer or school covering at least 10% of the respondent's transportation costs (with the reference category being the absence of such a cost burden, though this is determined from more granular information in the survey), and the type of their residential neighborhood that the respondent would describe as urban or suburban (for every location, respondents choose one option among urban, suburban, and rural communities). In all discrete choice models that we have performed, we have found that coefficients corresponding to a refusal to respond to questions about gender, race, age, and annual household income are either not significantly different from zero or are dropped from the model by R, so we omit those values for those variables when we present discrete choice modeling results.

When considering models of the frequencies of using different modes or performing different activities or of the presence of other relevant characteristics, we will show a model that does not account for disability as an independent variable at all, a model that accounts for disability as a single binary independent variable, and a model that accounts for disability as a set of binary variables corresponding to different forms of disability. We will compare these models using pairwise likelihood ratio tests (as the model without disability as an independent variable is a simple subset of any model with disability as an independent variable, and the model with disability as a single binary independent variable is a constrained version of the model with disability as a set of multiple binary independent variables); the likelihood ratio test penalizes models that have too many additional parameters without significantly improved explanatory power in return. We will make particular note of more complicated models that do better than simpler models if the p-value of the corresponding likelihood ratio test is below the threshold of 0.05, as such results could justify consideration of disability as an independent variable more broadly in studies of travel behavior.

Disability and Prerequisites to Using Some Transportation Modes or Performing Some Activities

We apply discrete choice models to understand the dependence of the presence of travel cost burden, driver licensing status, car ownership status, and tendency to never leave home, upon relevant sociodemographic and disability-related variables, as these dependent variables are related to actual travel behavior. In each case, the dependent variable is binary, so all of these models involve binomial logistic regression.

Binomial logistic regression of the presence of travel cost burden

We consider the binary variable of the presence of travel cost burden. As this is the dependent variable, these models are the only ones we consider in which the presence of travel cost burden is not included as an independent variable.

Per Table 1, in every model, the intercept being close to -3 and having a confidence interval far from 0 even in the upper bound means that when each independent variable takes on its reference value, the probability of experiencing travel cost burden is approximately 0.05. All of the other coefficients which are significantly different from 0 are considerably smaller in magnitude than the intercept, so those coefficients individually have somewhat smaller effects on this probability and may only noticeably shift the probability distribution when taken in conjunction with each other. The only coefficients statistically significant from 0, all of which are positive (implying a greater probability of experiencing travel cost burden than in the reference cases for all independent variables), are those corresponding to women (compared to men), people in lower income brackets (compared to the highest income bracket), and people in younger age groups (compared to the oldest age group). This means that geographic region in California, neighborhood type, and race have little to do with the presence of travel cost burdens after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in lower income brackets are more likely to experience travel cost burdens than people in the highest income bracket. However, it is slightly surprising that the coefficient is slightly larger for people in the middle income bracket of $50,000-99,999 compared to the lower income bracket of $0-49,999. Additionally, the fact that we control simultaneously for income and other variables means that the coefficient being positive for women cannot be explained only by women tending to have lower incomes. A possible explanation for both phenomena is that people who get government assistance or financial assistance from other individuals in their lives for transportation may get such assistance by having low individual incomes even if the household incomes are high; the survey did not ask respondents about their individual incomes, so we cannot further investigate this possibility directly using the survey data. Furthermore, it seems slightly surprising that after controlling for household income, younger people are more likely to report travel cost burdens than people in the oldest age bracket despite people in the oldest age bracket being more likely to be eligible for broader government assistance programs like Social Security, though this could be indicative of a deeper correlation between cumulative earnings (which would not be captured by annual household income by itself) and age.

Disability, whether considered in a binary sense or by form, significantly increases the likelihood of experiencing travel cost burdens even after controlling for income and other relevant variables; in particular, people with physical, mental, or other driving-preventing disabilities are significantly more likely than those without such disabilities to experience travel cost burdens. Additionally, including disability as an independent variable, whether as a single binary independent variable or as a set of multiple binary independent variables by form, does not noticeably change the intercept or the coefficients corresponding to female gender identity or to the household income bracket of $50,000-99,999, which is why the models with disability for this dependent variable do better than the models without disability according to the likelihood ratio test as shown in Table 2. Including disability in any way does reduce the value of the coefficient (putting it closer to 0) for the age group of 18-33 and makes the coefficient for the household income bracket of $0-49,999 no longer significantly different from 0, suggesting a weak correlation between disability identification and younger age and with lower income (especially as those with lower household incomes might be more likely to live alone or not share finances with housemates), and including disability in its different forms makes the coefficient for the age group of 34-49 no longer significantly different from 0, suggesting a weak correlation between specific forms of disability and the next-lowest age bracket. For this reason, for this dependent variable, the model that considers disability by form is not significantly better than the model that considers disability in a binary way. Thus, statistically, there is no benefit to considering disability by form when studying the presence of travel cost burdens, although qualitatively, the correlations with physical, mental, and other driving-preventing disabilities may suggest the need for further investigation.

Table 1. Binomial logistic regression coefficients for the presence of travel cost burden (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercept	(-3.78, -1.77)	(-4.21, -2.17)	(-3.97, -1.91)
Gender (base: male)			
Female	(0.30, 0.85)	(0.28, 0.83)	(0.32, 0.88)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	NS	NS	NS
Black or African American only	NS	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(0.07, 0.84)	NS	NS
$50,000-99,999	(0.15, 0.96)	(0.08, 0.90)	(0.10, 0.93)
Age (base: 66+)			
18-33	(0.59, 1.35)	(0.46, 1.24)	(0.35, 1.19)
34-49	(0.08, 0.81)	(0.10, 0.84)	NS
50-65	NS	NS	NS
Region in California (base: SANDAG)			
SCAG	NS	NS	NS

CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	(0.62, 1.15)	N/A
Physical	N/A	N/A	(0.07, 0.75)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	(0.34, 1.00)
Other that prevents driving	N/A	N/A	(0.08, 1.40)

Table 2. Likelihood ratio test results for models of the presence of travel cost burden, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	3.5 * 10^-11
Disability ignored	**Disability by type**	3.5 * 10^-11
Disability as single binary variable	**Disability by type**	> 5 * 10^-2

Binomial logistic regression of private vehicle ownership

We consider the binary variable of the presence of private vehicle ownership. The survey asked respondents about vehicles that they or people in their household own.

As shown in Table 3, in every model, the intercept being close to 2 and having a confidence interval far from 0 even in the lower bound means that when each independent variable takes on its reference value, the probability of experiencing travel cost burden is approximately 0.88. However, many of the other coefficients which are significantly different from 0 have magnitudes similar to the intercept and with varying signs, so the probability distribution may noticeably shift depending on which independent variables are relevant. The only coefficients that are statistically significant from 0 and are negative (implying a lesser probability of owning a private vehicle than in the reference cases for all independent variables) are those corresponding to Black or African American racial identity by itself (compared to White or Caucasian racial identity by itself), Native American racial identity by itself (compared to White or Caucasian racial identity by itself), people in the lowest income bracket (compared to the highest income bracket), and people experiencing travel cost burdens (compared to those who do not). The only coefficients that are statistically significant from 0 and are positive (implying a greater probability of owning a private vehicle than in the reference cases for all independent variables) are those corresponding to living in the SCAG region (compared to the SANDAG region) and living in a more suburban neighborhood (compared to a more rural neighborhood). This means that gender, Asian or Pacific Islander racial identity by itself, other racial or multiracial identity, the middle income bracket, other regions in California, and urban neighborhood types have little to do with private vehicle ownership after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in lowest income brackets and people with travel cost burdens are each less likely to own private vehicles than than people in the highest income bracket or people without travel cost burdens. Additionally, it is only marginally surprising that the greater urban sprawl of the SCAG region compared to the SANDAG region may lead to a significantly greater likelihood of private vehicle ownership in the SCAG region, though the effect size is not so big. However, it is slightly surprising to see a greater likelihood of private vehicle ownership in suburban neighborhoods compared to rural neighborhoods with a nontrivial effect size. This may indicate a weak correlation of suburban neighborhoods with the presence of people from a broader range of income brackets (with rural neighborhoods potentially being more associated with people specifically in lower income brackets). A similar weak correlation with rural neighborhoods may explain the negative coefficient for people who identify as Native American only. It is more surprising to see, and harder to explain, a negative coefficient for people who identify as Black or African American only, even after controlling for household income.

People with disabilities, whether considered in a binary sense or by form of disability, are significantly less likely than those without disabilities to own a private vehicle even after controlling for income and other relevant variables, though the effect size is not as big as for Black or African American racial identity by itself, for Native American racial identity by itself, or for being in the lowest income bracket. Additionally, including disability as an independent variable, whether as a single binary independent variable or as a set of multiple binary independent variables by form, does not noticeably change the intercept or the other coefficients that are significantly different from 0, which is why the models with disability for this dependent variable do better than the models without disability according to the likelihood ratio test as shown in Table 4. That said, the effect of disability comes almost exclusively through people with physical disabilities, as other forms of disability do not have a significant effect on private vehicle ownership. For this reason, for this dependent variable, the model that considers disability by form is not significantly better than the model that considers disability in a binary way. Thus, statistically, there is no benefit to considering disability by form when studying the presence of travel cost burdens, although qualitatively, the correlations with physical disabilities may suggest the need for further investigation. It is interesting to note that having another driving-preventing disability or having a vision disability (which usually precludes driver licensing) does not have a significant effect on private vehicle ownership; this might be because people can own vehicles without being able to drive them (especially if they could drive those vehicles in the past), though the survey does not have enough information for us to directly test that possibility.

Table 3. Binomial logistic regression coefficients for car ownership (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercept	(1.03, 2.97)	(1.27, 3.22)	(1.02, 2.98)
Gender (base: male)			
Female	NS	NS	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	NS	NS	NS
Black or African American only	(-1.31, -0.32)	(-1.25, -0.25)	(-1.28, -0.26)
Native American only	(-1.76, -0.45)	(-1.66, -0.33)	(-1.65, -0.31)
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-1.25, -0.37)	(-1.21, -0.32)	(-1.20, -0.30)
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	NS	NS	NS
34-49	NS	NS	NS
50-65	NS	NS	NS
Region in California (base: SANDAG)			
SCAG	(0.05, 0.96)	(0.04, 0.95)	(0.03, 0.95)

CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(-0.92, -0.24)	(-0.78, -0.09)	(-0.77, -0.07)
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	(0.13, 1.80)	(0.13, 1.80)	(0.25, 1.93)
Disability			
Present (binary)	N/A	(-0.94, -0.38)	N/A
Physical	N/A	N/A	(-0.90, -0.19)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 4. Likelihood ratio test results for models of car ownership, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	4.4 * 10^-6
Disability ignored	**Disability by type**	4.0 * 10^-4
Disability as single binary variable	**Disability by type**	> 5 * 10^-2

Binomial logistic regression of driver licensing

We consider the binary variable of driver licensing status. As shown in Table 5, in every model, the intercept being close to 4 and having a confidence interval far from 0 even in the lower bound means that when each independent variable takes on its reference value, the probability of experiencing travel cost burden is approximately 0.98. All of the other coefficients which are significantly different from 0 are considerably smaller in magnitude than the intercept, so those coefficients individually have somewhat smaller effects on this probability and may only noticeably shift the probability distribution when taken in conjunction with each other. Apart from coefficients about disability, the only coefficients statistically significant from 0, all of which are negative (implying a lesser probability of driver licensing than in the reference cases for all independent variables), are those corresponding to Black or African American racial identity by itself (compared to White or Caucasian racial identity by itself), the lowest income bracket (compared to the highest income bracket), the youngest age bracket (compared to the oldest age bracket), living in the SACOG region (compared to the SANDAG region), and the presence of travel cost burdens. This means that other geographic regions in California, neighborhood type, other racial identities, gender, other age brackets beyond the youngest, and the middle income bracket have little to do with the presence of travel cost burdens after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in lowest income brackets and people with travel cost burdens are each less likely to have driving licenses than than people in the highest income bracket or people without travel cost burdens, given the association with private vehicle ownership. This association may also help to explain the results for people with Black or African American racial identity only and people in the youngest age bracket. However, it is surprising and hard to explain the lesser likelihood of driver licensing for people in the SACOG region compared to the SANDAG region.

People with disabilities, whether considered in a binary sense or by form of disability, are significantly less likely than those without disabilities to have driving licenses even after controlling for income and other relevant variables. Additionally, including disability as an independent variable, whether as a single binary independent variable or as a set of multiple binary independent variables by form, does not noticeably change the intercept or the other coefficients that are significantly different from 0, which is why the models with disability for this dependent variable do better than the models without disability according to the likelihood ratio test as shown in Table 6. That said, when considering disability by form, one can see that people with physical, cognitive, or other driving-preventing disabilities are much less likely to have driving licenses (though the effect is close to 0 for people with cognitive disabilities), whereas people with hearing disabilities are more likely to have driving licenses than those without hearing disabilities. For this reason, for this dependent variable, the model that considers disability by form is not significantly better than the model that considers disability in a binary way. Thus, statistically, there is no benefit to considering disability by form when studying the presence of travel cost burdens, although qualitatively, the correlations in different directions with physical, hearing, cognitive, and other driving-preventing disabilities may suggest the need for further investigation. It is interesting to note that the negative coefficient associated with having another driving-preventing disability does not have a bigger magnitude. This situation has arisen because the survey did not prevent those who reported having a driving-preventing disability from saying that they had driving licenses, so these results could be a mixture of respondents erroneously marking responses or respondents reporting having had driving licenses in the past or driving licenses that might still technically remain valid in the present, though the survey does not have enough information for us to directly test those possibilities.

Table 5. Binomial logistic regression coefficients for driver licensing (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercept	(2.43, 4.75)	(3.09, 5.48)	(2.51, 4.89)
Gender (base: male)			
Female	NS	NS	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	NS	NS	NS
Black or African American only	(-1.29, -0.22)	(-1.19, -0.09)	(-1.15, -0.02)
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-1.80, -0.72)	(-1.77, -0.67)	(-1.79, -0.67)
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	(-1.10, -0.26)	(-0.97, -0.11)	(-1.10, -0.16)
34-49	NS	NS	NS
50-65	NS	NS	NS
Region in California (base: SANDAG)			
SCAG	NS	NS	NS

CV	NS	NS	NS
SACOG	(-1.39, -0.08)	(-1.45, -0.11)	(-1.47, -0.10)
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(-1.37, -0.70)	(-1.16, -0.47)	(-1.15, -0.44)
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	(-1.64, -0.98)	N/A
Physical	N/A	N/A	(-1.02, -0.26)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	(0.38, 1.72)
Cognitive	N/A	N/A	(-0.81, -0.01)
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	(-2.43, -1.05)

Table 6. Likelihood ratio test results for models of driver licensing, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	2.8 * 10^-16
Disability ignored	**Disability by type**	5.6 * 10^-14
Disability as single binary variable	**Disability by type**	> 5 * 10^-2

Binomial logistic regression of never leaving home

We consider the binary variable of never leaving home. This is the only other dependent variable for which we do not include experiencing travel cost burdens as an independent variable, because if someone never travels even if that person could get financial assistance from government agencies or other individuals to travel, that independent variable should be irrelevant.

As shown in Table 7, in every model, the intercept being close to -4.3 and having a confidence interval far from 0 even in the upper bound means that when each independent variable takes on its reference value, the probability of never leaving home is approximately 0.01. All of the other coefficients which are significantly different from 0 are considerably smaller in magnitude than the intercept, so those coefficients individually have somewhat smaller effects on this probability and may only noticeably shift the probability distribution when taken in conjunction with each other. Apart from coefficients about disability, the only coefficients statistically significant from 0, all of which are positive (implying a greater probability of never leaving home than in the reference cases for all independent variables), are those corresponding to Asian or Pacific Islander racial identity by itself (compared to White or Caucasian racial identity by itself) and each age bracket (compared to the oldest age bracket). This means that gender, geographic region in California, neighborhood type, other racial identities, and annual household income have little to do with never leaving home after controlling for the aforementioned other factors.

Intuitively, it is surprising that younger people are more likely to report never leaving home than do people in the oldest age bracket, given the greater propensity of elderly people to have travel-limiting health problems and the lesser propensity of elderly people to have jobs or other obligations that would require them to leave home. The only explanation that we can think of is that people in the oldest age bracket might be projecting their more regular travel outside of the home from long ago instead of their current travel behaviors when thinking about this issue or might be less acutely aware (compared to younger people) that they really never leave home. Additionally, the greater likelihood of people with Asian or Pacific Islander racial identity by itself to never leave home may stereotypically be explained by greater rates of poverty and transport burden at least among those who are immigrants (though many Asian or Pacific Islander residents of California are not immigrants), but the insignificance of household income renders this explanation suspect.

Disability does not have a significant effect on predicting the probability of never leaving home, whether considered as a single binary variable or as multiple binary variables by form. This may seem counterintuitive but could be explained by the notion that never leaving home is an extreme scenario (evinced by the very low probability, from the intercept, of never leaving home when all independent variables take their respective reference values), and it is more likely for disability to reduce but not completely preclude travel overall. The model that considers disability as multiple binary variables by form technically does better by the likelihood ratio test as shown in Table 8 than both the model that ignores disability and the model that considers disability as a single binary variable (while there is no significant difference between the latter two), but the differences in the coefficients for other variables are quite marginal.

Table 7. Binomial logistic regression coefficients for never leaving home (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercept	(-5.90, -2.46)	(-6.03, -2.59)	(-6.09, -2.61)
Gender (base: male)			
Female	NS	NS	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(0.28, 1.28)	(0.32, 1.32)	(0.34, 1.36)
Black or African American only	NS	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	NS	NS	NS
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	(0.24, 1.85)	(0.15, 1.78)	(0.14, 1.84)
34-49	(0.73, 2.17)	(0.72, 2.17)	(0.63, 2.11)
50-65	(0.19, 1.70)	(0.17, 1.68)	(0.12, 1.66)
Region in California (base: SANDAG)			
SCAG	NS	NS	NS

CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	NS	N/A
Physical	N/A	N/A	NS
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 8. Likelihood ratio test results for models of never leaving home, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	> 5 * 10^-2
Disability ignored	**Disability by type**	2.6 * 10^-2
Disability as single binary variable	**Disability by type**	4.5 * 10^-2

Disability and Activity Performance

We analyze the extent to which sociodemographic and disability-related variables affect the frequency of performing different activities outside of the home, given that much travel is a derived demand stemming from the need to perform these activities outside of the home. We analyze individual activity frequencies using discrete choice models, and we analyze frequencies and desires for groups of similar activities using descriptive statistics from the survey.

Ordinal logistic regression of individual activity frequencies

We apply discrete choice models to understand the dependence of activity performance frequency for individual activities upon relevant sociodemographic and disability-related variables. In each case, the dependent variable is the frequency of performing an individual activity as measured in the survey using an ordinal Likert-type scale of never, less than once per month, 1-3 times per month, 1-3 times per week, or more than 3 times per week, so all of these models involve ordinal logistic regression.

Visiting friends or family

We consider the ordinal variable of the frequency of visiting friends and relatives. As shown in Table 9, in every model, the intercept corresponding to the frequency being at most once 1-3 times per month is somewhat close to 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for visiting friends and relatives at most 1-3 times per month as for at least once per week. However, many of the other coefficients which are significantly different from 0 have magnitudes similar to the intercepts and with varying signs, so the probability distribution may noticeably shift depending on which independent variables are relevant. The only coefficients that are statistically significant from 0 and are negative (implying a probability distribution skewed toward lesser frequency of visiting friends and relatives than in the reference cases for all independent variables) are those corresponding to Asian or Pacific Islander racial identity by itself (compared to White or Caucasian racial identity by itself) and people in the lowest and middle income brackets (compared to the highest income bracket). The only coefficient that is statistically significant from 0 and is positive (implying a probability distribution skewed toward greater frequency of visiting friends and relatives than in the reference cases for all independent variables) is that for the youngest age bracket (compared to the oldest age bracket). This means that gender, Black or African American racial identity by itself, other racial or multiracial identity, region in California, and neighborhood type have little to do with the frequency of visiting friends and relatives after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in the youngest age bracket visit friends and relatives more than people in the oldest age bracket due to potentially greater mobility after controlling for other factors, and it is not surprising that people with lower incomes visit friends and relatives less than people in the highest income bracket as this indicates a positive correlation of income with mobility. Additionally, the lesser frequency of visiting friends and relatives among people with Asian or Pacific Islander racial identity by itself may be related to their relatively greater likelihood of never leaving home, but the likelihood of never leaving home is very small overall, making this explanation suspect.

People with disabilities, whether considered in a binary sense or by form of disability, have probability distributions significantly skewed toward lower frequencies of visiting friends and relatives than those without disabilities even after controlling for income and other relevant variables. Additionally, including disability as an independent variable, whether as a single binary independent variable or as a set of multiple binary independent variables by form, does not noticeably change the intercepts or many of the coefficients that are significantly different from 0, specifically associated with income, age, or Asian or Pacific Islander racial identity by itself, which is why the models with disability for this dependent variable do better than the models without disability according to the likelihood ratio test as shown in Table 10. However, the correlation of travel cost burden with disability means that including disability, whether in a binary sense or by form of disability, makes the coefficient associated with travel cost burden insignificantly different from 0. Additionally, the fact that the upper bound of the confidence interval for the coefficient associated with Native American racial identity by itself comes closer to 0 when disability is included as a binary variable and then becomes insignificant when disability is included by form suggests a correlation in the survey sample of Native American racial identity by itself with certain forms of disability, though we do not investigate this further. Finally, we note that when including disability by form, only the coefficients associated with people with physical disabilities and with people with cognitive disabilities are significantly different from 0 (and negative), but unexpectedly, the confidence intervals are closer to 0 in both the upper and lower bounds than the confidence interval for the coefficient associated with disability as a single binary variable.

Table 9. Ordinal logistic regression coefficients for the frequency of visiting friends or family (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(-3.79, -2.52)	(-4.05, -2.77)	(-3.95, -2.66)
Frequency <= 1	(-3.79, -2.52)	(-4.05, -2.77)	(-3.95, -2.66)
Frequency <= 2	(-1.49, -0.27)	(-1.73, -0.50)	(-1.61, -0.38)
Frequency <= 3	(0.13, 1.34)	NS	(0.04, 1.28)
Frequency <= 4	(1.81, 3.06)	(1.62, 2.88)	(1.75, 3.01)
Gender (base: male)			
Female	NS	NS	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.58, -0.12)	(-0.64, -0.18)	(-0.64, -0.18)
Black or African American only	NS	NS	NS
Native American only	(-1.18, -0.12)	(-1.08, -0.03)	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.59, -0.13)	(-0.54, -0.08)	(-0.54, -0.08)
$50,000-99,999	(-0.60, -0.11)	(-0.55, -0.06)	(-0.56, -0.07)
Age (base: 66+)			
18-33	(0.24, 0.76)	(0.34, 0.86)	(0.33, 0.88)
34-49	NS	NS	NS

50-65	NS	NS	NS
Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(-0.48, -0.01)	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	(-0.77, -0.42)	N/A
Physical	N/A	N/A	(-0.58, -0.11)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	(-0.68, -0.17)
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 10. Likelihood ratio test results for models of frequency of visiting friends or family, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	2.5 * 10^-11
Disability ignored	**Disability by type**	4.0 * 10^-10
Disability as single binary variable	**Disability by type**	3.8 * 10^-2

In-person grocery shopping

We consider the ordinal variable of the frequency of doing groceries outside of the home. As shown in Table 11, in every model, the intercept corresponding to the frequency being at most once 1-3 times per week is somewhat close to 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for getting groceries outside of the home at most 1-3 times per week as for more than 3 times per week. Apart from those related to disability, most coefficients are insignificantly different from 0, implying that most people need to get groceries at similar frequencies regardless of sociodemographic traits, geographic characteristics, or other circumstances. In a few cases, such as Asian or Pacific Islander racial identity by itself as well as the middle income bracket, the corresponding coefficient in some models is technically significantly different from 0, but the way that disability is or is not included changes this because the upper bound of the confidence interval is so close to 0. Additionally, the correlation of disability with the presence of travel cost burden means that although the coefficient associated with the presence of travel cost burden is significantly different from 0 in all models, it moves closer to 0 for models that include disability as an independent variable (whether as a single binary independent variable or by form as multiple binary independent variables). Only the coefficients corresponding to the lowest income bracket and the youngest age bracket are consistently significantly different from 0 and do not change much with the inclusion of disability. The coefficient corresponding to the lowest income bracket being negative suggests that our analysis captures the phenomenon of food deserts to some degree, but we did not test any models with cross terms involving neighborhood type and annual household income.

Despite these caveats, the inclusion of disability significantly improves the model, evinced by the likelihood ratio tests in Table 12. This is because the coefficient associated with disability as a single binary independent variable is significantly different from 0 and (as it is negative) the upper bound of its confidence interval is much farther from 0 than are the upper bounds of the confidence intervals of many coefficients that are technically significantly different from 0 in these models. When disability is included as multiple binary independent variables by form, one can see that people with physical, hearing, or other driving-preventing disabilities have probability distributions skewed toward lower frequencies of getting groceries outside of the home. Thus, getting groceries outside of the home is among the few domains (of activity performance or transportation mode usage) in which people with hearing disabilities exhibit lower frequencies. Additionally, after controlling for disability, the intercepts shift to be more negative or less positive, implying probability distributions skewed toward greater frequencies of getting groceries outside of the home in the base cases of all independent variables.

Table 11. Ordinal logistic regression coefficients for the frequency of in-person grocery shopping (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(-3.98, -2.67)	(-4.20, -2.88)	(-4.26, -2.92)
Frequency <= 1	(-3.98, -2.67)	(-4.20, -2.88)	(-4.26, -2.92)
Frequency <= 2	(-3.31, -2.02)	(-3.53, -2.23)	(-3.58, -2.26)
Frequency <= 3	(-1.29, -0.03)	(-1.48, -0.21)	(-1.50, -0.21)
Frequency <= 4	(1.69, 2.99)	(1.53, 2.84)	(1.52, 2.84)
Gender (base: male)			
Female	NS	NS	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	NS	NS	(-0.48, -0.01)
Black or African American only	NS	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.60, -0.12)	(-0.56, -0.07)	(-0.59, -0.10)
$50,000-99,999	(-0.52, -0.01)	NS	(-0.52, -0.01)
Age (base: 66+)			
18-33	(-0.61, -0.08)	(-0.55, -0.02)	(-0.64, -0.08)
34-49	NS	NS	NS

50-65	NS	NS	NS
Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(-0.61, -0.13)	(-0.52, -0.03)	(-0.50, -0.01)
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	(-0.67, -0.31)	N/A
Physical	N/A	N/A	(-0.53, -0.05)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	(-0.80, -0.09)
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	(-1.46, -0.27)

Table 12. Likelihood ratio test results for models of frequency of in-person grocery shopping, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	1.0 * 10^-7
Disability ignored	**Disability by type**	5.9 * 10^-9
Disability as single binary variable	**Disability by type**	6.2 * 10^-4

Medical care outside of the home

We consider the ordinal variable of the frequency of getting medical care outside of the home. As shown in Table 13, in every model, the intercept corresponding to the frequency being at most less than once per month (but not never) is somewhat close to 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for getting medical care outside of the home at most less than once per month (but not never) as for at least once per month. Apart from those related to disability, most coefficients are insignificantly different from 0, implying that most people need to get and are able to get medical care outside of the home at similar frequencies regardless of sociodemographic traits, geographic characteristics, or other circumstances. Only the coefficient corresponding to Asian or Pacific Islander racial identity by itself is consistently significantly different from 0, though it is harder to explain more deeply why it is negative and significantly different from 0; that said, in models where disability is included, the coefficient corresponding to Asian or Pacific Islander racial identity by itself shifts closer to 0.

Despite these caveats, the inclusion of disability significantly improves the model, evinced by the likelihood ratio tests in Table 14. This is because the coefficients associated with disability as a single binary independent variable, as well as those associated with people with physical disabilities and people with mental disabilities when disability is included by form, are significantly different from 0 and positive. This analysis shows that getting medical care outside of the home is the only activity in which disability is consistently associated with higher frequency of use or performance. This is consistent with a biopsychosocial conceptual framework for disability, in which the experience of disability is mediated by interactions among an individual's internal physiological characteristics, that individual's internal psychological characteristics, and social attitudes toward that individual based on those physiological and psychological characteristics.

Table 13. Ordinal logistic regression coefficients for the frequency of getting medical care outside of the home (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(-3.74, -2.26)	(-3.57, -2.08)	(-3.68, -2.18)
Frequency <= 1	(-3.74, -2.26)	(-3.57, -2.08)	(-3.68, -2.18)
Frequency <= 2	(0.27, 1.70)	(0.50, 1.94)	(0.41, 1.87)
Frequency <= 3	(2.22, 3.70)	(2.47, 3.97)	(2.41, 3.92)
Frequency <= 4	(3.88, 5.62)	(4.13, 5.89)	(4.08, 5.85)
Gender (base: male)			
Female	NS	NS	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.86, -0.30)	(-0.80, -0.24)	(-0.77, -0.21)
Black or African American only	NS	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	NS	NS	NS
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	NS	NS	NS
34-49	NS	NS	NS

50-65	NS	NS	NS
Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	(0.42, 0.83)	N/A
Physical	N/A	N/A	(0.47, 1.00)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	(0.11, 0.69)
Other that prevents driving	N/A	N/A	NS

Table 14. Likelihood ratio test results for models of frequency of getting medical care outside of the home, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	2.4 * 10^-9
Disability ignored	**Disability by type**	6.1 * 10^-11
Disability as single binary variable	**Disability by type**	1.9 * 10^-4

Going to restaurants

We consider the ordinal variable of the frequency of going to restaurants. As shown in Table 15, in every model, the intercept corresponding to the frequency being at most less than once per month (but not never) is not significantly different from 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for going to restaurants at most less than once per month (but not never) as for at least once per month. The only coefficients that are consistently statistically significant from 0 and are negative (implying a probability distribution skewed toward lesser frequency of going to restaurants than in the reference cases for all independent variables) are those corresponding to the lowest income bracket (compared to the highest income bracket) and people experiencing travel cost burdens (compared to those who do not). The only coefficients that are consistently statistically significant from 0 and are positive (implying a probability distribution skewed toward greater frequency of going to restaurants than in the reference cases for all independent variables) are those corresponding to the youngest or second-youngest age brackets (each compared to the oldest age bracket) as well as living in the SCAG region (compared to the SANDAG region). The coefficient for Black or African American racial identity by itself is significantly different from 0 and negative for the model that does not include disability, but the upper bound of its confidence interval is quite close to 0, and that coefficient becomes insignificantly different from 0 when disability is included as one or more independent variables, suggesting a correlation among those independent variables in our sample. Similarly, the coefficient for the middle income bracket is significantly different from 0 and negative for the model that does not include disability, but the upper bound of its confidence interval is quite close to 0, it becomes even closer to 0 when disability is included as a single binary independent variable, and it becomes insignificantly different from 0 when disability is included by form as multiple binary independent variables. Furthermore, we note that the correlation of disability with the presence of travel cost burden means that although the coefficient corresponding to the presence of travel cost burden is consistently significantly different from 0 and is negative, it shifts closer to 0 when disability is included. Finally, we note that gender, Asian or Pacific Islander racial identity by itself, Native American racial identity by itself, other racial or multiracial identity, other regions in California, and neighborhood type have little to do with the frequency of going to restaurants after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in lowest income brackets and people with travel cost burdens are each less likely to go to restaurants. Additionally, it is not surprising that younger adults (compared to elderly adults), controlling for other factors, are more likely to go to restaurants. It is slightly surprising that people in the SCAG region are significantly more likely than people in other regions (including the highly urbanized MTC and SANDAG regions) to go to restaurants.

People with disabilities, whether considered in a binary sense or by form of disability, have probability distributions significantly skewed toward lower frequencies of going to restaurants than those without disabilities even after controlling for income and other relevant variables. Additionally, including disability as an independent variable, whether as a single binary independent variable or as a set of multiple binary independent variables by form, does not noticeably change the intercepts or many of the coefficients that are significantly different from 0, specifically associated with the lowest income bracket, the youngest two age brackets, or residence in the SCAG region, which is why the models with disability for this dependent variable do better than the models without disability according to the likelihood ratio test as shown in Table 16. Finally, we note that when including disability by form, only the coefficients associated with people with physical disabilities, with people with cognitive disabilities, and with people with communication disabilities are significantly different from 0 (and negative), though in the latter two cases, the upper bounds of the respective confidence intervals are very close to 0.

Table 15. Ordinal logistic regression coefficients for the frequency of going to restaurants (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(-2.82, -1.59)	(-3.02, -1.78)	(-2.99, -1.74)
Frequency <= 1	(-2.44, -1.23)	(-2.64, -1.42)	(-2.60, -1.37)
Frequency <= 2	NS	NS	NS
Frequency <= 3	(0.78, 1.99)	(0.62, 1.84)	(0.71, 1.93)
Frequency <= 4	(2.68, 3.94)	(2.52, 3.79)	(2.61, 3.89)
Gender (base: male)			
Female	NS	NS	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	NS	NS	NS
Black or African American only	(-0.76, -0.03)	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.64, -0.18)	(-0.60, -0.13)	(-0.58, -0.11)
$50,000-99,999	(-0.54, -0.05)	(-0.50, -0.01)	NS
Age (base: 66+)			
18-33	(0.25, 0.77)	(0.32, 0.83)	(0.27, 0.82)
34-49	(0.05, 0.50)	(0.04, 0.49)	(0.05, 0.51)

50-65	NS	NS	NS
Region in California (base: SANDAG)			
SCAG	(0.08, 0.66)	(0.08, 0.66)	(0.06, 0.64)
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(-0.85, -0.38)	(-0.75, -0.28)	(-0.70, -0.22)
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	(-0.63, -0.28)	N/A
Physical	N/A	N/A	(-0.72, -0.26)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	(-0.52, -0.01)
Communication	N/A	N/A	(-1.00, -0.03)
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 16. Likelihood ratio test results for models of frequency of going to restaurants, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	2.7 * 10^-7
Disability ignored	**Disability by type**	2.1 * 10^-10
Disability as single binary variable	**Disability by type**	1.2 * 10^-5

Going to places of worship

We consider the ordinal variable of the frequency of going to places of worship. As shown in Table 17, in every model, the intercept corresponding to the frequency being at most never is not significantly different from 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for never going to places of worship as for going to places of worship at any nonzero frequency. The only coefficients that are consistently statistically significant from 0 and are negative (implying a probability distribution skewed toward lesser frequency of going to places of worship than in the reference cases for all independent variables) are those corresponding respectively to female or other gender identities (compared to male gender identity). The only coefficient that is consistently statistically significant from 0 and is positive (implying a probability distribution skewed toward greater frequency of going to places of worship than in the reference cases for all independent variables) corresponds to Black or African American racial identity by itself. This means that Asian or Pacific Islander racial identity by itself, Native American racial identity by itself, other racial or multiracial identity, annual household income, age, region in California, presence of travel cost burden, and neighborhood type have little to do with the frequency of going to places of worship after controlling for the aforementioned other factors.

Intuitively, the fact that most independent variables that we consider do not have significant effects on the frequency of going to places of worship is because in the limited sample size of the survey, most subgroups did not exhibit strong enough deviations in behavior from their corresponding reference cases given that when all independent variables take their respective reference values, the probability distribution of going to places of worship is skewed toward never going. The more noticeable skew toward lower frequency among people who do not have a male gender identity is consistent with other findings, as is the more noticeable skew toward higher frequency among people who have Black or African American racial identity by itself.

Disability does not have any significant effect on the frequency of going to places of worship, and the inclusion of disability, whether as a single binary independent variable or as multiple binary independent variables by form, does not noticeably change any of the other coefficients. As shown in Table 18, this means that the inclusion of disability does not significantly improve the model per the likelihood ratio test. This is among the few analyses in which we have found such a result.

Table 17. Ordinal logistic regression coefficients for the frequency of going to places of worship (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	NS	NS	NS
Frequency <= 1	NS	NS	NS
Frequency <= 2	(0.01, 1.25)	(0.05, 1.31)	(0.07, 1.33)
Frequency <= 3	(0.89, 2.15)	(0.94, 2.21)	(0.96, 2.23)
Frequency <= 4	(2.89, 4.30)	(2.94, 4.35)	(2.96, 4.38)
Gender (base: male)			
Female	(-0.46, -0.11)	(-0.46, -0.12)	(-0.44, -0.09)
Other	(-1.39, -0.08)	(-1.42, -0.11)	(-1.37, -0.05)
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	NS	NS	NS
Black or African American only	(0.64, 1.33)	(0.62, 1.32)	(0.58, 1.28)
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	NS	NS	NS
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	NS	NS	NS
34-49	NS	NS	NS

50-65	NS	NS	NS
Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	NS	N/A
Physical	N/A	N/A	NS
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 18. Likelihood ratio test results for models of frequency of going to places of worship, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	> 5 * 10^-2
Disability ignored	**Disability by type**	> 5 * 10^-2
Disability as single binary variable	**Disability by type**	> 5 * 10^-2

Going to sports fields or stadiums

We consider the ordinal variable of the frequency of going to sports fields or stadiums. This may have included going as a participant in a casual game, as a spectator to a casual game, as a picnicker, or as a spectator to a formalized amateur or professional game, though the survey did not ask respondents for those details.

As shown in Table 19, in every model, the intercept corresponding to the frequency being at most never is not significantly different from 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for never going to sports fields or stadiums as for going to sports fields or stadiums at any nonzero frequency. This is similar to the intercepts for the models of the frequency of going to places of worship, and in fact, the intercepts for higher frequencies are larger (more positive) in the case of going to sports fields or stadiums than in the case of going to places of worship, implying that the probability distribution is even more skewed toward lower frequency of going to sports fields or stadiums compared to going to places of worship. Despite this, many more coefficients are consistently significantly different from 0 in the case of going to sports fields or stadiums compared to going to places of worship, implying that differences among different subgroups are big enough to pierce through a distribution skewed overall toward low frequency.

The only coefficients that are consistently statistically significant from 0 and are negative (implying a probability distribution skewed toward lesser frequency of going to sports fields or stadiums than in the reference cases for all independent variables) are those corresponding respectively to female or other gender identities (compared to male gender identity), Asian or Pacific Islander racial identity by itself (compared to White or Caucasian racial identity by itself), the lowest income bracket (compared to the highest income bracket), and the CV, SACOG, ROC, and MTC regions (compared to the SANDAG region). The only coefficients that are consistently statistically significant from 0 and are positive (implying a probability distribution skewed toward greater frequency of going to sports fields or stadiums than in the reference cases for all independent variables) correspond to all younger age brackets (compared to the oldest age bracket) and living in a suburban neighborhood (compared to living in a rural neighborhood). This means that Asian or Pacific Islander racial identity by itself, Native American racial identity by itself, other racial or multiracial identity, the middle income bracket, age, living in the SCAG

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region, presence of travel cost burden, and living in an urban neighborhood have little to do with the frequency of going to restaurants after controlling for the aforementioned other factors.

Intuitively, the fact people with female or other gender identities as well as people with Asian or Pacific Islander racial identity by itself are less likely to go to sports fields or stadiums is consistent with their lesser participation in sports in the US as adults. The fact that people in the lowest income bracket are less likely to go to sports fields or stadiums may be explained by lesser availability of such facilities in their neighborhoods and, to the extent that participating in such athletic activities cost money or take time, less disposable income and time for such activities. The fact that younger people are more likely to go to sports fields or stadiums may be explained by having more physical energy and interest in such things; moreover, the coefficients are indeed higher for younger age brackets than for older age brackets. The fact that the coefficient is significantly different from 0 and negative for people living in the ROC region may be explained by lesser availability of such facilities in those places, as the ROC region is largely rural, with few major urban centers with the resources needed to sustain such facilities; the coefficients corresponding to the CV, SACOG, and MTC regions are technically significantly different from 0 and negative, but their confidence intervals' respective upper bounds are very close to 0, and their confidence intervals' respective lower bounds are smaller in magnitude than the lower bound of the confidence interval for the coefficient corresponding to the ROC region. Finally, the fact that the coefficient is significantly different and positive for suburban neighborhoods may reflect a greater availability of such facilities in those neighborhoods compared to urban neighborhoods which may have less land and rural neighborhoods which may have fewer financial resources to maintain such facilities.

People with disabilities, whether considered in a binary sense or by form of disability, have probability distributions significantly skewed toward lower frequencies of going to restaurants than those without disabilities even after controlling for income and other relevant variables. Additionally, including disability as an independent variable, whether as a single binary independent variable or as a set of multiple binary independent variables by form, does not noticeably change the intercepts or almost all of the coefficients that are significantly different from 0, with the only exceptions being the coefficients corresponding respectively to other gender identity and to the lowest income bracket (the latter of which might be explained by a correlation of disability with low household income, though we do not investigate this further); this is why the models with disability for this dependent variable do better than the models without disability according to the likelihood ratio test as shown in Table 20. Finally, we note that when including disability by form, only the coefficients associated with people with physical disabilities and with people with cognitive disabilities are significantly different from 0 (and negative), though in the latter case, the upper bound of the confidence interval is very close to 0.

Table 19. Ordinal logistic regression coefficients for the frequency of going to sports fields or stadiums (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	NS	NS	NS
Frequency <= 1	NS	NS	NS
Frequency <= 2	(1.49, 2.78)	(1.39, 2.70)	(1.58, 2.89)
Frequency <= 3	(2.38, 3.70)	(2.28, 3.61)	(2.47, 3.81)
Frequency <= 4	(3.68, 5.15)	(3.59, 5.07)	(3.78, 5.27)
Gender (base: male)			
Female	(-0.71, -0.36)	(-0.71, -0.36)	(-0.68, -0.32)
Other	(-1.62, -0.28)	(-1.56, -0.23)	(-1.45, -0.11)
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.55, -0.08)	(-0.57, -0.11)	(-0.60, -0.14)
Black or African American only	NS	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.59, -0.12)	(-0.56, -0.10)	(-0.53, -0.06)
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	(0.66, 1.18)	(0.67, 1.22)	(0.66, 1.23)
34-49	(0.59, 1.06)	(0.59, 1.06)	(0.59, 1.07)

50-65	(0.06, 0.52)	(0.06, 0.53)	(0.09, 0.55)
Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	(-0.86, -0.03)	(-0.84, -0.01)	(-0.87, -0.03)
SACOG	(-0.78, -0.07)	(-0.77, -0.07)	(-0.75, -0.04)
ROC	(-1.29, -0.32)	(-1.28, -0.31)	(-1.23, -0.26)
MTC	(-0.65, -0.02)	(-0.66, -0.03)	(-0.66, -0.03)
Presence of travel cost burden	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	(0.16, 1.32)	(0.13, 1.29)	(0.26, 1.42)
Disability			
Present (binary)	N/A	(-0.42, -0.07)	N/A
Physical	N/A	N/A	(-0.63, -0.15)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	(-0.53, -0.01)
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 20. Likelihood ratio test results for models of frequency of going to sports fields or stadiums, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	7.3 * 10^-3
Disability ignored	**Disability by type**	1.4 * 10^-4
Disability as single binary variable	**Disability by type**	1.3 * 10^-3

Going to concert halls

We consider the ordinal variable of the frequency of going to bars. As shown in Table 21, in every model, the intercept corresponding to the frequency being never is not significantly different from 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for never going to concert halls as for going to concert halls at any positive frequency.

For going to concert halls, most coefficients, as well as the intercepts, are essentially stable regardless of the inclusion of disability as a single binary independent variable or as multiple binary independent variables by form. In particular, people with Asian or Pacific Islander racial identity by itself (compared to people with White or Caucasian racial identity by itself), people in the lowest income bracket (compared to the highest income bracket), and people who live in any region other than SANDAG (compared to SANDAG) are significantly less likely to go to concert halls; with respect to region, the effect size is strongest for the CV region as well as the ROC region, both of which are more rural. Additionally, people with Black or African American racial identity by itself (compared to people with White or Caucasian racial identity by itself), people in the youngest two age brackets (compared to the oldest age bracket), people in urban neighborhoods (compared to rural neighborhoods), and people in suburban neighborhoods (compared to rural neighborhoods) are significantly more likely to go to bars; the effect sizes are stronger for the age group of 18-33 compared to 34-49 and for suburban neighborhoods compared to urban neighborhoods. This means that gender, Native American racial identity by itself, other racial or multiracial identity, the middle income bracket, and the age group 50-65 have little to do with the frequency of going to concert halls after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in lowest income bracket are less likely to go to restaurants given financial constraints. It is not surprising that younger people are more likely to go to concert halls due to the attractiveness of such venues for younger people. It is also not surprising that people are more likely to go to concert halls when living in urban or suburban neighborhoods compared to rural neighborhoods given the rarity of concert halls close to rural neighborhoods. It is marginally surprising that people with Black or African American racial identity by itself are more likely to go to concert halls, but while the explanation might be hard to produce, the effect size is less certain anyway because the lower limit of the confidence interval in each model is very close to 0. It is more surprising that and harder to explain why people with Asian or Pacific Islander racial identity by itself are less likely to go to concert halls, because while this could be naively explained in general by the greater prevalence of immigrants in this racial group who have less English-language proficiency and therefore less interest in English-language events at such concert halls, the survey was administered only in English, so this should have biased the sample toward English speakers among people with Asian or Pacific Islander racial identity by itself. Additionally, it is more surprising that people in every region other than SANDAG are significantly less likely to go to bars; this may be easier to explain in the CV and ROC regions, as they are more rural, but harder to explain in the SCAG, SACOG, and MTC regions, which are comparably urbanized as the SANDAG region.

People with disabilities, whether considered in a binary sense or by form of disability, have probability distributions significantly skewed toward lower frequencies of going to concert halls than those without disabilities even after controlling for income and other relevant variables. We reiterate that including disability does not noticeably change most of the intercepts or coefficients. The only exception is that the coefficient corresponding to experiencing travel cost burdens changes from being significantly different from 0 and negative when disability is excluded to being insignificantly different from 0 when disability is included, likely due to the correlation of disability with travel cost burdens. This is why the models with disability for this dependent variable do better than the models without disability according to the likelihood ratio test as shown in Table 22. Finally, we note that when including disability by form, only the coefficients associated with people with physical disabilities and with people with cognitive disabilities are significantly different from 0 (and negative), though the likelihood ratio test suggests that that including disability by form does not yield significantly more predictive power than including disability as a single binary independent variable. Interestingly, the coefficient associated with people with hearing disabilities or who identify as Deaf/deaf is insignificantly different from 0; this could indicate limitations in the survey sample, or it could suggest that there are enough events attractive in their own ways to people with hearing disabilities or who identify as Deaf/deaf that such people have no difference in the frequency of going to concert halls in the absence of differences in other sociodemographic or geographic characteristics.

Table 21. Ordinal logistic regression coefficients for the frequency of going to concert halls (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(-1.41, -0.13)	(-1.51, -0.23)	(-1.40, -0.10)
Frequency <= 1	NS	NS	NS
Frequency <= 2	(1.95, 3.25)	(1.86, 3.17)	(1.98, 3.30)
Frequency <= 3	(3.18, 4.59)	(3.09, 4.50)	(3.22, 4.64)
Frequency <= 4	(4.17, 5.83)	(4.08, 5.75)	(4.21, 5.88)
Gender (base: male)			
Female	NS	NS	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.61, -0.15)	(-0.64, -0.18)	(-0.66, -0.19)
Black or African American only	(0.02, 0.82)	(0.06, 0.85)	(0.02, 0.82)
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.78, -0.30)	(-0.75, -0.27)	(-0.74, -0.26)
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	(0.42, 0.95)	(0.45, 0.99)	(0.37, 0.94)
34-49	(0.15, 0.61)	(0.14, 0.61)	(0.11, 0.59)

50-65	NS	NS	NS
Region in California (base: SANDAG)			
SCAG	(-0.72, -0.13)	(-0.72, -0.13)	(-0.73, -0.13)
CV	(-1.34, -0.51)	(-1.31, -0.48)	(-1.34, -0.50)
SACOG	(-1.06, -0.35)	(-1.04, -0.33)	(-1.02, -0.30)
ROC	(-1.32, -0.39)	(-1.30, -0.36)	(-1.26, -0.32)
MTC	(-0.72, -0.08)	(-0.73, -0.09)	(-0.73, -0.08)
Presence of travel cost burden	(-0.50, -0.03)	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	(0.03, 1.20)	(0.01, 1.18)	(0.11, 1.28)
Suburban	(0.21, 1.36)	(0.19, 1.34)	(0.29, 1.44)
Disability			
Present (binary)	N/A	(-0.46, -0.10)	N/A
Physical	N/A	N/A	(-0.60, -0.12)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	(-0.57, -0.05)
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 22. Likelihood ratio test results for models of frequency of going to concert halls, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	2.0 * 10^-3
Disability ignored	**Disability by type**	6.0 * 10^-3
Disability as single binary variable	**Disability by type**	> 5 * 10^-2

Going to parks

We consider the ordinal variable of the frequency of going to parks. As shown in Table 23, in every model, the intercept corresponding to the frequency being at most less than once per month is not significantly different from 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for going to parks less than once per month as for going to parks at least once per month.

For going to parks, many coefficients and all of the intercepts are essentially stable regardless of the inclusion of disability as a single binary independent variable or as multiple binary independent variables by form. In particular, people with Asian or Pacific Islander racial identity by itself (compared to people with White or Caucasian racial identity by itself) and people in the lowest and middle income brackets (compared to the highest income bracket) are significantly less likely to go to parks. Additionally, people in the youngest two age brackets (compared to the oldest age bracket) and people in suburban neighborhoods (compared to rural neighborhoods) are significantly more likely to go to bars. This means that Black or African American racial identity by itself, Native American racial identity by itself, other racial or multiracial identity, the age group 50-65, region in California (apart from the MTC region), and urban neighborhood type have little to do with the frequency of going to parks after controlling for the aforementioned other factors. Additionally, in contrast to when disability is excluded as an independent variable, the inclusion of disability as a single binary independent variable or as multiple binary independent variables by form makes the coefficients associated with gender, living in the MTC region, and experiencing travel cost burdens insignificantly different from 0; the last of those is likely because of the correlation of disability with experiencing travel cost burdens; the opposite happens for urban neighborhood types when disability is included, though the lower limit of the corresponding confidence interval is still quite close to 0.

Intuitively, it is not surprising that people in lowest and middle income brackets are less likely to go to parks, especially if their neighborhoods (controlling for neighborhood type) are disinvested. It is not surprising that younger people are more likely to go to parks due to the attractiveness of such venues for younger people and greater levels of physical activity or of taking young children there. It is also not surprising that people are more likely to go to parks when living in suburban neighborhoods compared to rural neighborhoods given the relative rarity of parks in rural neighborhoods. It is marginally surprising that people with Asian or Pacific Islander racial identity by itself are less likely to go to parks; this could reflect lesser travel overall among people in this group as has been seen with other activities presented thus far.

People with disabilities, whether considered in a binary sense or by form of disability, have probability distributions significantly skewed toward lower frequencies of going to parks than those without disabilities even after controlling for income and other relevant variables. We reiterate that including disability does not noticeably change most of the intercepts or many of the coefficients. This is why the models with disability for this dependent variable do better than the models without disability according to the likelihood ratio test as shown in Table 24. Finally, we note that when including disability by form, only the coefficient associated with people with physical disabilities is significantly different from 0 (and negative), though the likelihood ratio test suggests that that including disability by form does not yield significantly more predictive power than including disability as a single binary independent variable.

Table 23. Ordinal logistic regression coefficients for the frequency of going to parks (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(-3.09, -1.81)	(-3.22, -1.93)	(-3.14, -1.85)
Frequency <= 1	(-3.09, -1.81)	(-3.22, -1.93)	(-3.14, -1.85)
Frequency <= 2	NS	NS	NS
Frequency <= 3	(0.99, 2.24)	(0.88, 2.14)	(0.99, 2.26)
Frequency <= 4	(2.23, 3.51)	(2.12, 3.41)	(2.23, 3.53)
Gender (base: male)			
Female	(-0.36, -0.01)	(-0.36, -0.01)	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.48, -0.02)	(-0.51, -0.05)	(-0.54, -0.07)
Black or African American only	NS	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.63, -0.16)	(-0.59, -0.13)	(-0.58, -0.11)
$50,000-99,999	(-0.65, -0.16)	(-0.62, -0.12)	(-0.61, -0.11)
Age (base: 66+)			
18-33	(0.45, 0.97)	(0.50, 1.02)	(0.46, 1.01)
34-49	(0.40, 0.86)	(0.40, 0.86)	(0.40, 0.87)

50-65	NS	NS	NS
Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	(0.01, 0.64)	NS	NS
Presence of travel cost burden	(-0.57, -0.09)	(-0.50, -0.02)	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	(0.02, 1.16)
Suburban	(0.16, 1.26)	(0.13, 1.23)	(0.22, 1.33)
Disability			
Present (binary)	N/A	(-0.52, -0.16)	N/A
Physical	N/A	N/A	(-0.68, -0.20)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 24. Likelihood ratio test results for models of frequency of going to parks, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	1.6 * 10^-4
Disability ignored	**Disability by type**	4.6 * 10^-5
Disability as single binary variable	**Disability by type**	7.8 * 10^-3

Going to bars

We consider the ordinal variable of the frequency of going to bars. As shown in Table 25, in every model, the intercept corresponding to the frequency being never is not significantly different from 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for never going to bars as for going to bars with any positive frequency.

For going to bars, all coefficients and intercepts are essentially stable regardless of the inclusion of disability as a single binary independent variable or as multiple binary independent variables by form. In particular, women, people with Asian or Pacific Islander racial identity by itself (compared to people with White or Caucasian racial identity by itself), people with another racial identity by itself or multiple racial identities (compared to people with White or Caucasian racial identity by itself), people in the lowest and middle income brackets (compared to the highest income bracket), people in the SACOG region, and people who experience travel cost burdens are significantly less likely to go to bars. Additionally, people in all younger age brackets (compared to the oldest age bracket) and people in urban neighborhoods (compared to rural neighborhoods) are significantly more likely to go to bars. This means that Black or African American racial identity by itself, Native American racial identity by itself, other racial or multiracial identity, region in California (apart from the SACOG region), and suburban neighborhood type have little to do with the frequency of going to bars after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in lowest and middle income brackets are less likely to go to bars due to financial constraints, and the same goes for people who experience travel cost burdens. It is not surprising that younger and middle-aged people are more likely to go to bars due to the attractiveness of such venues for such people compared to the oldest age group. It is also not surprising that people are more likely to go to bars when living in urban neighborhoods compared to rural neighborhoods given the relative rarity of bars in rural neighborhoods. Additionally, it is not surprising that people with Asian or Pacific Islander racial identity by itself are less likely to go to bars; this could reflect the prevalence of alcohol flush reaction among people of Chinese, Japanese, or Korean ancestry. It is marginally surprising that people who live in the SACOG region are less likely to go to bars, but the explanation seems to be moot as the upper limit of the corresponding confidence interval is very close to 0.

People with disabilities, whether considered in a binary sense or by form of disability, have probability distributions significantly skewed toward lower frequencies of going to bars than those without disabilities even after controlling for income and other relevant variables. We reiterate that including disability does not noticeably change the intercepts or coefficients. This is why the models with disability for this dependent variable do better than the models without disability according to the likelihood ratio test as shown in Table 26. Finally, we note that when including disability by form, only the coefficients associated with people with physical disabilities, people with hearing disabilities, and people with cognitive disabilities are significantly different from 0, with the first and third of these being negative and the second being positive; the likelihood ratio test suggests that that including disability by form yields significantly more predictive power than including disability as a single binary independent variable. It is notable that people with hearing disabilities are more likely to go to bars; this is similar to how people with hearing disabilities are more likely than those without hearing disabilities to have driving licenses, and in the case of going to bars, it could be that people who identify as Deaf/deaf are less deterred by loud ambient noise levels at bars, though our analysis cannot determine this with confidence.

Table 25. Ordinal logistic regression coefficients for the frequency of going to bars (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	NS	NS	NS
Frequency <= 1	NS	NS	(0.05, 1.37)
Frequency <= 2	(1.27, 2.58)	(1.18, 2.50)	(1.38, 2.71)
Frequency <= 3	(2.58, 3.92)	(2.49, 3.84)	(2.70, 4.05)
Frequency <= 4	(4.20, 5.70)	(4.11, 5.63)	(4.32, 5.84)
Gender (base: male)			
Female	(-0.52, -0.17)	(-0.52, -0.16)	(-0.49, -0.13)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.83, -0.35)	(-0.87, -0.39)	(-0.88, -0.39)
Black or African American only	NS	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	(-1.02, -0.08)	(-1.04, -0.09)	(-1.02, -0.07)
Annual household income (base: $100,000+)			
$0-49,999	(-0.66, -0.19)	(-0.63, -0.16)	(-0.60, -0.12)
$50,000-99,999	(-0.59, -0.09)	(-0.56, -0.06)	(-0.54, -0.03)
Age (base: 66+)			
18-33	(1.44, 1.99)	(1.49, 2.04)	(1.47, 2.05)
34-49	(1.14, 1.62)	(1.14, 1.61)	(1.14, 1.64)

50-65	(0.16, 0.64)	(0.16, 0.65)	(0.20, 0.68)
Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	(-0.77, -0.03)	(-0.77, -0.03)	(-0.75, -0.01)
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(-0.69, -0.20)	(-0.62, -0.13)	(-0.61, -0.11)
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	(0.03, 1.22)	(0.03, 1.22)	(0.14, 1.34)
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	(-0.49, -0.13)	N/A
Physical	N/A	N/A	(-0.62, -0.13)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	(0.10, 0.82)
Cognitive	N/A	N/A	(-0.55, -0.03)
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 26. Likelihood ratio test results for models of frequency of going to bars, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	7.1 * 10^-4
Disability ignored	**Disability by type**	2.5 * 10^-4
Disability as single binary variable	**Disability by type**	1.3 * 10^-2

Descriptive statistics of frequencies and desires of performing groups of activities, by disability and income

In addition to using ordinal logistic regression to analyze the probability distribution of doing different activities outside of the home with respect to frequency, we consider descriptive statistics from the survey data about the extent to which people perform groups of different activities outside of the home relative to a frequency threshold, which we define as once per month, or desire performing those activities more often than they currently do. We also show overlaps among these groups and focus on the breakdown by people with versus without disabilities (considering disability as a single binary independent variable) and by income bracket.

Basic activities

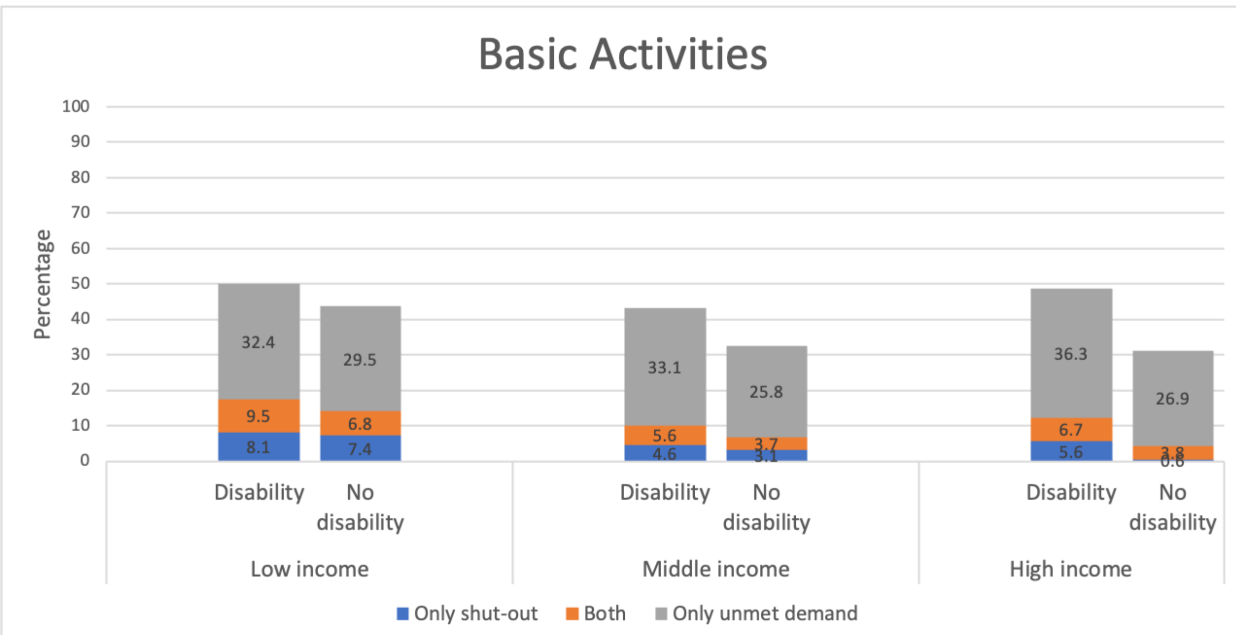
The survey defines the group of basic activities to include visiting relatives or friends, getting groceries outside of the home, going to a medical appointment outside of the home, doing other errands like going to a post office or other government office outside of the home, and going to a park. In this context, we define being shut out of this group of activities as doing at most 1 of these 5 activities at least once per month and having latent demand for this group of activities as wanting to do at least 2 of these 5 activities more often than currently (or at all if currently not). The statistical significance of comparisons between different fractions in these descriptive statistics is determining by computing a two-sided p-value from a comparison of proportions statistical test and comparing this to a threshold of 0.05. We show these results in Figure 1.

The rates of being shut out without having unmet demand are 5-8% for people with disabilities and 1-7% for people without disabilities. The only significant difference by binary disability status controlling for income is that in the highest income bracket, people with disabilities are more likely than their peers without disabilities to be shut out of basic activities without having unmet demand for them. The only significant differences by income bracket controlling for disability status are the consistent decreases with increasing income in the rates of people without disabilities being shut out of basic activities without having unmet demand for them.

The rates of having unmet demand without being shut out are 30-35% for people with disabilities and 25-30% for people without disabilities. The only significant differences by binary disability status controlling for income are that in the middle and highest income brackets, people with disabilities are more likely than their peers without disabilities to have unmet demand for these activities without being shut out of them. No difference by income group controlling for disability is significant.

The rates of both being shut out of and having unmet demand for basic activities are 5-10% for people with disabilities and 3-7% of people without disabilities. No difference by binary disability status or income bracket is significant. We point out that these rates are similar in magnitude to the rates of never leaving home in each group.

Figure 1. Extent to which people with or without disabilities at different incomes are shut out of or have unmet demand for basic activities



Putting these rates together, the rates of being shut out, including those who do or do not have unmet demand, are 10-15% for people with disabilities and 5-15% for people without disabilities. The only significant difference by binary disability status controlling for income bracket is that in the highest income bracket, people with disabilities are more likely than their peers without disabilities to be shut out of these activities. The only significant differences by income bracket controlling for disability status are that when considering people without disabilities, those in the highest income bracket are less likely to both be shut out of and have unmet demand for these activities than those in the lower two income brackets. The rates of having unmet demand, including those who are or are not shut out, are around 40% for people with disabilities and 30-35% for people without disabilities. The only significant differences by binary disability status controlling for income bracket are that in the middle and highest income brackets, people with disabilities are more likely than their respective peers without disabilities to have unmet demand for these activities. No difference by income bracket controlling for binary disability status is significant.

Disability and Transportation Mode Usage

We analyze the extent to which sociodemographic and disability-related variables affect the frequency of using different transportation modes. We analyze individual mode usage frequencies using discrete choice models, and we analyze frequencies and desires for groups of similar modes using descriptive statistics from the survey.

Ordinal logistic regression of individual transportation mode usage frequencies

We apply discrete choice models to understand the dependence of transportation mode usage frequency for individual activities upon relevant sociodemographic and disability-related variables. In each case, the dependent variable is the frequency of using an individual mode as measured in the survey using an ordinal Likert-type scale of never, less than once per month, 1-3 times per month, 1-3 times per week, or more than 3 times per week, so all of these models involve ordinal logistic regression.

In addition to the modes for which we show discrete choice modeling results, we also applied discrete choice modeling to data for driving a carsharing vehicle, riding as a passenger in a carsharing vehicle, using one's own standing scooter, using a bike from a bikesharing service, and using a standing scooter from a scooter-sharing service. The use of those modes was rare enough that the coefficients associated with multiple independent variables in each case were unrealistically large in magnitude and showed unrealistically small relative errors, suggesting an inability of the maximum likelihood estimation procedure to converge to a local maximum; essentially, when usage of those modes is so small, predicted differences in subgroups that may also be small will be unreliable. For this reason, we do not show results for those modes.

For most modes, just as for all activities, we show results for 3 different models, with the first being when disability is excluded as an independent variable in anyway, the second being when disability is included as a single binary independent variable, and the third being when disability is included as a set of multiple binary independent variables by form. In particular, when disability is included by form, the coefficient associated with each form of disability implies that the reference value is when the person does not have that form of disability. Thus, reducing disability to a single binary independent variable means that a person has a disability when reporting having at least one of the stated forms of disability in the survey (though the survey does not explicitly use terms like "disability" or refer to a purely medical conceptual framework of disability). However, paratransit buses, paratransit cars and vans, and non-emergency medical transportation (NEMT) are typically restricted in eligibility to people with disabilities. (The survey separated paratransit buses from paratransit cars and vans for the sake of respondents, as some paratransit agencies may use vehicles that do not look to riders like typical buses. Additionally, the survey did not specify that paratransit services must be ADA paratransit per se, so some respondents may have listed nonzero frequencies of using services with some similarities to ADA paratransit but that are not necessarily ADA paratransit.) In particular, the survey restricted responses for these modes only to people with any form of disability and thus could not capture the possibility of people without disabilities accompanying family members or friends with disabilities using these modes. For these modes, we show results for 2 different models. The first model only considers the subgroup of people with disabilities and does not break down results by form of disability. The second model breaks down results by form of disability, but because the sample considered is only people with disabilities, rather than considering each form independently as a binary variable, forms of disability are considered to constitute a multinomial variable in which the reference value is having two or more forms of disability, so each listed form of disability is taken to the exclusion of other forms in the analysis.

Several modes, including buses, trains, paratransit buses, paratransit cars and vans, taxis, TNC services, carsharing services, bikesharing services, and scooter-sharing services (for the latter three of which we do not show results) are provided by external entities but may not be available in every locality in California. Our analyses do not control for these differences in availability, so someone could claim to never use one of these modes, and the survey and our analyses would not distinguish whether this is due to a lack of availability versus due to an individual choice even where that mode is available.

Bus

We consider the ordinal variable of the frequency of using buses. As shown in Table 27, in every model, the intercept corresponding to the frequency being never is significantly different from 0 and positive, meaning that when each independent variable takes on its reference value, the probability is higher for never using buses than for using buses with any positive frequency.

For using buses, all intercepts and almost all coefficients are essentially stable regardless of the inclusion of disability as a single binary independent variable or as multiple binary independent variables by form. In particular, women (compared to men) are significantly less likely to use buses. Additionally, people with Black or African American racial identity by itself (compared to White or Caucasian racial identity by itself), people in the two youngest age brackets (compared to the oldest age bracket), people who live in the MTC region (compared to the SANDAG region), and people in urban neighborhoods (compared to rural neighborhoods) are significantly more likely to use buses. This means that other gender identity, Asian or Pacific Islander racial identity by itself, Native American racial identity by itself, other racial or multiracial identity, region in California (apart from the MTC region), experiencing travel cost burdens, and suburban neighborhood type have little to do with the frequency of using buses after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in the two youngest age brackets are more likely than those in the oldest age bracket to use buses, as this might simply reflect a greater likelihood of traveling using any mode with younger age. It is also not surprising that people in urban neighborhoods are more likely than those in rural neighborhoods to use buses due to the greater spatial and temporal availability of buses in urban neighborhoods; the same goes for the MTC region, which is more urbanized than the SANDAG region. It is somewhat surprising that this analysis does not show a greater propensity of using buses with lower income or with experiencing travel cost burdens, and given the correlation of Black or African American racial identity by itself with lower household income, of female gender identity with lower individual income (though this is not the same as household income), and of female gender identity with experiencing travel cost burdens, it is more surprising that the survey shows greater use of buses among people with Black or African American racial identity by itself and lesser use of buses among women.

People with disabilities, whether considered in a binary sense or by form of disability, have probability distributions significantly skewed toward higher frequencies of using buses than those without disabilities even after controlling for income and other relevant variables; this is among the few modes where disability is associated with greater use of the mode, though we emphasize that even among people with disabilities, if all of the other independent variables take their respective reference values, the probability distribution is still greatly skewed toward never using buses or using them at very low frequencies. We reiterate that including disability does not noticeably change the intercepts or most of the coefficients; the only exception is that the inclusion of disability as a set of multiple binary independent variables makes the coefficient associated with the age group 50-65 insignificantly different from 0. This is why the models with disability for this dependent variable do better than the models without disability according to the likelihood ratio test as shown in Table 28. Finally, we note that when including disability by form, only the coefficient associated with people with mental disabilities is significantly different from 0 (and positive). It is notable that the survey does not capture people with physical disabilities and people with vision disabilities using buses more often than those without such disabilities, suggesting that such people use other modes to travel even if they are shut out of more commonly used modes like driving. Thus, the likelihood ratio test suggests that that including disability by form does not yield significantly more predictive power than including disability as a single binary independent variable.

Table 27. Ordinal logistic regression coefficients for the frequency of using buses (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(1.19, 2.94)	(1.33, 3.09)	(1.26, 3.01)
Frequency <= 1	(2.31, 4.07)	(2.45, 4.22)	(2.39, 4.16)
Frequency <= 2	(3.15, 4.92)	(3.30, 5.08)	(3.23, 5.02)
Frequency <= 3	(4.10, 5.92)	(4.25, 6.08)	(4.19, 6.02)
Gender (base: male)			
Female	(-0.85, -0.45)	(-0.86, -0.46)	(-0.84, -0.42)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	NS	NS	NS
Black or African American only	(0.26, 1.05)	(0.20, 1.00)	(0.14, 0.95)
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	NS	NS	NS
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	(0.84, 1.44)	(0.80, 1.40)	(0.69, 1.34)
34-49	(0.39, 0.94)	(0.39, 0.94)	(0.29, 0.86)
50-65	(0.03, 0.59)	(0.02, 0.59)	NS

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	(0.33, 1.07)	(0.34, 1.09)	(0.37, 1.12)
Presence of travel cost burden	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	(1.17, 2.79)	(1.22, 2.84)	(1.18, 2.81)
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	(0.18, 0.59)	N/A
Physical	N/A	N/A	NS
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	(0.20, 0.77)
Other that prevents driving	N/A	N/A	NS

Table 28. Likelihood ratio test results for models of frequency of using buses, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	2.7 * 10^-4
Disability ignored	**Disability by type**	1.0 * 10^-3
Disability as single binary variable	**Disability by type**	> 5 * 10^-2

Train

We consider the ordinal variable of the frequency of using trains. As shown in Table 29, in every model, the intercept corresponding to the frequency being never is significantly different from 0 and positive, meaning that when each independent variable takes on its reference value, the probability is higher for never using trains than for using trains with any positive frequency.

For using trains, all intercepts and coefficients are essentially stable regardless of the inclusion of disability as a single binary independent variable or as multiple binary independent variables by form. In particular, women (compared to men), people in the lowest income bracket (compared to the highest income bracket), and people living in the CV or ROC regions (compared to the SANDAG region) are significantly less likely to use trains. Additionally, people with Black or African American racial identity by itself (compared to White or Caucasian racial identity by itself), people in all younger age brackets (compared to the oldest age bracket), people who live in the MTC region (compared to the SANDAG region), and people in urban neighborhoods (compared to rural neighborhoods) are significantly more likely to use trains. This means that other gender identity, Asian or Pacific Islander racial identity by itself, Native American racial identity by itself, other racial or multiracial identity, living in the SCAG or SACOG regions, experiencing travel cost burdens, and suburban neighborhood type have little to do with the frequency of using buses after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in all younger age brackets are more likely than those in the oldest age bracket to use trains, as this might simply reflect a greater likelihood of traveling using any mode with younger age. It is also not surprising that people in urban neighborhoods are more likely than those in rural neighborhoods to use trains due to the greater spatial and temporal availability of trains in urban neighborhoods; the same goes for the MTC region, which is more urbanized than the SANDAG region, and for the CV and ROC regions, which are more rural than the SANDAG region (though the upper limit of the confidence interval for the coefficient corresponding to the ROC region is very close to 0). Additionally, it is not surprising that people in the lowest income bracket are less likely to use trains, due to the typically higher cost of fares (especially compared to buses). Given the correlation of Black or African American racial identity by itself with lower household income, it is somewhat more surprising that the survey shows greater use of trains among people with Black or African American racial identity by itself.

Including disability as a single binary independent variable does not show any significant effect, and this is reflected in the likelihood ratio test in Table 30 showing that the model that includes disability as a single binary independent variable does not provide significantly more predictive power compared to the model that excludes disability as an independent variable. However, including disability as a set of multiple binary independent variables by form does show significantly greater predictive power compared to the other two models, and that model specifically shows that people with hearing disabilities are significantly more likely and people with cognitive disabilities are significantly less likely to use trains. It is interesting to note that for a mode that is higher-cost compared to other modes, people with hearing disabilities are more, not less, likely to use that mode, in contrast to people with other forms of disability.

Table 29. Ordinal logistic regression coefficients for the frequency of using trains (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(0.78, 2.60)	(0.72, 2.54)	(0.86, 2.69)
Frequency <= 1	(2.21, 4.04)	(2.15, 3.98)	(2.30, 4.14)
Frequency <= 2	(3.21, 5.06)	(3.15, 5.01)	(3.30, 5.18)
Frequency <= 3	(4.44, 6.40)	(4.38, 6.35)	(4.54, 6.52)
Gender (base: male)			
Female	(-0.60, -0.20)	(-0.60, -0.20)	(-0.56, -0.16)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	NS	NS	NS
Black or African American only	(0.23, 1.02)	(0.26, 1.05)	(0.14, 0.94)
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.62, -0.09)	(-0.61, -0.07)	(-0.60, -0.07)
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	(0.72, 1.33)	(0.75, 1.35)	(0.66, 1.31)
34-49	(0.44, 0.99)	(0.44, 0.98)	(0.38, 0.95)
50-65	(0.09, 0.64)	(0.09, 0.64)	(0.08, 0.65)

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	(-1.25, -0.16)	(-1.22, -0.12)	(-1.30, -0.20)
SACOG	NS	NS	NS
ROC	(-1.32, -0.04)	(-1.31, -0.03)	(-1.29, -0.01)
MTC	(0.26, 0.98)	(0.26, 0.98)	(0.27, 1.00)
Presence of travel cost burden	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	(0.75, 2.47)	(0.74, 2.45)	(0.81, 2.53)
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	NS	N/A
Physical	N/A	N/A	NS
Vision	N/A	N/A	NS
Hearing	N/A	N/A	(0.05, 0.86)
Cognitive	N/A	N/A	(-0.67, -0.04)
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 30. Likelihood ratio test results for models of frequency of using trains, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	> 5 * 10^-2
Disability ignored	**Disability by type**	1.1 * 10^-2
Disability as single binary variable	**Disability by type**	1.7 * 10^-2

Paratransit buses

We consider the ordinal variable of the frequency of using paratransit buses. As a reminder, the survey only lets people with disabilities answer questions about paratransit bus usage frequencies. As shown in Table 31, in every model, the intercept corresponding to the frequency being never is significantly different from 0 and positive, meaning that when each independent variable takes on its reference value, the probability is higher for never using paratransit buses than for using paratransit buses with any positive frequency. Additionally, we note that because disability, when included by form, is taken as a multinomial variable, the reference value in that model is of people with two or more disabilities.

For using paratransit buses, all intercepts and most coefficients are essentially stable regardless of the inclusion of disability as a multinomial independent variable by form. In particular, women (compared to men) are significantly less likely to use paratransit buses. Additionally, people with Black or African American racial identity by itself (compared to White or Caucasian racial identity by itself), people in the two youngest age brackets (compared to the oldest age bracket), and people who live in the ROC region (compared to the SANDAG region) are significantly more likely to use paratransit buses. This means that other gender identity, Asian or Pacific Islander racial identity by itself, other racial or multiracial identity, annual household income, the age group 50-65, region in California (other than the ROC region), and neighborhood type have little to do with the frequency of using paratransit buses after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in the two youngest age brackets are more likely than those in the oldest age bracket to use paratransit buses, as this might simply reflect a greater likelihood of traveling using any mode with younger age. It is marginally surprising that people in the ROC region are more likely to use paratransit buses given the lack of correlation to neighborhood type, though this might suggest a correlation between living in the ROC region (which tends to be more rural and poorer overall) and having a disability.

Including disability as a multinomial independent variable shows a significant effect, as the likelihood ratio test between these two models gives a p-value of 4.3 * 10^-5. In particular, people with only vision disabilities and people with only other driving-preventing disabilities are significantly more likely than those with two or more forms of disability to use paratransit buses. Coefficients associated with people with other forms of disability by themselves are insignificantly different from 0, likely because the reference value is of people with two or more forms of disability.

Table 31. Ordinal logistic regression coefficients for the frequency of using paratransit buses (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability included, but not as a multinomial variable	Disability included as a multinomial variable
Intercepts		
Frequency <= 0	(1.15, 3.91)	(1.75, 4.67)
Frequency <= 1	(1.94, 4.72)	(2.58, 5.52)
Frequency <= 2	(2.70, 5.50)	(3.37, 6.35)
Frequency <= 3	(4.47, 7.51)	(5.21, 8.43)
Gender (base: male)		
Female	(-1.45, -0.71)	(-1.36, -0.60)
Other	NS	NS
Race (base: White or Caucasian only)		
Asian or Pacific Islander only	NS	NS
Black or African American only	(0.52, 1.72)	(0.19, 1.44)
Native American only	(0.04, 1.58)	NS
Other racial identity only or two or more racial identities	NS	NS
Annual household income (base: $100,000+)		
$0-49,999	NS	NS
$50,000-99,999	NS	NS
Age (base: 66+)		
18-33	(1.11, 2.22)	(1.14, 2.45)
34-49	(0.65, 1.76)	(0.54, 1.78)
50-65	NS	NS
Region in California (base: SANDAG)		

SCAG	NS	NS
CV	NS	NS
SACOG	NS	NS
ROC	(0.07, 1.81)	(0.23, 2.02)
MTC	NS	NS
Presence of travel cost burden	(0.07, 0.87)	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)		
Urban	NS	NS
Suburban	NS	NS
Presence of disability type (base: two or more forms of disabilities)		
Physical only	N/A	NS
Vision only	N/A	(0.22, 1.02)
Hearing only	N/A	NS
Cognitive only	N/A	NS
Communication only	N/A	NS
Mental only	N/A	NS
Other only, that prevents driving	N/A	(0.26, 1.56)

Paratransit cars or vans

We consider the ordinal variable of the frequency of using paratransit cars or vans. As a reminder, the survey only lets people with disabilities answer questions about paratransit car or van usage frequencies. As shown in Table 32, in every model, the intercept corresponding to the frequency being never is significantly different from 0 and positive, meaning that when each independent variable takes on its reference value, the probability is higher for never using paratransit cars or vans than for using paratransit cars or vans with any positive frequency. Additionally, we note that because disability, when included by form, is taken as a multinomial variable, the reference value in that model is of people with two or more disabilities.

For using paratransit cars or vans, all intercepts and most coefficients are essentially stable regardless of the inclusion of disability as a multinomial independent variable by form. In particular, women (compared to men) are significantly less likely to use paratransit cars or vans. Additionally, people with Black or African American racial identity by itself (compared to White or Caucasian racial identity by itself), people in the two youngest age brackets (compared to the oldest age bracket), and people who experience travel cost burdens are significantly more likely to use paratransit cars or vans. This means that other gender identity, Asian or Pacific Islander racial identity by itself, Native American racial identity by itself, other racial or multiracial identity, annual household income, the age group 50-65, region in California, and neighborhood type have little to do with the frequency of using paratransit cars or vans after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in the two youngest age brackets are more likely than those in the oldest age bracket to use paratransit buses, as this might simply reflect a greater likelihood of traveling using any mode with younger age. Additionally, it is not surprising that people who experience travel cost burdens are more likely to use paratransit cars or vans, as such people may be more likely to live in poorer areas where paratransit services are provided using cars or vans rather than bigger, more standardized buses.

Including disability as a multinomial independent variable shows a significant effect, as the likelihood ratio test between these two models gives a p-value of 1.3 * 10^-3. In particular, people with only vision disabilities are significantly more likely than those with two or more forms of disability to use paratransit cars or vans. Coefficients associated with people with only individual non-vision forms of disability insignificantly differ from 0, likely because the reference value is of people with two or more forms of disability.

Table 32. Ordinal logistic regression coefficients for the frequency of using paratransit cars or vans (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability included, but not as a multinomial variable	Disability included as a multinomial variable
Intercepts		
Frequency <= 0	(0.62, 3.46)	(1.21, 4.16)
Frequency <= 1	(1.46, 4.32)	(2.09, 5.07)
Frequency <= 2	(2.34, 5.23)	(3.01, 6.03)
Frequency <= 3	(3.71, 6.78)	(4.40, 7.60)
Gender (base: male)		
Female	(-1.37, -0.60)	(-1.25, -0.47)
Other	NS	NS
Race (base: White or Caucasian only)		
Asian or Pacific Islander only	NS	NS
Black or African American only	(0.45, 1.63)	(0.13, 1.37)
Native American only	NS	NS
Other racial identity only or two or more racial identities	NS	NS
Annual household income (base: $100,000+)		
$0-49,999	NS	NS
$50,000-99,999	NS	NS
Age (base: 66+)		
18-33	(1.31, 2.54)	(1.33, 2.73)
34-49	(0.93, 2.15)	(0.85, 2.20)
50-65	NS	NS
Region in California (base: SANDAG)		

SCAG	NS	NS
CV	NS	NS
SACOG	NS	NS
ROC	NS	NS
MTC	NS	NS
Presence of travel cost burden	(0.09, 0.89)	(0.02, 0.83)
2017 American Housing Survey neighborhood type probability (base: 100% rural)		
Urban	NS	NS
Suburban	NS	NS
Presence of disability type (base: two or more forms of disabilities)		
Physical only	N/A	NS
Vision only	N/A	(0.21, 1.03)
Hearing only	N/A	NS
Cognitive only	N/A	NS
Communication only	N/A	NS
Mental only	N/A	NS
Other only, that prevents driving	N/A	NS

NEMT services

We consider the ordinal variable of the frequency of using NEMT services. As a reminder, the survey only lets people with disabilities answer questions about NEMT usage frequencies. As shown in Table 33, in every model, the intercept corresponding to the frequency being never is significantly different from 0 and positive, meaning that when each independent variable takes on its reference value, the probability is higher for never using NEMT services than for using NEMT services with any positive frequency. Additionally, we note that because disability, when included by form, is taken as a multinomial variable, the reference value in that model is of people with two or more disabilities.

For using NEMT services, all intercepts and most coefficients are essentially stable regardless of the inclusion of disability as a multinomial independent variable by form, and in fact, many coefficients that significantly differ from 0 in the model that does not break disability down by form move farther from 0 in the model that does break disability down by form. Thus, inclusion of disability as a multinomial independent variable by form significantly improves the predictive power of the model, as the likelihood ratio test has a p-value of 2.1 * 10^-8. In particular, women (compared to men) are significantly less likely to use NEMT services. Additionally, people with other racial or multiracial identity (compared to White or Caucasian racial identity by itself), people in the two youngest age brackets (compared to the oldest age bracket), and people who live in suburban neighborhoods are significantly more likely to use NEMT services. This means that other gender identity, Asian or Pacific Islander racial identity by itself, annual household income, the age group 50-65, region in California, experiencing travel cost burdens, and urban neighborhood type have little to do with the frequency of using NEMT services after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people who live in suburban neighborhoods are more likely to use NEMT services than those who live in rural neighborhoods, as this might simply reflect a greater availability of NEMT services in suburban neighborhoods, while in urban neighborhoods, usage might not differ much compared to rural neighborhoods simply because NEMT services are meant to be a "last resort" for getting to medical appointments, and people who live in urban neighborhoods may have more transportation options compared to people who live in suburban or rural neighborhoods even as NEMT services are more available in urban neighborhoods than in rural neighborhoods. It is somewhat more surprising, and harder to explain, that people in the two youngest age brackets are more likely than those in the oldest age bracket to use NEMT services; the idea that this might simply reflect a greater likelihood of traveling using any mode with younger age is suspect, as NEMT services, by their name and by law, are meant to provide transportation to non-emergency medical services outside of the home and not to other non-medical activities outside of the home, although one explanation could be that people in the oldest age bracket get more medical services in their own homes. It is also surprising that experiencing travel cost burdens shows no correlation with using NEMT services, as NEMT services are usually covered only by Medicaid, which is a form of government assistance that would cover the costs of specific forms of transportation including NEMT services; it is possible that because Medicaid covers costs including but not limited to transportation, some respondents to the survey did not see that as a form of government assistance specifically relevant to transportation, so such respondents would show up in our analysis as not experiencing travel cost burdens.

When disability is included as a multinomial independent variable shows a significant effect, people with only physical disabilities, only vision disabilities, only hearing disabilities, and only other driving-preventing disabilities are significantly more likely than those with two or more forms of disability to use NEMT services, while people with only cognitive disabilities are significantly less likely than those with two or more forms of disability to use NEMT services, though the upper limit of the confidence interval for the latter coefficient is very close to 0. Coefficients associated with people with only communication disabilities and with people with only mental disabilities are insignificantly different from 0, likely because the reference value is of people with two or more forms of disability. Additionally, coefficients associated with Black or African American racial identity by itself and with Native American racial identity by itself no longer significantly differ from 0.

Table 33. Ordinal logistic regression coefficients for the frequency of using NEMT (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability included, but not as a multinomial variable	Disability included as a multinomial variable
Intercepts		
Frequency <= 0	(1.81, 5.26)	(2.87, 6.61)
Frequency <= 1	(2.84, 6.33)	(4.00, 7.79)
Frequency <= 2	(3.50, 7.03)	(4.71, 8.56)
Frequency <= 3	(5.11, 8.92)	(6.37, 10.50)
Gender (base: male)		
Female	(-1.17, -0.36)	(-1.01, -0.16)
Other	NS	NS
Race (base: White or Caucasian only)		
Asian or Pacific Islander only	NS	NS
Black or African American only	(0.28, 1.62)	NS
Native American only	(0.10, 1.79)	NS
Other racial identity only or two or more racial identities	(0.10, 1.88)	(0.17, 1.90)
Annual household income (base: $100,000+)		
$0-49,999	NS	NS
$50,000-99,999	NS	NS
Age (base: 66+)		
18-33	(0.86, 2.08)	(1.14, 2.59)
34-49	(0.46, 1.68)	(0.46, 1.85)
50-65	NS	NS
Region in California (base: SANDAG)		

SCAG	NS	NS
CV	NS	NS
SACOG	NS	NS
ROC	NS	NS
MTC	NS	NS
Presence of travel cost burden	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)		
Urban	NS	NS
Suburban	(0.14, 3.34)	(0.28, 3.64)
Presence of disability type (base: two or more forms of disabilities)		
Physical only	N/A	(0.29, 1.18)
Vision only	N/A	(0.24, 1.12)
Hearing only	N/A	(0.16, 1.18)
Cognitive only	N/A	(-0.92, -0.02)
Communication only	N/A	NS
Mental only	N/A	NS
Other only, that prevents driving	N/A	(0.21, 1.57)

Driving one’s own vehicle

We consider the ordinal variable of the frequency of driving one's own vehicle. In the survey, people who did not have driving licenses were not asked about the frequency of driving their own vehicle, and people who did not have a vehicle that they or someone else in their household own or lease were not asked about the frequency of driving their own vehicle, so in our analysis, people without driving licenses as well as people without their own vehicles in the household were considered in the Likert-type scale of frequencies to never drive their own vehicles.

As shown in Table 34, in every model, the intercept corresponding to the frequency being 1-3 times per week insignificantly differs from 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for driving one's own vehicle at most 3 times per week as for driving one's own vehicle more than 3 times per week.

For driving one's own vehicle, all intercepts are essentially stable regardless of the inclusion of disability as a single binary independent variable or as multiple binary independent variables by form, but many coefficients, even if they remain significant regardless of the inclusion of disability, have effect sizes of lesser magnitudes when disability is included (more so when disability is included as multiple binary independent variables by form). In particular, people with Black or African American racial identity by itself (compared to White or Caucasian racial identity by itself), people in the lowest income bracket (compared to the highest income bracket), people in the youngest age bracket (compared to the oldest age bracket), and people who experience travel cost burdens are significantly less likely to drive their own vehicles. There are no independent variables correlating to a significantly greater likelihood of driving one's own vehicle. This means that gender, other racial or multiracial identity, the middle income bracket, age group (apart from the youngest age bracket), region in California, and neighborhood type have little to do with the frequency of driving one's own vehicle after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in the youngest age bracket, people in the lowest income bracket, and people who experience travel cost burdens are less likely than those in the oldest age bracket, in the highest income bracket, or not experiencing travel cost burdens to drive their own vehicles, due to the high costs of owning and maintaining a vehicle (especially as younger people are less likely to be earning or to have saved enough money to afford buying a vehicle immediately). The negative correlation with people with Black or African American racial identity by itself can be explained with the findings above that people with Black or African American racial identity by itself are less likely to have driving licenses and also less likely to own a vehicle. Additionally, it is only marginally surprising that there is no correlation with neighborhood type, as the ease (and in some cases necessity) in California of using a private vehicle to get to work even in more urbanized areas forces many people to make this decision.

People with disabilities, whether considered in a binary sense or by form of disability, have probability distributions significantly skewed toward lower frequencies of driving one's own vehicle than those without disabilities even after controlling for income and other relevant variables. However, this is compensated for by the decreased magnitudes of effect sizes of many independent variables; most notably, the coefficient corresponding to people with Native American racial identity by itself becomes barely significantly different from 0 in the model with disability as a single binary independent variable and then insignificantly different from 0 in the model with disability as a set of multiple binary independent variables by form, and the coefficient corresponding to urban neighborhood type becomes barely significantly different from 0 only in the model with disability as a single binary independent variable and insignificantly different from 0 for the other two models. Ultimately, the models with disability for this dependent variable do better than the models without disability according to the likelihood ratio test as shown in Table 35 (and those p-values are below 64-bit floating point precision), but the model with disability as a set of multiple binary independent variables by form does not have significantly better predictive power overall than the model with disability as a single binary independent variable. Finally, we note that when including disability by form, the coefficients associated with people with physical, vision, mental, and other driving-preventing disabilities are all significantly different from 0 (and negative). These results are not surprising given the problems that typical private vehicle designs pose for people with physical disabilities, especially people who use wheelchairs (though further analysis by detailed presentation of disability, which the survey does capture, is left for future work), the stresses of driving for people with mental disabilities, and the ways that people with vision disabilities and people with other driving-preventing disabilities are in most cases (and by definition in the case of people with other driving-preventing disabilities) prevented from getting driving licenses, though the survey did not prevent people with vision disabilities or people with other driving-preventing disabilities from reporting having a driving license, owning a vehicle, or driving their own vehicles at some positive frequency.

Table 34. Ordinal logistic regression coefficients for the frequency of driving one's own vehicle (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(-2.18, -0.90)	(-2.57, -1.28)	(-2.32, -1.02)
Frequency <= 1	(-2.03, -0.76)	(-2.42, -1.13)	(-2.17, -0.87)
Frequency <= 2	(-1.68, -0.41)	(-2.06, -0.77)	(-1.80, -0.50)
Frequency <= 3	NS	NS	NS
Gender (base: male)			
Female	NS	NS	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	NS	(-0.57, -0.11)	(-0.56, -0.09)
Black or African American only	(-1.09, -0.33)	(-0.98, -0.20)	(-0.92, -0.12)
Native American only	(-1.27, -0.16)	(-1.15, -0.01)	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.69, -0.22)	(-0.62, -0.14)	(-0.62, -0.13)
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	(-0.78, -0.25)	(-0.67, -0.14)	(-0.70, -0.13)
34-49	NS	NS	NS
50-65	NS	NS	NS

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(-1.29, -0.81)	(-1.11, -0.63)	(-1.08, -0.58)
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	(-1.16, -0.01)	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	(-1.11, -0.75)	N/A
Physical	N/A	N/A	(-0.81, -0.32)
Vision	N/A	N/A	(-0.67, -0.06)
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	(-0.71, -0.19)
Other that prevents driving	N/A	N/A	(-1.63, -0.34)

Table 35. Likelihood ratio test results for models of frequency of driving one’s own vehicle, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	< 2.2 * 10^-16
Disability ignored	**Disability by type**	< 2.2 * 10^-16
Disability as single binary variable	**Disability by type**	> 5 * 10^-2

Riding as a passenger in one's own vehicle

We consider the ordinal variable of the frequency of riding as a passenger in one's own vehicle. In the survey, people who did not own or lease their own vehicles were not asked about the frequency of riding in a passenger in their own vehicle, so in our analysis, such people were considered in the Likert-type scale of frequencies to never ride as a passenger in their own vehicles. As shown in Table 36, in most models, the intercept corresponding to the frequency being never insignificantly differs from 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for never riding as a passenger in one's own vehicle as for riding as a passenger in one's own vehicle at any positive frequency. The only exception is the model with disability as a single binary independent variable, in which the probabilities are instead equal at the frequency threshold of less than once per month (but not never). Additionally, in each model, the intercept corresponding to the frequency threshold of 1-3 times per month insignificantly differs from 0 too, which means that the probability distribution is bimodal, with equal probabilities of never riding in one's own vehicle as a passenger and of riding in one's own vehicle as a passenger at least once per week. This bimodal behavior of the probability distribution may partially account for the unpredictable behavior of the coefficients corresponding to each independent variable (as bimodal behavior in the probability distribution of an ordinal dependent variable may become harder to numerically fit through maximum likelihood estimation).

For riding as a passenger in one's own vehicle, most intercepts are essentially stable regardless of the inclusion of disability, but a few coefficients, even if they remain significant regardless of the inclusion of disability, have effect sizes of different magnitudes when disability is included, and the effect sizes tend to have lesser magnitudes particularly in the model that includes disability by form. In particular, for all models, people with Asian or Pacific Islander racial identity by itself (compared to White or Caucasian racial identity by itself) and people in the lowest and middle income brackets (compared to the highest income bracket, though the effect size has a markedly smaller magnitude for the lowest income bracket when disability is included by form) are significantly less likely to ride as passengers in their own vehicles. Additionally, women (compared to men), people in the two youngest age brackets (compared to the oldest age bracket) and people who experience travel cost burdens are significantly more likely to ride as passengers in their own vehicles. This means that other gender identity, Native American racial identity by itself, other racial or multiracial identity, the middle income bracket, the age group 50-65, region in California, and neighborhood type have little to do with the frequency of riding as a passenger one's own vehicle after controlling for the aforementioned other factors.

Although the negative correlation of lower income with private vehicle ownership makes it seem like a negative correlation between lower income and riding as a passenger in one's own vehicle should be obvious, the observed negative correlation could also be explained by households with lower income being more likely to have people who live alone, so such people would be less likely to have people other than themselves in the household to drive them in vehicles available to the household. Additionally, the effect size for the lowest income bracket drastically decreases in magnitude when disability is included by form, which is harder to explain. Separately, the negative correlation of Asian or Pacific Islander racial identity by itself with using this mode may relate to the lesser frequency of people with Asian or Pacific Islander racial identity by itself going out, as seen in some of our analyses above. The positive correlation of experiencing travel cost burdens with riding as a passenger in one's own vehicle could be explained by riding in vehicles owned by other people in the same household even if an individual receives financial assistance from others for transportation. The positive correlation of female gender identity with riding as a passenger in one's own vehicle could be explained by stereotypical gender roles in which, in an opposite-sex romantic couple, a man may be more likely to drive than a woman when both travel together, though future analysis would control for the presence of others in the household and for LGBTQ+ identity (the latter beyond other gender identity). Finally, the positive correlation of the two youngest age brackets with using this mode could be explained mostly by a lesser frequency of travel overall among the oldest age bracket compared to younger age brackets.

People with disabilities, whether considered in a binary sense or by form of disability, have probability distributions significantly skewed toward lower frequencies of riding as a passenger in one's own vehicle than those without disabilities even after controlling for income and other relevant variables. However, this is compensated for by the decreased magnitudes of effect sizes of many independent variables; most notably, the coefficient corresponding to people with Black or African American racial identity by itself becomes insignificantly different from 0 when disability is included. Ultimately, for this dependent variable, the model with disability as a single binary independent variable has significantly more predictive power than the other two models, and the model with disability by form does not have significantly more predictive power than the model without disability, for this dependent variable do better than the models without disability, according to the likelihood ratio test as shown in Table 37. Finally, we note that when including disability by form, the coefficients associated with people with physical disabilities and with people with mental disabilities are all significantly different from 0 (and negative). The result for people with physical disabilities is not surprising given the problems that typical private vehicle designs pose for people with physical disabilities, especially people who use wheelchairs (though further analysis by detailed presentation of disability, which the survey does capture, is left for future work), but the result for people with mental disabilities is surprising and harder to explain given the relief from the stresses of driving; that said, the upper limits of the confidence intervals both of those coefficients are close to 0. Additionally, the coefficients associated with people with vision disabilities and with people with other driving-preventing disabilities insignificantly differing from 0 may be explained by the overall rarity of using this mode.

Table 36. Ordinal logistic regression coefficients for the frequency of riding as a passenger in one's own vehicle (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	NS	(-1.29, -0.06)	NS
Frequency <= 1	NS	NS	NS
Frequency <= 2	NS	NS	NS
Frequency <= 3	(1.03, 2.26)	(0.95, 2.19)	(1.05, 2.29)
Gender (base: male)			
Female	(0.04, 0.39)	(0.05, 0.41)	(0.05, 0.40)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.49, -0.03)	(-0.52, -0.06)	(-0.52, -0.06)
Black or African American only	(-0.80, -0.01)	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.86, -0.41)	(-0.84, -0.38)	(-0.55, -0.03)
$50,000-99,999	(-0.72, -0.24)	(-0.70, -0.22)	(-0.83, -0.37)
Age (base: 66+)			
18-33	(0.09, 0.61)	(0.12, 0.65)	(0.10, 0.66)
34-49	(0.12, 0.58)	(0.12, 0.58)	(0.13, 0.61)
50-65	NS	NS	NS

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(0.01, 0.47)	(0.07, 0.54)	(0.07, 0.55)
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	(-0.45, -0.09)	N/A
Physical	N/A	N/A	(-0.48, -0.01)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	(-0.53, -0.02)
Other that prevents driving	N/A	N/A	NS

Table 37. Likelihood ratio test results for models of frequency of riding as a passenger in one's own vehicle, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	2.9 * 10^-3
Disability ignored	**Disability by type**	> 5 * 10^-2
Disability as single binary variable	**Disability by type**	> 5 * 10^-2

Driving a relative’s or friend’s vehicle

We consider the ordinal variable of the frequency of driving a relative's or friend's vehicle. In the survey, people who did not have a driving license were not asked about the frequency of driving a relative's or friend's vehicle, so in our analysis, such people were considered in the Likert-type scale of frequencies to never drive a relative's or friend's vehicle. As shown in Table 38, the intercept corresponding to the frequency being never is significantly different from 0 and is positive, meaning that when each independent variable takes on its reference value, the probability is higher for never driving a relative's or friend's vehicle than for driving a relative's or friend's vehicle at any positive frequency.

For driving a relative's or friend's vehicle, all intercepts and coefficients are essentially stable regardless of the inclusion of disability. In particular, women (compared to men), people with Asian or Pacific Islander racial identity by itself (compared to White or Caucasian racial identity by itself) and people in the lowest income bracket (compared to the highest income bracket) are significantly less likely to drive a relative's or friend's vehicle. Additionally, people in all younger age brackets (compared to the oldest age bracket) are significantly more likely to drive a relative's or friend's vehicle. This means that other gender identity, Black or African American racial identity by itself, Native American racial identity by itself, other racial or multiracial identity, the middle income bracket, region in California, experiencing travel cost burdens, and neighborhood type have little to do with the frequency of driving a relative's or friend's vehicle after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in the lowest income bracket are less likely to drive a relative's or friend's vehicle, as prevalent geographic and social segregation by socioeconomic status in California would suggest that people in the lowest income bracket are less likely to have relatives or friends who can afford their own vehicles. It is also not surprising that people in all younger age groups are more likely to drive a relative's or friend's vehicle as this may simply correlate with being out and about less with greater age; in particular, the effect size does indeed decrease with age. It is more surprising and harder to explain the negative correlation of usage of this mode with female gender identity and separately with Asian or Pacific Islander racial identity by itself, as neither of these independent variables has any significant effect on driver licensing, though perhaps the negative correlation with Asian or Pacific Islander racial identity by itself may be consistent with overall lesser travel among this group (as we have shown in a few other analyses in this report).

The model with disability by form has significantly more predictive power than the model without disability, which in turn surprisingly has significantly more predictive power than the model with disability as a single binary independent variable, according to the likelihood ratio test results in Table 39. In particular, disability as a single binary independent variable has no significant effect on the dependent variable. By contrast, when disability is included by form, people with physical disabilities are significantly less likely to drive a relative's or friend's vehicle, probably because of the even greater difficulty of other people's vehicles accommodating the needs of a person with physical disabilities who lives in a different household. Additionally, the coefficients associated with people with vision disabilities and with people with other driving-preventing disabilities insignificantly differing from 0 may be explained by the overall rarity of using this mode.

Table 38. Ordinal logistic regression coefficients for the frequency of driving a relative’s or friend’s vehicle (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(0.36, 1.81)	(0.38, 1.83)	(0.43, 1.89)
Frequency <= 1	(1.37, 2.83)	(1.40, 2.86)	(1.45, 2.93)
Frequency <= 2	(2.27, 3.75)	(2.30, 3.78)	(2.36, 3.85)
Frequency <= 3	(3.42, 4.98)	(3.45, 5.01)	(3.51, 5.08)
Gender (base: male)			
Female	(-0.41, -0.02)	(-0.41, -0.02)	(-0.40, -0.01)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.65, -0.11)	(-0.64, -0.11)	(-0.66, -0.12)
Black or African American only	NS	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.54, -0.03)	(-0.55, -0.03)	(-0.55, -0.03)
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	(0.99, 1.58)	(0.97, 1.57)	(0.83, 1.46)
34-49	(0.68, 1.21)	(0.68, 1.21)	(0.61, 1.16)
50-65	(0.19, 0.73)	(0.19, 0.73)	(0.18, 0.73)

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	NS	NS
Physical	N/A	N/A	(-0.60, -0.03)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 39. Likelihood ratio test results for models of frequency of driving a relative's or friend's vehicle, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	> 5 * 10^-2
Disability ignored	**Disability by type**	3.6 * 10^-2
Disability as single binary variable	**Disability by type**	2.6 * 10^-2

Riding as a passenger in a relative’s or friend’s vehicle

We consider the ordinal variable of the frequency of riding as a passenger in a relative's or friend's vehicle. As shown in Table 40, the intercept corresponding to the frequency being never is insignificantly different from 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for never riding as a passenger in a relative's or friend's vehicle as for riding as a passenger in a relative's or friend's vehicle at any positive frequency.

For riding as a passenger in a relative's or friend's vehicle, all intercepts and almost all coefficients are essentially stable regardless of the inclusion of disability. In particular, people with Asian or Pacific Islander racial identity by itself (compared to White or Caucasian racial identity by itself), and people living in the CV region are significantly less likely to ride as a passenger in a relative's or friend's vehicle. Additionally, women (compared to men), people with other racial identity or multiracial identity (compared to White or Caucasian racial identity by itself), people the two youngest age brackets (compared to the oldest age bracket), and people who live in urban neighborhoods are significantly more likely to ride as a passenger in a relative's or friend's vehicle. This means that other gender identity, Black or African American racial identity by itself, Native American racial identity by itself, household income, region in California (apart from the CV region), experiencing travel cost burdens, and suburban neighborhood type have little to do with the frequency of riding as a passenger in a relative's or friend's vehicle after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people in the two youngest age brackets are more likely to ride as a passenger in a relative's or friend's vehicle as this may simply correlate with being out and about less with greater age; in particular, the effect size does indeed decrease with age. It is also not surprising to see that women are more likely to ride as a passenger in a relative's or friend's vehicle to the extent that the explanations are consistent with why women may be more likely to ride as a passenger in their own vehicles. It is more surprising and harder to explain the negative correlation of usage of this mode with living in the CV region and separately with Asian or Pacific Islander racial identity by itself, though perhaps the negative correlation with Asian or Pacific Islander racial identity by itself may be consistent with overall lesser travel among this group (as we have shown in a few other analyses in this report). It is also more surprising and harder to explain the positive correlation of usage of this mode with other racial identity or multiracial identity and separately with living in an urban neighborhood, though perhaps the positive correlation with living an urban neighborhood could be explained by living in a denser area with more relatives and friends nearby with whom to share rides.

Including disability in any way does not significantly improve predictive power of the model, according to the likelihood ratio test results in Table 41. In particular, disability as a single binary independent variable has no significant effect on the dependent variable. When disability is included by form, only people with cognitive disabilities are significantly more likely to ride as a passenger in a relative's or friend's vehicle, perhaps because people with cognitive disabilities are more likely to depend on others for help with transportation more broadly, though the lower bound of the confidence interval for that coefficient is very closer to 0. Additionally, the coefficients associated with people with non-cognitive disabilities insignificantly differing from 0 may be explained by the overall rarity of using this mode.

Table 40. Ordinal logistic regression coefficients for the frequency of riding as a passenger in a relative's or friend's vehicle (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	NS	NS	NS
Frequency <= 1	(1.06, 2.32)	(1.11, 2.37)	(1.12, 2.38)
Frequency <= 2	(2.15, 3.42)	(2.20, 3.48)	(2.21, 3.50)
Frequency <= 3	(3.50, 4.83)	(3.55, 4.89)	(3.57, 4.92)
Gender (base: male)			
Female	(0.04, 0.38)	(0.03, 0.37)	(0.04, 0.39)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.77, -0.31)	(-0.76, -0.29)	(-0.78, -0.31)
Black or African American only	NS	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	(0.16, 1.02)	(0.16, 1.02)	(0.19, 1.05)
Annual household income (base: $100,000+)			
$0-49,999	NS	NS	NS
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	(1.03, 1.56)	(1.00, 1.53)	(0.91, 1.47)
34-49	(0.19, 0.64)	(0.19, 0.64)	(0.13, 0.60)
50-65	NS	NS	NS

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	(-0.88, -0.04)	(-0.91, -0.07)	(-0.90, -0.05)
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	(0.04, 1.18)	(0.06, 1.20)	(0.09, 1.24)
Suburban	NS	NS	(0.01, 1.13)
Disability			
Present (binary)	N/A	NS	N/A
Physical	N/A	N/A	NS
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	(0.02, 0.53)
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 41. Likelihood ratio test results for models of frequency of riding as a passenger in a relative's or friend's vehicle, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	> 5 * 10^-2
Disability ignored	**Disability by type**	> 5 * 10^-2
Disability as single binary variable	**Disability by type**	> 5 * 10^-2

Using taxi services

We consider the ordinal variable of the frequency of using taxi services. As shown in Table 42, the intercept corresponding to the frequency being never is significantly different from 0 and positive, meaning that when each independent variable takes on its reference value, the probability is higher for never using taxi services than for using taxi services at any positive frequency.

For using taxi services, all intercepts but only some coefficients are essentially stable regardless of the inclusion of disability. In particular, women (compared to men) as well as people with Asian or Pacific Islander racial identity by itself (compared to White or Caucasian racial identity by itself) are significantly less likely to use taxi services. Additionally, people with Black or African American racial identity by itself (compared to White or Caucasian racial identity by itself) as well as people who live in urban neighborhoods (compared to rural neighborhoods) are significantly more likely to use taxi services. This means that other gender identity, Native American racial identity by itself, other racial identity or multiracial identity, household income, the age groups 18-33 as well as 50-65, region in California, and experiencing travel cost burdens have little to do with the frequency of using taxi services after controlling for the aforementioned other factors.

Intuitively, it is not surprising that people living in urban neighborhoods are more likely to use taxi services, given the greater availability of taxi services in urban neighborhoods compared to rural neighborhoods. It is marginally surprising that women as well as people with Asian or Pacific Islander racial identity by itself are less likely to use taxi services. The results for women may be consistent with less use of externally-provided (by people who are not relatives or friends) transportation services, like buses or trains; a potential explanation could be fear of abuse or exploitation by drivers, but the survey did not include questions whose answers could be used to test that hypothesis. The results for people with Asian or Pacific Islander racial identity by itself may be consistent with our other results showing lesser use of other modes or lesser performance of some activities among people in this group. It is also marginally surprising that people with Black or African American racial identity by itself are more likely to use taxi services, but this could be explained by taxi services being a substitute mode to compensate for the lesser use of modes involving individually-owned vehicles (for non-commercial use) among people in this group without decreasing the frequency of travel overall.

Including disability as a single binary independent variable does not significantly improve the predictive power of the model, but including disability by form does significantly improve the predictive power of the model, as shown through the likelihood ratio test results in Table 43. In particular, when disability is included as a single binary independent variable, the coefficient corresponding to disability insignificantly differs from 0, and none of the other coefficients noticeably change. By contrast, when disability is included by form, the effect sizes corresponding to the intercepts increase, the coefficient corresponding to suburban neighborhood type changes from being insignificantly different from 0 to being marginally significantly different from 0 and positive, the coefficient corresponding to the age group 34-49 changes to being insignificantly different from 0, and the effect sizes of female gender identity and Black or African American racial idnetity by itself decrease slightly in magnitude, while the coefficients corresponding to people with vision disabilities as well as people with other driving-preventing disabilities are significantly different from 0 and positive. It is notable that the coefficients do not suggest lesser use of taxi services by people who use wheelchairs in this broad categorization of disability, perhaps because that effect is outweighed by a greater use of taxi services by people with disabilities who cannot drive but who are able to use typical taxi services without needing specialized vehicles; in any case, as the survey did ask about wheelchair use and other aspects of disability, testing such hypotheses will be the subject of future work.

Table 42. Ordinal logistic regression coefficients for the frequency of using taxi services (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(0.97, 2.84)	(1.03, 2.90)	(1.18, 3.08)
Frequency <= 1	(2.63, 4.53)	(2.69, 4.60)	(2.88, 4.81)
Frequency <= 2	(3.66, 5.62)	(3.73, 5.69)	(3.94, 5.94)
Frequency <= 3	(5.01, 7.25)	(5.08, 7.32)	(5.30, 7.58)
Gender (base: male)			
Female	(-0.61, -0.17)	(-0.61, -0.18)	(-0.55, -0.10)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.75, -0.13)	(-0.73, -0.11)	(-0.73, -0.10)
Black or African American only	(0.54, 1.37)	(0.52, 1.34)	(0.35, 1.19)
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	NS	NS	NS
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	NS	NS	NS
34-49	(0.05, 0.61)	(0.06, 0.61)	NS
50-65	NS	NS	NS

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	(0.41, 2.16)	(0.42, 2.17)	(0.45, 2.22)
Suburban	NS	NS	(0.06, 1.82)
Disability			
Present (binary)	N/A	NS	NS
Physical	N/A	N/A	NS
Vision	N/A	N/A	(0.21, 0.91)
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	(0.28, 1.51)

Table 43. Likelihood ratio test results for models of frequency of using taxi services, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	> 5 * 10^-2
Disability ignored	**Disability by type**	2.1 * 10^-6
Disability as single binary variable	**Disability by type**	2.4 * 10^-6

Using TNC services

We consider the ordinal variable of the frequency of using TNC services. As shown in Table 44, the intercept corresponding to the frequency being never is significantly different from 0 and positive, meaning that when each independent variable takes on its reference value, the probability is higher for never using TNC services than for using taxi services at any positive frequency.

For using TNC services, all intercepts and coefficients are essentially stable regardless of the inclusion of disability. In particular, women (compared to men), people with Asian or Pacific Islander racial identity by itself (compared to White or Caucasian racial identity by itself), people in the lowest income bracket (compared to the highest income bracket), and people who live in the CV region (compared to the SANDAG region) are significantly less likely to use TNC services. Additionally, people with Black or African American racial identity by itself (compared to White or Caucasian racial identity by itself), people in all younger age brackets (compared to the oldest age bracket), and people who live in urban or suburban neighborhoods (compared to rural neighborhoods) are significantly more likely to use taxi services. This means that other gender identity, Native American racial identity by itself, other racial identity or multiracial identity, the middle income bracket, region in California (apart from the CV region), and experiencing travel cost burdens have little to do with the frequency of using TNC services after controlling for the aforementioned other factors.

The respective effects of female gender identity, Asian or Pacific Islander racial identity by itself, Black or African American racial identity by itself, and living in an urban neighborhood on the frequency of using TNC services go in the same respective directions as on the frequency of using taxi services, and the explanations are similar to that case too. The greater likelihood of people living in suburban neighborhoods to use TNC services is also not surprising given the greater availability of TNC services in suburban neighborhoods compared to rural neighborhoods; moreover, in the Greater Los Angeles area, a study has found comparable levels of TNC service in urban as well as suburban neighborhoods and little evidence of service inequities that map to socioeconomic segregation. Additionally, it is only marginally surprising that people in the lowest income bracket are less likely to use TNC services, because such services are similar to taxi services which do not show significant effects from income, though this difference could be explained by lesser ownership or use of smartphones which are typically required to use TNC services. It is more surprising that people living in the CV region are less likely to use TNC services; this could reflect the more rural character of the CV region compared to the SCAG, SACOG, SANDAG, and MTC regions, as it has already been established that people living in rural neighborhoods are less likely to use TNC services than their peers in urban or suburban neighborhoods, but the ROC region has even fewer large urban centers than the CV region, so this explanation seems suspect.

Including disability as a single binary independent variable does not significantly improve the predictive power of the model, but including disability by form does significantly improve the predictive power of the model, as shown through the likelihood ratio test results in Table 45; in fact, the model has more predictive power when excluding disability than when including disability as a single binary independent variable. In particular, when disability is included as a single binary independent variable, the coefficient corresponding to disability insignificantly differs from 0, and none of the intercepts or other coefficients noticeably change. By contrast, when disability is included by form, none of the intercepts or other coefficients noticeably change, but the coefficients corresponding to people with mental disabilities as well as people with other driving-preventing disabilities are significantly different from 0 and positive (though the lower limit of the confidence interval of the coefficient for people with other driving-preventing disabilities is very close to 0). Similar to the use of taxi services, it is notable that the coefficients do not suggest lesser use of TNC services by people who use wheelchairs in this broad categorization of disability, perhaps because that effect is outweighed by a greater use of TNC services by people with disabilities who cannot drive but who are able to use typical TNC services without needing specialized vehicles; in any case, as the survey did ask about wheelchair use and other aspects of disability, testing such hypotheses will be the subject of future work. Additionally, it is notable that any problems that may exist with smartphone app design for people with vision disabilities are not reflected in the coefficient corresponding to people with vision disabilities for this dependent variable, which is insignificantly different from 0.

Table 44. Ordinal logistic regression coefficients for the frequency of using TNC services (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(0.75, 2.27)	(0.76, 2.29)	(0.73, 2.26)
Frequency <= 1	(2.68, 4.23)	(2.69, 4.24)	(2.68, 4.23)
Frequency <= 2	(3.94, 5.52)	(3.95, 5.54)	(3.94, 5.53)
Frequency <= 3	(5.31, 7.04)	(5.32, 7.06)	(5.32, 7.06)
Gender (base: male)			
Female	(-0.50, -0.13)	(-0.50, -0.13)	(-0.49, -0.12)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.54, -0.05)	(-0.53, -0.05)	(-0.55, -0.06)
Black or African American only	(0.30, 1.08)	(0.29, 1.08)	(0.25, 1.04)
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.53, -0.05)	(-0.54, -0.05)	(-0.54, -0.05)
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	(1.25, 1.81)	(1.24, 1.81)	(1.11, 1.71)
34-49	(0.78, 1.27)	(0.78, 1.27)	(0.70, 1.20)
50-65	(0.16, 0.65)	(0.16, 0.65)	(0.13, 0.63)

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	(-1.07, -0.14)	(-1.08, -0.14)	(-1.08, -0.14)
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	(0.98, 2.40)	(0.98, 2.41)	(0.97, 2.40)
Suburban	(0.66, 2.07)	(0.66, 2.08)	(0.65, 2.06)
Disability			
Present (binary)	N/A	NS	N/A
Physical	N/A	N/A	NS
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	(0.18, 0.71)
Other that prevents driving	N/A	N/A	(0.01, 1.21)

Table 45. Likelihood ratio test results for models of frequency of using TNC services, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	> 5 * 10^-2
Disability ignored	**Disability by type**	3.4 * 10^-3
Disability as single binary variable	**Disability by type**	1.7 * 10^-3

Walking

We consider the ordinal variable of the frequency of walking outside of the home; the survey explicitly clarified that this includes using a walker, wheelchair, medical scooter, or similar assistive device. As shown in Table 46, the intercept corresponding to the frequency being less than once per month (but not never) is insignificantly different from 0, meaning that when each independent variable takes on its reference value, the probabilities are equal for walking less than once per month as for walking at least once per month. Additionally, in each model, the intercept corresponding to the frequency threshold of 1-3 times per month insignificantly differs from 0 too, which means that the probability distribution is bimodal, with equal probabilities of walking less than once per month and of walking at least once per week.

For walking, all intercepts and most coefficients are essentially stable regardless of the inclusion of disability. In particular, women (compared to men), people with Asian or Pacific Islander racial identity by itself (compared to White or Caucasian racial identity by itself), people in the lowest income brackets (compared to the highest income bracket), and people who live in the CV region (compared to the SANDAG region) are significantly less likely to walk. Additionally, people who live in urban or suburban neighborhoods (compared to rural neighborhoods) are significantly more likely to walk. This means that other gender identity, Black or African American racial identity by itself, Native American racial identity by itself, other racial identity or multiracial identity, age, and region in California (apart from the CV region) have little to do with the frequency of walking after controlling for the aforementioned other factors.

The respective effects of female gender identity and of Asian or Pacific Islander racial identity by itself go in the same respective directions as on the frequency of using taxi services, and the explanations are similar to that case too; in particular, women may be more concerned about their personal security in pedestrian environments outside of the home, which may reduce walking, while people with Asian or Pacific Islander racial identity by itself may walk less as part of traveling less overall. It is not surprising that people in the lowest and middle income brackets are less likely to walk, due to a greater incidence of unsafe or disinvested pedestrian environments in their neighborhoods. It is also not surprising that people living in urban or suburban neighborhoods are more likely to walk due to the lesser distances of travel and the greater likelihood of having safe pedestrian infrastructure compared to rural neighborhoods. Just as with using taxi services or TNC services, it is more surprising that people living in the CV region are less likely to walk. This could reflect the more rural character of the CV region compared to the SCAG, SACOG, SANDAG, and MTC regions, as it has already been established that people living in rural neighborhoods are less likely to walk than their peers in urban or suburban neighborhoods, but the ROC region has even fewer large urban centers than the CV region, so this explanation seems suspect. It is also possible that higher levels of interpersonal crime in the major urban centers of the CV region may deter walking, but the survey does not ask questions whose answers could allow testing that hypothesis.

Including disability, whether as a single binary independent variable or by form, significantly improves the predictive power of the model, and including disability by form in particular yields a further improvement, as shown through the likelihood ratio test results in Table 47. When disability is included as a single binary independent variable, the coefficient corresponding to disability significantly differs from 0 and is negative, and none of the intercepts or other coefficients noticeably change. When disability is included by form, none of the intercepts noticeably change, the only coefficient to noticeably change is the one corresponding to experiencing travel cost burdens as that becomes insignificantly different from 0 (likely due to the positive correlation of that independent variable with disability), and the coefficient corresponding to people with physical disabilities is significantly different from 0 and negative. It is intuitively not surprising that this skew toward low frequencies among people with disabilities mostly comes from people with physical disabilities, as the questions in the survey were designed to count people who have trouble walking as having a physical disability.

Table 46. Ordinal logistic regression coefficients for the frequency of walking (NS = not significant at a p-value threshold of 0.05)

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(-1.60, -0.37)	(-1.78, -0.54)	(-1.73, -0.48)
Frequency <= 1	NS	NS	NS
Frequency <= 2	NS	NS	NS
Frequency <= 3	(0.68, 1.91)	(0.52, 1.76)	(0.58, 1.83)
Gender (base: male)			
Female	(-0.39, -0.05)	(-0.39, -0.05)	(-0.39, -0.05)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.50, -0.06)	(-0.54, -0.10)	(-0.56, -0.12)
Black or African American only	NS	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.60, -0.15)	(-0.58, -0.12)	(-0.56, -0.10)
$50,000-99,999	(-0.65, -0.16)	(-0.62, -0.13)	(-0.61, -0.12)
Age (base: 66+)			
18-33	NS	NS	NS
34-49	NS	NS	NS
50-65	NS	NS	NS

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	(-0.87, -0.06)	(-0.83, -0.02)	(-0.86, -0.05)
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(-0.56, -0.12)	(-0.48, -0.03)	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	(0.78, 1.90)	(0.74, 1.86)	(0.82, 1.95)
Suburban	(0.18, 1.26)	(0.13, 1.22)	(0.19, 1.28)
Disability			
Present (binary)	N/A	(-0.56, -0.22)	N/A
Physical	N/A	N/A	(-0.71, -0.24)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	NS
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 47. Likelihood ratio test results for models of frequency of walking, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	7.6 * 10^-6
Disability ignored	**Disability by type**	6.3 * 10^-7
Disability as single binary variable	**Disability by type**	1.5 * 10^-3

Using one's own bicycle

We consider the ordinal variable of the frequency of using one's own bicycle outside of the home. The survey asked about bicycles, tricycles, and similar adapted devices when considering ownership as well as use. In the survey, people who did not own a bicycle were not asked about the frequency of using their own bicycle, so in our analysis, such people were considered in the Likert-type scale of frequencies to never use their own bicycle. As shown in Table 48, the intercept corresponding to the frequency being never is significantly different from 0 and positive, meaning that when each independent variable takes on its reference value, the probability is greater for never using one's own bicycle than for using one's own bicycle at any positive frequency.

For using one's own bicycle, all intercepts and most coefficients are essentially stable regardless of the inclusion of disability. In particular, women (compared to men), people with Asian or Pacific Islander racial identity by itself (compared to White or Caucasian racial identity by itself), and people in the lowest income brackets (compared to the highest income bracket) are significantly less likely to use their own bicycles. Additionally, people in all younger age brackets (compared to the oldest age bracket) as well as people who live in the CV or MTC regions (compared to the SANDAG region) are significantly more likely to use their own bicycles. This means that other gender identity, Black or African American racial identity by itself, Native American racial identity by itself, other racial identity or multiracial identity, region in California (apart from the CV region) have little to do with the frequency of walking after controlling for the aforementioned other factors.

The respective effects of female gender identity and of Asian or Pacific Islander racial identity by itself go in the same respective directions as on the frequency of using walking, and the explanations are similar to that case too; in particular, women may be more concerned about their personal security in active mode environments outside of the home, which may reduce using their own bicycles, while people with Asian or Pacific Islander racial identity by itself may use their own bicycles less as part of traveling less overall. It is not surprising that people in the lowest and middle income brackets are less likely to use their own bicycles due to the cost of purchasing a bicycle and potentially also due to a greater incidence of unsafe or disinvested bicycling environments in their neighborhoods. Just as with walking, it is also not surprising that people living in urban or suburban neighborhoods are more likely to use their own bicycles due to the lesser distances of travel and the greater likelihood of having safe pedestrian infrastructure compared to rural neighborhoods. Furthermore, it is not surprising that the likelihood of using one's own bicycle increases with decreasing age due to lesser travel overall and greater incidence of physical limitations relevant to bicycling with age. Finally, it is not surprising that people who live in the SACOG or MTC regions are more likely to use their own bicycles due to the greater level of urbanization and connectivity to public transit in the MTC region, for which bicycling can be an effective mode for first-/last-mile connectivity, as well as the flat terrain, warm weather, and culture of bicycling in the major urban centers of the SACOG region.

Including disability, whether as a single binary independent variable or by form, significantly improves the predictive power of the model, though including disability by form does not yield a further improvement compared to including disability as a single binary independent variable, as shown through the likelihood ratio test results in Table 49. When disability is included as a single binary independent variable, the coefficient corresponding to disability significantly differs from 0 and is negative, and none of the intercepts or other coefficients noticeably change. When disability is included by form, none of the intercepts noticeably change, the only coefficient to noticeably change is the one corresponding to living in the ROC region which changes from being insignificantly different from 0 to being significantly different from 0 and positive (though the lower bound of its confidence interval is still quite close to 0), and the coefficient corresponding to people with physical disabilities is significantly different from 0 and negative. It is intuitively not surprising that this skew toward low frequencies among people with disabilities mostly comes from people with physical disabilities. Additionally, if one expects that people with vision disabilities would not be able to ride a bicycle, then it may seem surprising that the coefficient associated with people with vision disabilities is insignificantly different from 0; however, recent work has shown the nontrivial extent to which people with vision disabilities use bicycles.

Table 48. Ordinal logistic regression coefficients for the frequency of using one’s own bicycle (NS = not significant at a p-value threshold of 0.05) without including disability as a variable

Coefficient	Disability ignored	Disability included as a single binary variable	Disability included as multiple binary variables
Intercepts			
Frequency <= 0	(0.24, 1.73)	(0.10, 1.60)	(0.27, 1.78)
Frequency <= 1	(0.92, 2.41)	(0.78, 2.29)	(0.95, 2.47)
Frequency <= 2	(1.62, 3.13)	(1.48, 3.00)	(1.66, 3.19)
Frequency <= 3	(2.70, 4.25)	(2.56, 4.13)	(2.74, 4.31)
Gender (base: male)			
Female	(-0.93, -0.51)	(-0.93, -0.51)	(-0.91, -0.49)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.61, -0.04)	(-0.65, -0.08)	(-0.65, -0.08)
Black or African American only	NS	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.87, -0.34)	(-0.83, -0.30)	(-0.82, -0.29)
$50,000-99,999	(-0.72, -0.16)	(-0.69, -0.12)	(-0.68, -0.12)
Age (base: 66+)			
18-33	(0.75, 1.40)	(0.81, 1.46)	(0.71, 1.40)
34-49	(0.89, 1.46)	(0.89, 1.46)	(0.86, 1.45)
50-65	(0.31, 0.90)	(0.31, 0.90)	(0.33, 0.93)

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	(0.06, 0.96)	(0.08, 0.98)	(0.10, 1.01)
ROC	NS	NS	(0.03, 1.17)
MTC	(0.11, 0.92)	(0.10, 0.92)	(0.10, 0.92)
Presence of travel cost burden	NS	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	NS	NS
Suburban	NS	NS	NS
Disability			
Present (binary)	N/A	(-0.63, -0.20)	N/A
Physical	N/A	N/A	(-0.81, -0.18)
Vision	N/A	N/A	NS
Hearing	N/A	N/A	NS
Cognitive	N/A	N/A	(-0.67, -0.12)
Communication	N/A	N/A	NS
Mental	N/A	N/A	NS
Other that prevents driving	N/A	N/A	NS

Table 49. Likelihood ratio test results for models of frequency of using one's own bicycle, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	1.8 * 10^-4
Disability ignored	**Disability by type**	2.0 * 10^-3
Disability as single binary variable	**Disability by type**	> 5 * 10^-2

Descriptive statistics of frequencies and desires of using groups of modes, by disability and income

In addition to using ordinal logistic regression to analyze the probability distribution of using different individual modes with respect to frequency, we consider descriptive statistics from the survey data about the extent to which people use groups of different modes relative to a frequency threshold, which we define as once per month, or desire using these modes more often than they currently do. We also show overlaps among these groups and focus on the breakdown by people with versus without disabilities (considering disability as a single binary independent variable) and by income bracket.

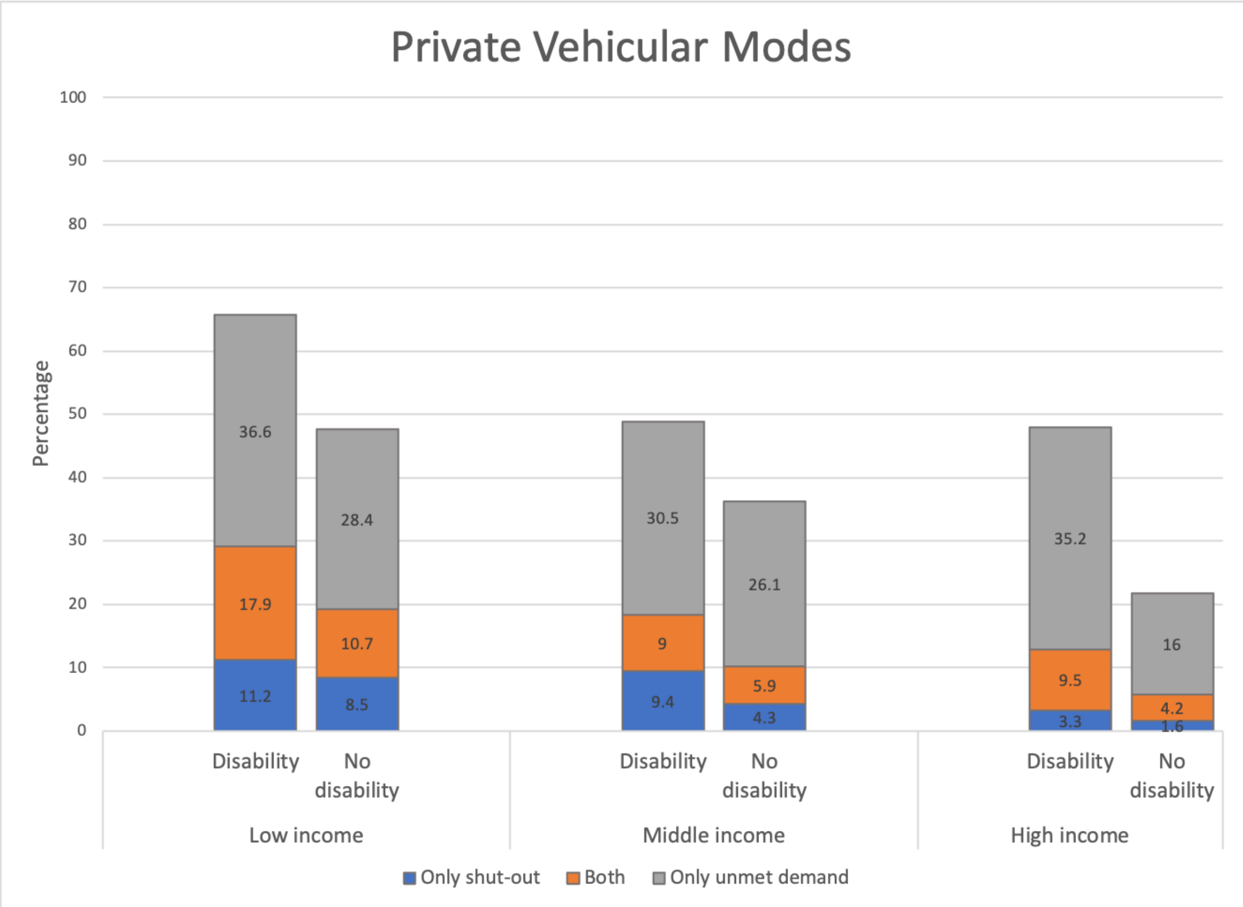
We group modes as follows. We consider private vehicular modes to include 4 modes, namely, driving one's own vehicle, riding as a passenger in one's own vehicle, driving a relative's or friend's vehicle, and riding as a passenger in a relative's or friend's vehicle. We consider public transit modes to include 5 modes, namely, buses, trains, paratransit buses, paratransit cars and vans, and NEMT; however, paratransit buses, paratransit cars and vans, and NEMT are only applicable in the survey to people with disabilities, so while people with disabilities have 5 public transit modes available to them, people without disabilities only have 2 public transit modes available to them (namely, buses and trains). We consider for-hire modes to include 4 modes, namely, taxi services, TNC services, driving a carsharing vehicle, and riding as a passenger in a carsharing vehicle. We consider active modes to include 5 modes, namely, walking, using one's own bicycle, using one's own standing scooter, using a bikesharing device, and using a scooter-sharing device.

We define being shut out of a group of modes as using all modes in that group at most less than once per month and having latent demand for this group of modes as wanting to use at least one mode in that group more often than currently (or at all if currently not). The statistical significance of comparisons between different fractions in these descriptive statistics is determining by computing a two-sided p-value from a comparison of proportions statistical test and comparing this to a threshold of 0.05.

With this in mind, we focus on private vehicular modes, public transit modes, and active modes. We do not focus as much on for-hire modes due to the overall lower frequency of use among respondents to the survey.

Private vehicular modes

Figure 2. Extent to which people with or without disabilities at different incomes are shut out of or have unmet demand for private vehicular modes



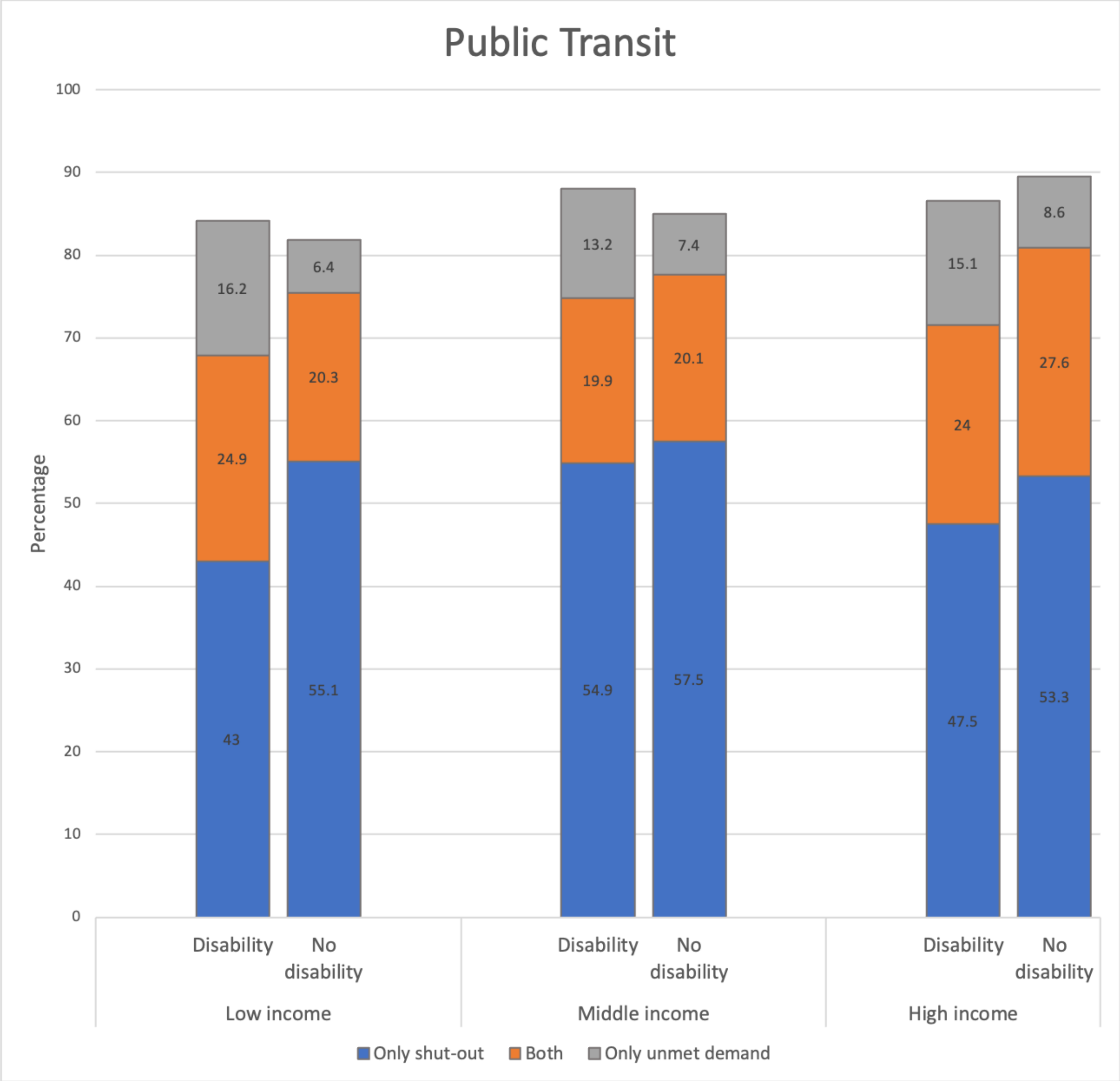
For private vehicular modes, as shown in Figure 2, the rates of being shut out without having unmet demand are 3-11% for people with disabilities and 2-9% for people without disabilities. The only significant difference by binary disability status controlling for income is that in the middle income bracket, people with disabilities are more likely than their peers without disabilities to be shut out of these modes and not have unmet demand for them. The only significant differences by income group controlling for disability status are that when considering people with disabilities, those in the highest income bracket are less likely than those in the lower two income brackets to be shut out of these modes and not have unmet demand for them, and when considering people without disabilities, those in the lower two income brackets are more likely than those at all correspondingly higher income brackets to be shut out of these modes and not have unmet demand for them. The survey allowed people who do not have driving licenses or who do not own or lease vehicles to mark whether they want to use corresponding modes at all (under the assumption that they currently never use those modes). Thus, the rates of having unmet demand without being shut out are 30-35% for people with disabilities and 15-30% for people without disabilities. The only significant differences by binary disability status controlling for income are that in the lowest and highest income brackets, people with disabilities are more likely than their peers without disabilities to have unmet demand for these modes and not be shut out of them. The only significant differences by income bracket controlling for disability status are that when considering people without disabilities, those in the highest income bracket are less likely than those in the lower two income brackets to have unmet demand for these modes and not be shut out of them. Finally, the rates of both being shut out of and having unmet demand for private vehicular modes are 10-20% for people with disabilities and 5-10% of people without disabilities, which can be considered the core priority group for policymaking. The only significant differences by binary disability status are that in the lowest and highest income brackets, people with disabilities are more likely to both be shut out of and have unmet demand for private vehicular modes than their peers without disabilities. The only significant differences by income bracket are that when separately considering people with and without disabilities, those in the lowest income bracket are more likely to both being shut out of and having unmet demand for private vehicular modes compared to their respective peers in the higher two income brackets.

Putting these rates together, the rates of being shut out, including those who do or do not have unmet demand, are 10-30% for people with disabilities and 5-20% for people without disabilities. All differences in these rates by binary disability status controlling for income and by income bracket controlling for binary disability status are significant. In particular, for every income bracket holding income fixed, people with disabilities are much more likely than their peers without disabilities to be shut out of private vehicular modes, and for both binary disability statuses holding that fixed, people in each income bracket are much more likely than their peers in any higher income bracket to be similarly shut out of private vehicular modes. The rates of having unmet demand, including those who are or are not shut out, are 40-55% for people with disabilities and 20-40% for people without disabilities. Once again, for every income bracket holding that fixed, people with disabilities are significantly more likely than people without disabilities to have unmet demand for private vehicular modes. When considering people without disabilities, people in each income bracket are much more likely than those in any higher income bracket to have unmet demand for private vehicular modes; this income effect is present but more muted for people with disabilities, as significant differences only exist when comparing people in the lowest versus the higher two income brackets. As the rates of only being shut out, only having unmet demand, and both all decrease with increasing income and when comparing people without disabilities to people with disabilities, the dominant influences on these trends are harder to intuitively tease out.

Public transit modes

Figure 3. Extent to which people with or without disabilities at different incomes are shut out of or have unmet demand for public transit modes.

For public transit modes, as shown in Figure 3, the rates of being shut out without having unmet demand are 45-55% for people with disabilities and 55-60% for people without disabilities. The only significant difference by binary disability status controlling for income is that in the lowest income bracket, people with disabilities are less likely than their peers without disabilities to be shut out of these modes without having unmet demand for them, which suggests a disproportionate dependence of people with disabilities at low income on public transit modes. There is no significant difference by income bracket controlling for binary disability status. The fact that majorities or near-majorities of people with each combination of disability status and income rarely or never use public transit modes and do not report unmet demand for them could indicate discouragement among people with or without disabilities due to problems with the active mode environment for first-/last-mile travel (as we showed when discussing active modes) or among people with disabilities due to problems with public transit service (such as those identified by Bezyak et al., 2017), suggesting possible avenues for policymaking to encourage public transit use. It could also simply reflect a preference to use other modes, given our analysis of the lower rates of being shut out of private vehicular modes. The rates of having unmet demand without being shut out are around 15% for people with disabilities and 7% for people without disabilities. These rates are all significantly higher for people with disabilities compared to people without disabilities in each income bracket, though no difference by income bracket controlling for binary disability status is significant. Finally, the rates of both being shut out and having unmet demand are 20-25% for people with and without disabilities. No difference by binary disability status controlling for income is significant. The only significant differences by income bracket controlling for binary disability status are that when considering people without disabilities, those in the highest



income bracket are more likely to both be shut out and have unmet demand for these modes than those in the lower two income brackets.

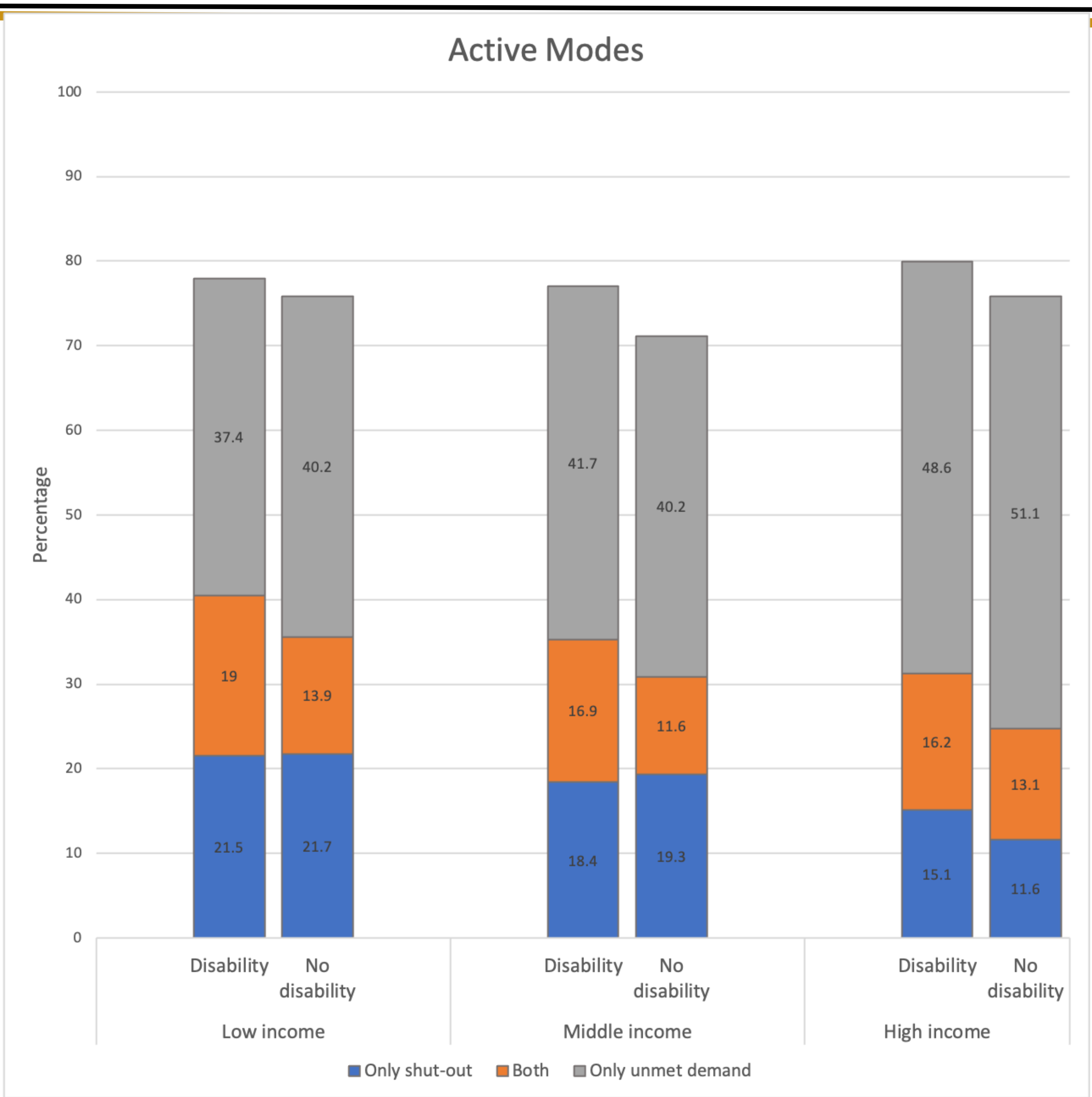
Putting these rates together, the rates of being shut out, including those who do or do not have unmet demand, are 65-75% for people with disabilities and 75-80% for people without disabilities. The only significant differences by binary disability status controlling for income are that in the lowest and highest income brackets, people with disabilities are less likely than their peers without disabilities to be shut out of public transit modes. No difference by income bracket controlling for disability status is significant. We emphasize that in contrast to the case of private vehicular or active modes, people with disabilities are much less likely than their peers without disabilities in the same income bracket to be shut out of public transit modes. This may reflect a greater dependence of people with disabilities on public transit modes due to problems experienced with other modes (though further correlations with specific disability subgroups will be the subject of future work) and conversely a greater dependence of people without disabilities on private vehicular modes, obviating the need for other modes (including public transit modes). Moreover, these differences are largely driven by differences in the portions of these subgroups who are shut out and do not have unmet demand.

The rates of having unmet demand, including those who are or are not shut out, are 35-40% for people with disabilities and 25-35% for people without disabilities. The only significant difference by binary disability status is in the lowest income bracket, where people with disabilities are more likely to have unmet demand than people without disabilities, and this is driven more by differences in the portions of these subgroups who are not shut out. There is no significant difference in these rates between income brackets among people with disabilities. The only significant differences between income brackets among people without disabilities are that people in the highest income bracket are more likely than people in the lower two income brackets to have unmet demand, and these are driven largely by differences in the portions of these subgroups who are shut out. The greater level of unmet demand among people without disabilities as income increases, being driven more by people who are shut out, may reflect a public-facing aspiration to use more socially idealistic or environmentally sustainable modes when one has the choice to do so even if one does not privately intend to do so, especially if such desires are unrealistic such as expecting fixed-route public transit to expand to effectively become point-to-point; in lower income brackets, such choices may be more constrained, and for people with disabilities, the greater dependence in the first place on public transit modes and potential consequent difficulties posed by public transit may weaken such idealistic attitudes. The higher level of unmet demand for public transit modes among people without disabilities in the highest income bracket being an arguably empty aspiration, driven by people who rarely or never use those modes, contrasts with the case of active modes (discussed further in the next subsection), where the increase in unmet demand in the same group is driven more by people who use active modes semi-regularly, while the rate of both being shut out of and having unmet demand for active modes is smaller and more stable across income brackets for people without disabilities.

Active modes

Figure 4. Extent to which people with or without disabilities at different incomes are shut out of or have unmet demand for active modes

For active modes, as shown in Figure 4, the rates of being shut out without having unmet demand are 15-20% for people with disabilities and 10-20% for people without disabilities. The survey allowed respondents who do not own bicycles or scooters to mark whether they want to use corresponding modes at all (under the assumption that they currently never use those modes). Thus, the rates of having unmet demand without being shut out are 35-50% for people with disabilities and 40-50% for people without disabilities. For both sets of rates, no difference by binary disability status controlling for income is significant. The only significant differences by income bracket controlling for disability status are that when considering people without disabilities, compared to those in the lower two income brackets, those in the highest income bracket are both less likely to be shut out of and not have unmet demand for these modes and more likely to have unmet demand for and not be shut out of these modes. This suggests that people without disabilities in the highest income bracket are less discouraged to use active modes, as they have more unmet demand for them and are more likely to use them at least semi-regularly than their peers in the lower two income brackets. Discouragement from using or wanting to use active modes could arise among people with or without disabilities due to generally a hostile travel environment for active mode users; for people with physical, vision, hearing, cognitive, or other disabilities, this could extend to barriers like broken sidewalks, lack of audible crossing indicators, obstructed lines of sight in crosswalks, and confusing intersection designs. Additionally, discouragement could indicate pain or fatigue among people with physical disabilities. The survey captures some of these correlations, so analyses of the extent to which extant differences are due to disability versus income will be the subject of future work. Finally, the rates of both being shut out of and having unmet demand for active modes are 15-20% for people with disabilities and 10-15% of people without



disabilities; this can be considered the core priority group for policymaking, though no difference by binary disability status or by income bracket is significant.

Putting these rates together, the rates of being shut out, including those who do or do not have unmet demand, are 30-40% for people with disabilities and 25-35% for people without disabilities. The rates of having unmet demand, including those who are or are not shut out, are 55-65% for people with disabilities and 50-65% for people without disabilities. No difference in these sets of rates by binary disability status controlling for income is significant. The only significant differences by income bracket controlling for binary disability status are when considering people without disabilities, those in the highest income are less likely to be shut out and more likely to have unmet demand than those in the lower two income brackets, and these differences are largely driven by differences in the portions of these subgroups who respectively are shut out and do not have unmet demand or have unmet demand and are not shut out.

Multinomial logistic regression to understand multimodal travel behavior involving public transit and possible substitutes

To estimate the extent to which people may exhibit multimodal travel behavior, we consider whether they use modes within each group above a certain frequency threshold (as we defined mode groups in the previous section). Broadly, we consider a specific pair of mode groups, which we may generically label group A and group B, and apply multinomial logistic regression, defining the dependent variable to belong to one of the following 4 categories which we parenthetically describe for ease of interpretation: the person uses at least one mode in group A at a frequency of at least the threshold but all modes in group B at frequencies below the threshold (traveling regularly predominantly using group A), the person uses at least one mode in group B at a frequency of at least the threshold but all modes in group A at frequencies below the threshold (traveling regularly predominantly using group B), the person uses at least one mode in group A at a frequency of at least the threshold and at least one mode in group B at a frequency of at least the threshold (traveling regularly in a multimodal way with respect to groups A and B), and the person uses at least all modes in group A at frequencies below the threshold and all modes in group B at frequencies below the threshold (traveling infrequently with respect to groups A and B). Multinomial logistic regression requires choosing a reference value for the dependent variable and thus produces coefficients for the logarithm of the ratio of the probability of the dependent variable taking on a different value to the probability of the dependent variable taking on the reference value; we choose the reference value to be traveling infrequently with respect to groups A and B, so any intuitive interpretation of results must account for the fact that the coefficients by themselves encode information about who is traveling frequently using at least one of these modes compared to who may generally be traveling infrequently. We recognize that our definition of multimodal travel is only an approximation, as the survey captures general frequencies of using different modes but does not capture mode use from specific trips or trip chains over the course of a day.

In the following analyses, we set the threshold to be once per week, such that regular use of a mode group corresponds to using at least one mode in that group at least once per week. We are especially interested in understanding the extent to which other modes may substitute for public transit, so we consistently set group A to be public transit modes. We show results for group B being private vehicular modes. We performed similar calculations for group B being for-hire modes, but we do not show those results because the generally low levels of use of for-hire modes meant that many of the coefficients showed unrealistically large magnitudes or unrealistically small relative errors, indicating that the maximum likelihood estimation procedure was unable to converge. We did not perform similar calculations for group B being active modes because we expect that active modes may more likely be used as complementary modes to public transit, suggesting the need for a different approach as the subject of future work.

We further note that with group A being public transit modes, the fact that the survey does not capture people without disabilities using paratransit buses, paratransit cars or vans, or NEMT, meaning that people without disabilities would be considered eligible to use only buses or trains, does not directly affect the procedure of determining the most-used public transit mode and corresponding frequency for a survey respondent. Thus, the results for people with and without disabilities are directly comparable. Additionally, as a note about formatting, we show results for models that exclude disability, include disability as a single binary independent variable, and include disability by form in separate tables for ease of reading (unlike our ordinal logistic regression results for individual modes).

Public transit and private vehicular modes

We consider the multinomial variable of using public transit modes versus private vehicular modes at a frequency at or above the threshold of once per week. We show the model results excluding disability in Table 50, including disability as a single binary independent variable in Table 51, and including disability by form in Table 52.

Relative to those who use private vehicular modes less than once per week and public transit modes less than once per week, people in the reference cases for all independent variables are significantly more likely to use private vehicular modes at least once per week but public transit modes less than once per week, meaning that frequent private vehicle use by itself is much more common than infrequent travel using these modes. This choice of the reference case for the dependent variable explains the positive coefficient corresponding to women, meaning that women are also much more likely to use private vehicular modes regularly without using public transit modes regularly than to more broadly travel infrequently. However, consistent with the ordinal logistic regression results that we have presented for driving one’s own vehicle, people with Asian or Pacific Islander racial identity by itself as well as people with Black or African American racial identity by itself are consistently less likely to to use private vehicular modes regularly without using public transit modes regularly than to more broadly travel infrequently, while the result that people with Native American racial identity by itself behave similarly only holds when disability is excluded, suggesting a positive correlation between Native American racial identity by itself and some forms of disability. Unlike the ordinal logistic regression results that we have presented for driving one’s own vehicle, these multinomial logistic regression results do not consistently show any significant effect of income or age on using private vehicular modes frequently while not using public transit modes frequently compared to not using either mode group frequently; this may be because those independent variables skew the distribution of driving one’s own vehicle toward lower frequencies, but not so much below the threshold of once per week. That said, similar to the ordinal logistic regression results that we have presented for driving one’s own vehicle, these multinomial logistic regression results consistently show that experiencing travel cost burdens as well as having a disability (whether captured as a single binary independent variable or in the specific forms of physical, vision, or other driving-preventing disabilities) are all factors that would in isolation make one more likely to not use either mode group frequently compared to using private vehicular modes but not public transit modes frequently.

Relative to those who use private vehicular modes less than once per week and public transit modes less than once per week, people in the reference cases for all independent variables are significantly less likely to use public transit modes at least once per week but use private vehicular modes less than once per week, meaning that frequent use mostly of public transit modes is much less common than infrequent travel using both of these mode groups. Most of the independent variables that have significant effects on the frequency of using various individual public transit modes do not have significant effects on the probability of this multinomial outcome because a very small percentage of people use public transit modes at least once per week, so most effects in the ordinal logistic regression on the probability distribution are for frequencies below once per week; for example, when each independent variable takes on its reference value, the probability of using buses at least once per week is only 0.02. The only exception is urban neighborhood type, which has a significant positive effect on the probability of predominantly using public transit modes and not private vehicular modes at least once per week compared to traveling infrequently using both of these mode groups. If a neighborhood is 100% urban according to the 2017 AHS, the effect size is comparable in magnitude and opposite in sign to the intercept, which means that people in 100% urban neighborhoods who are in the reference categories for all other independent variables are close to equally likely to use public transit modes and not private vehicular modes at least once per week as to travel infrequently using both of these mode groups; this is not the same as being more likely to travel using public transit modes than to infrequently travel at all, but it is a significant change from being much less likely to travel using public transit modes than to infrequently travel at all. Additionally, because of the probability distribution of using public transit modes generally skewing to much lower frequencies, disability does not have a consistent effect on this multinomial outcome; it has a small positive effect when included as a single independent binary variable but has no significant effect when included by form.

Relative to those who use private vehicular modes less than once per week and public transit modes less than once per week, people in the reference cases for all independent variables are significantly less likely to use private vehicular modes and public transit modes at least once per week, meaning that frequent multimodal travel using these modes is much less common than infrequent travel using these modes. That said, a handful of independent variables have statistically significant small effects on this probability. Women are even less likely to exhibit such frequent multimodal travel compared to infrequent travel using these modes, which is consistent with female gender identity (relative to male gender identity) having a negative correlation with the frequency of using buses and no correlation with the frequency of driving one's own vehicle. The probability distribution is still skewed, but slightly less so, toward infrequent travel using these modes compared to frequent multimodal travel using these modes for people in the youngest two age brackets; this is consistent with people in those age brackets being more likely than people in the oldest age bracket to use buses in particular and to travel in general, and the slightly lower likelihood of people in the youngest age bracket compared to the oldest age bracket to drive their own vehicles is overcompensated by the intercepts in the ordinal logistic regression results for driving one's own vehicle. Additionally, the probability distribution is still skewed, but slightly less so, toward infrequent travel using these modes compared to frequent multimodal travel using these modes for people who live in urban neighborhoods, which is consistent with the much greater relative use of buses among people who live in urban neighborhoods. Finally, the effects of disability are not consistent, as people with physical disabilities are even more likely to infrequently travel using these modes than to frequently multimodally travel using these modes, while for people with mental disabilities, the probability distribution is still skewed, but slightly less so, toward infrequent travel using these modes compared to frequent multimodal travel using these modes, and disability as a single independent binary variable has no significant effect on this multinomial outcome.

Including disability, whether as a single binary independent variable or by form, significantly improves the predictive power of the model, and including disability by form yields a further improvement compared to including disability as a single binary independent variable, as shown through the likelihood ratio test results in Table 53. This largely comes through the statistically significant effects, with effect sizes that are relatively large in magnitude, on the probability of frequently using private vehicular modes but not frequently using public transit modes, as that is by far the most likely multinomial outcome in this analysis.

Table 50. Multinomial logistic regression coefficients (given as 95% confidence intervals) for the probability of using at least one public transit mode at least once per week along with at least one private vehicular mode at least once per week (NS = not significant at a p-value threshold of 0.05) without including disability as a variable

Coefficient (base: uses no public transit mode at least once per week and no private vehicular mode at least once per week)	Uses no public transit mode at least once per week and at least one private vehicular mode at least once per week	Uses at least one public transit mode at least once per week and at least one private vehicular mode at least once per week	Uses at least one public transit mode at least once per week and no private vehicular mode at least once per week
Intercept	(0.76, 2.45)	(-6.16, -1.40)	(-5.95, -0.88)
Gender (base: male)			
Female	(0.05, 0.54)	(-0.96, -0.12)	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.63, -0.01)	NS	NS
Black or African American only	(-1.43, -0.42)	NS	NS
Native American only	(-1.43, -0.01)	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	(-0.70, -0.01)	NS	NS
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	NS	(1.15, 2.56)	NS
34-49	NS	(0.57, 1.93)	NS
50-65	NS	NS	NS

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(-1.14, -0.53)	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	(0.01, 4.43)	(0.43, 5.20)
Suburban	NS	NS	NS

Table 51. Multinomial logistic regression coefficients (given as 95% confidence intervals) for the probability of using at least one public transit mode at least once per week along with at least one private vehicular mode at least once per week (NS = not significant at a p-value threshold of 0.05) including disability as a single overall binary variable

Coefficient (base: uses no public transit mode at least once per week and no private vehicular mode at least once per week)	Uses no public transit mode at least once per week and at least one private vehicular mode at least once per week	Uses at least one public transit mode at least once per week and at least one private vehicular mode at least once per week	Uses at least one public transit mode at least once per week and no private vehicular mode at least once per week
Intercept	(1.02, 2.73)	(-6.25, -1.45)	(-6.29, -1.21)
Gender (base: male)			
Female	(0.07, 0.57)	(-0.95, -0.12)	NS
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.72, -0.08)	NS	NS
Black or African American only	(-1.41, -0.38)	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	NS	NS	NS
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	NS	(1.15, 2.57)	NS
34-49	(-0.64, -0.01)	(0.57, 1.94)	NS
50-65	NS	NS	NS

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(-1.01, -0.39)	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	(0.02, 4.45)	(0.52, 5.25)
Suburban	NS	NS	NS
Presence of disability	(-0.98, -0.48)	NS	(0.09, 1.09)

Table 52. Multinomial logistic regression coefficients (given as 95% confidence intervals) for the probability of using at least one public transit mode at least once per week along with at least one private vehicular mode at least once per week (NS = not significant at a p-value threshold of 0.05) including disability as a set of binary variables by type

Coefficient (base: uses no public transit mode at least once per week and no private vehicular mode at least once per week)	Uses no public transit mode at least once per week and at least one private vehicular mode at least once per week	Uses at least one public transit mode at least once per week and at least one private vehicular mode at least once per week	Uses at least one public transit mode at least once per week and no private vehicular mode at least once per week
Intercept	(0.95, 2.68)	(-6.47, -1.46)	(-5.84, -0.86)
Gender (base: male)			
Female	(0.03, 0.54)	(-0.92, -0.07)	(-1.01, -0.03)
Other	NS	NS	NS
Race (base: White or Caucasian only)			
Asian or Pacific Islander only	(-0.75, -0.11)	NS	NS
Black or African American only	(-1.33, -0.28)	NS	NS
Native American only	NS	NS	NS
Other racial identity only or two or more racial identities	NS	NS	NS
Annual household income (base: $100,000+)			
$0-49,999	NS	NS	NS
$50,000-99,999	NS	NS	NS
Age (base: 66+)			
18-33	NS	(0.81, 2.29)	NS
34-49	NS	(0.33, 1.74)	NS
50-65	NS	NS	NS

Region in California (base: SANDAG)			
SCAG	NS	NS	NS
CV	NS	NS	NS
SACOG	NS	NS	NS
ROC	NS	NS	NS
MTC	NS	NS	NS
Presence of travel cost burden	(-0.96, -0.33)	NS	NS
2017 American Housing Survey neighborhood type probability (base: 100% rural)			
Urban	NS	(0.19, 4.84)	(0.40, 5.01)
Suburban	NS	NS	NS
Presence of disability type			
Physical	(-0.87, -0.23)	(-1.19, -0.01)	NS
Vision	(-0.95, -0.18)	NS	NS
Hearing	NS	NS	NS
Cognitive	NS	NS	NS
Communication	NS	NS	NS
Mental	NS	(0.28, 1.33)	NS
Other that prevents driving	(0.29, 1.84)	NS	NS

Table 53. Likelihood ratio test results for models of probability of using at least one public transit mode at least once per week along with at least one private vehicular mode at least once per week, by treatment of disability variables

Model 1	Model 2	Likelihood ratio test p-value
Disability ignored	**Disability as single binary variable**	1.0 * 10^-13
Disability ignored	**Disability by type**	2.7 * 10^-14
Disability as single binary variable	**Disability by type**	1.7 * 10^-4

Discussion and Potential Implications for Research and Policy

The focus of this work was to show the need for including disability as an independent variable when studying transportation mode choices and the performance of activities outside of the home. We show in Table 54 the positive and negative effects that disability, whether considered as a single binary independent variables or as multiple binary independent variables by form, may have on the likelihood of a transportation-related binary variable being "true" (namely, whether one does not experience travel cost burdens, whether one owns a private vehicle, whether one has a driving license, and whether one ever leaves home, in which some of these are logically negated relative to how we have presented them in Tables 1-8 so that any of these variables being "true" is more likely to correspond to a lesser likelihood of experiencing burdens or being excluded from travel) or on the probability distribution of the frequencies of performing different activities outside of the home or using different transportation modes (in which a positive (negative) effect corresponds to the distribution skewing toward higher (lower) frequencies). We exclude paratransit buses, paratransit cars and vans, and NEMT from the list of transportation modes considered in this broader summary because of their restriction in the survey to people with disabilities.

Our analysis of the survey data suggests that people with physical disabilities consistently experience the most travel burdens. They are more likely to experience travel cost burdens, less likely to own a private vehicle, and less likely to have a driving license. They are also less likely to participate in many activities, to use private vehicular modes, and to use active modes. The only activity that they do at greater frequency is seeking medical care outside of the home, and this could be more related to medical conditions tied to the experience of physical disability, though the survey did not capture information related to the latter point. Additionally, the fact that people with physical disabilities are less likely than those without physical disabilities to use many modes but are not more likely than those without physical disabilities to use any other individual mode suggests that people with physical disabilities are less likely to travel overall. The effect sizes are consistently moderate in magnitude for people with disabilities upon all of these dependent variables, which is why, when disability is considered as a single binary independent variable, the dependent variables for which disability has a negative (with the exception of the absence of driving a relative's or friend's vehicle) or positive (with the exception of the presence of using buses, due to the contribution from people with mental disabilities) effect are all the same as for people with physical disabilities.

By contrast, people with most other forms of disability who are less likely to use a certain mode are more likely to use a different mode, which suggests a potential mitigation (compared to people with physical disabilities) of the effect that people with disabilities travel less overall. In particular, people with vision disabilities, compared to those without vision disabilities, are less likely to drive their own vehicles but are more likely to use taxi services. People with hearing disabilities are actually more likely to use trains and are not less likely to use any other mode than those without hearing disabilities, and they are more likely to have driving licenses (though they are not more likely to use any mode that involves driving a vehicle), suggesting that people with hearing disabilities may experience fewer travel burdens than people without hearing disabilities. People with cognitive disabilities are less likely than those without cognitive disabilities to use trains or their own bicycles but are more likely to ride as a passenger in a relative's or friend's vehicle; additionally, they are less likely to have driving licenses but not less likely to drive their own or a relative’s or friend’s vehicle than people without cognitive disabilities, suggesting that people with cognitive disabilities who have driving licenses are driving at a high enough frequency to compensate the difference with people with cognitive disabilities who do not have driving licenses. People with mental disabilities are less likely than those without mental disabilities to use their own vehicles as drivers or passengers but are more likely to use buses or TNC services. People with other driving-preventing disabilities are (consistent with the definition) less likely to drive their own vehicles but more likely to use taxi or TNC services. Finally, people with mental or other driving-preventing disabilities are more likely to experience travel cost burdens and get financial help (whether from government agencies or from relatives or friends) in that regard. We emphasize that people with these forms of disability could still travel less overall than people without disabilities, even with these alternative modes available, because the provider-view availability of these alternative modes, with geographic and time-based restrictions of use, will be less than that of driving one’s own vehicle.

These results are consistent with the idea that problems with private vehicles facing people with physical disabilities relate more to aspects of immediate usability tied to vehicle design (especially to accommodate people using wheelchairs), whereas people with disabilities who do not have physical disabilities may be more concerned with provider-view availability due to fewer concerns with immediate usability. That said, the fact that people with cognitive disabilities are less likely than those without cognitive disabilities to use trains or their own bicycles suggests a need for policymakers to improve aspects of train services, such as the comprehensibility of train station designs, train schedules, and train fares or payment options, for people with cognitive disabilities, and for improvements, perhaps including more protected bicycling infrastructure, for people with cognitive disabilities and others with or without disabilities in turn to feel safer when using their bicycles. Additionally, the fact that people with some forms of disability may use certain modes more often than those without such disabilities should not be used as an excuse for policymakers to ignore the needs of such people with disabilities using those modes; on the contrary, policymakers should continue to improve infrastructure and services for users of those modes to retain them. In particular, taxi services should adhere to standards of service in wayfinding (between the vehicle and the origin or destination), hailing, and fare payment for people with vision disabilities, train services should adhere to standards for real-time visual information provision for people with hearing disabilities, TNC and bus services should adhere to standards for minimizing anxiety or other potential triggers for people with mental disabilities, and government agencies may need to provide more financial support for relatives and friends giving rides to people with cognitive disabilities.

For people with disabilities apart from physical disabilities, those forms of disability have effects on fewer activities outside of the home. Only people with cognitive disabilities have a comparably broad set of activities as people with physical disabilities for which that form of disability is associated with lower frequency. People with communication disabilities are less likely to go to restaurants than those without communication disabilities, and people with hearing or other driving-preventing disabilities are less likely to do groceries as frequently as those without such disabilities. Additionally, people with mental disabilities, like people with physical disabilities, are more likely than those without such disabilities to seek medical care outside of the home, possibly because of the nature of some mental disabilities involving events that require acute care.

The survey allowed people to report multiple forms of disability. Each form of disability corresponded to at least 100 respondents, with the exceptions of communication and other driving-preventing disabilities (though each of those corresponded to at least 50 respondents). This could explain why communication disability does not seem to have an effect on many dependent variables from the survey. Additionally, multiple disabilities could have effects on individual dependent variables that add in a specific (either positive or negative) direction or cancel each other out.

Table 54. Effects of disability as a single binary independent variable or as multiple binary independent variables by form on relevant transportation-related binary dependent variables (with a positive effect meaning a higher likelihood of that binary dependent variable being “true” and a negative effect meaning a higher likelihood of that variable being “false”) and on the frequency of performing different activities outside of the home and using different transportation modes (excluding paratransit buses, paratransit cars and vans, and NEMT, all of which are restricted to people with disabilities

Disability	Positive effect on the following dependent variables	Negative effect on the following dependent variables
Present (binary)	Getting medical care, using buses	Not experiencing travel cost burdens, owning a private vehicle, having a driving license, visiting relatives or friends, doing groceries, going to restaurants, going to sports fields, going to concert halls, going to parks, going to bars, driving one’s own vehicle, riding as a passenger in one’s own

		vehicle, walking, using one's own bicycle
Physical	Getting medical care	Not experiencing travel cost burdens, owning a private vehicle, having a driving license, visiting relatives or friends, doing groceries, going to restaurants, going to sports fields, going to concert halls, going to parks, going to bars, driving one's own vehicle, riding as a passenger in one's own vehicle, driving a relative's or friend's vehicle, walking, using one's own bicycle
Vision	Using taxi services	Driving one's own vehicle
Hearing	Having a driving license, going to bars, using trains	Doing groceries
Cognitive	Riding as a passenger in a relative's or friend's vehicle	Having a driving license, visiting relatives or friends, going to restaurants, going to sports fields, going to concert halls, going to bars, using trains, using one's own bicycle
Communication	[NONE]	Going to restaurants
Mental	Getting medical care, using buses, using TNC services	Not experiencing travel cost burdens, driving one's own vehicle, riding as a passenger in one's own vehicle
Other that prevents driving	Using taxi services, using TNC services	Not experiencing travel cost burdens, having a driving license, doing groceries, driving one's own vehicle

That said, disability is not the only sociodemographic independent variable relevant to activity performance or transportation use. We show in Table 55 the positive and negative effects that other relevant sociodemographic independent variables may have on the likelihood of a transportation-related binary variable being "true" (namely, whether one does not experience travel cost burdens, whether one owns a private vehicle, whether one has a driving license, and whether one ever leaves home, in which some of these are logically negated relative to how we have presented them in Tables 1-8 so that any of these variables being "true" is more likely to correspond to a lesser likelihood of experiencing burdens or being excluded from travel) or on the probability distribution of the frequencies of performing different activities outside of the home or using different transportation modes (in which a positive (negative) effect corresponds to the distribution skewing toward higher (lower) frequencies). We specifically consider female gender identity, Asian or Pacific Islander identity by itself, Black or African American identity by itself, the lowest income bracket, experiencing travel cost burdens, urban neighborhood type, and suburban neighborhood type as the independent variables of interest, as these constitute an almost complete list of the independent variables that consistently have significant effects on the dependent variables of interest. We exclude paratransit buses, paratransit cars and vans, and NEMT from the list of transportation modes considered in this broader summary because of their restriction in the survey to people with disabilities. These results have the following notable features.

First, women, compared to men, seem to be consistently more likely to use modes where they are with people, namely relatives and friends, whom they can trust, and are less likely to use modes that expose them to strangers, including public transit modes, for-hire modes, and active modes, though the survey does not capture reasons for not using specific modes. Additionally, they seem to be consistently less likely to go to activity places that are stereotypically dominated by men in either number or group hierarchy, including places of worship, sports fields, and bars; the survey captures problems that people may have with different activity places, so analyzing the extent to which women may have more concerns about safety in these activity places will be the subject of future work.

Second, people with Asian or Pacific Islander racial identity by itself are more likely than those with White or Caucasian racial identity by itself to never leave home (although this is arguably an extreme situation), they are also less likely to participate in a variety of activities outside of the home (especially social activities apart from work), and they are less likely to use any mode other than public transit modes or driving their own vehicles. As it is rare for anyone to never leave home, once that aspect is discounted, these results suggest that people with Asian or Pacific Islander racial identity are more likely to travel only for work or school (though we leave the analysis of those results for future work and did not present them in this report because of the issue of controlling for employment or current school enrollment status) by driving their own vehicles or using public transit and not for other things (apart from doing groceries).

Third, people with Black or African American racial identity by itself are less likely than people with White or Caucasian racial identity by itself to drive their own vehicles or have the prerequisites to that mode (namely, owning a private vehicle or having a driving license). They are more likely to use public transit and for-hire modes instead. As we control for income, these mode choices are less likely to be income effects. Additionally, they are more likely to go to places of worship as well as concert halls.

Fourth, the fact that more modes are negatively affected in frequency of use by the lowest income bracket than by experiencing travel cost burdens adds credence to the idea that the lowest income bracket is not perfectly correlated with the experience of travel cost burdens; additionally, as we control for disability in 2 of the 3 models that we consider for each activity, mode, and transportation-related binary independent variable, these results cannot be purely ascribed to the correlation with disability. That said, driving one's own vehicle as well as having the prerequisites to that mode (namely, owning a private vehicle or having a driving license) are all less likely for people in the lowest income bracket as well as for people who experience travel cost burdens. Strangely, despite the lower rate of private vehicle ownership among people in these groups, people who experience travel cost burdens are somehow more likely to ride as passengers in their own vehicles, even as people in the lowest income bracket are less likely to ride as passengers in their own vehicles; perhaps people who experience travel cost burdens whose households can afford their own vehicles are more likely to ride in them more often, and this could be related to the possibility that some people who experience travel cost burdens have low individual incomes within high household incomes and therefore personally need financial assistance for transportation.

Fifth, urban and suburban neighborhoods are not associated with a lesser likelihood of observing any relevant dependent variable. Living in an urban neighborhood makes people more likely to use public transit modes, use for-hire modes, walk, and ride as a passenger in a relative's or friend's vehicle, likely because the greater density of urban neighborhoods allows for a greater spatial and temporal availability of those options. That said, suburban neighborhoods, compared to rural neighborhoods, also make people more likely to use TNC services, walk, and ow a private vehicle (though not necessarily drive or ride as a passenger in one’s own private vehicle); we find it difficult to explain the last of these results unless rural respondents to the survey were disproportionately in the lowest income bracket, and we leave that analysis to future work. Additionally, urban and suburban neighborhoods are more amenable to certain developed activity places, like concert halls, sports fields, parks, and bars, compared to rural neighborhoods.

We emphasize that these independent variables, taken together with each other and with independent variables related to disability, could have effects on individual dependent variables that add in a specific (either positive or negative) direction or cancel each other out. We have applied discrete choice models to the survey data in which the models also include cross terms involving disability and other sociodemographic variables but have found no significant improvement in the predictive power of those models, which is why we do not show the results for those models.

Table 55. Effects of other relevant sociodemographic independent variables apart from disability on relevant transportation-related binary dependent variables (with a positive effect meaning a higher likelihood of that binary dependent variable being “true” and a negative effect meaning a higher likelihood of that variable being “false”) and on the frequency of performing different activities outside of the home and using different transportation modes (excluding paratransit buses, paratransit cars and vans, and NEMT, all of which are restricted to people with disabilities

Relevant sociodemographic independent variable apart from disability	**Positive effect on the following dependent variables**	**Negative effect on the following dependent variables**

Female gender identity	Riding as a passenger in one's own vehicle, riding as a passenger in a relative's or friend's vehicle	Not experiencing travel cost burdens, going to places of worship, going to sports fields, going to bars, using buses, using trains, driving a relative's or friend's vehicle, using taxi services, using TNC services, walking, using one's own bicycle
Asian or Pacific Islander racial identity by itself	[NONE]	Ever leaving home, visiting relatives or friends, getting medical care, going to sports fields, going to concert halls, going to parks, going to bars, riding as a passenger in one's own vehicle, driving a relative's or friend's vehicle, riding as a passenger in a relative's or friend's vehicle, using taxi services, using TNC services, walking, using one's own bicycle
Black or African American racial identity by itself	Going to places of worship, going to concert halls, using buses, using trains, using taxi services, using TNC services	Owning a private vehicle, having a driving license, driving one's own vehicle
Lowest income bracket	[NONE]	Owning a private vehicle, having a driving license, visiting people, doing groceries, going to restaurants, going to sports fields, going to concert halls, going to parks, going to bars, using trains, driving one's own vehicle, riding as a passenger in one's own vehicle, driving a relative's or friend's vehicle, using TNC services, walking, using one's own bicycle
Travel cost burdens	Riding as a passenger in one's own vehicle	Owning a private vehicle, having a driving license, doing groceries, going to restaurants,

		going to bars, driving one's own vehicle
Urban neighborhood	Going to concert halls, going to bars, using buses, using trains, riding as a passenger in a relative's or friend's vehicle, using taxi services, using TNC services, walking	[NONE]
Suburban neighborhood	Owning a private vehicle, going to sports fields, going to concert halls, going to parks, using TNC services, walking	[NONE]

Although many of the independent variables that we have considered have statistically significant effects on many of the dependent variables that we have considered, many of the effect sizes are have small magnitudes. To understand the most notable effect sizes, we consider dependent variables which are rare. In the case of transportation-related binary independent variables, this means that the probability of that variable being "true" as written is less than 0.10. In the case of the probability distribution of the frequency of performing various activities or using various transportation modes, this means that the probability of that activity being done or mode being used at least once per month is less than 0.10. We show in Table 56 independent variables that, in isolation, make the corresponding dependent variables no longer rare.

All of the prerequisites to transportation are not rare, meaning that their respective logical complements, namely, experiencing travel cost burdens, not owning a private vehicle, not having a driving license, and never leaving home, are all rare. However, disability as a single binary independent variable makes experiencing travel cost burdens as well as not owning a private vehicle no longer rare. Having another driving-preventing disability makes experiencing travel cost burdens as well as not having a driving license no longer rare. Having a mental disability makes experiencing travel cost burdens no longer rare, and having a physical disability makes not owning a private vehicle no longer rare. Apart from disability, men rarely experience travel cost burdens, but this is not the case for women. Additionally, it is rare for people with White or Caucasian racial identity by itself, for people in the highest income bracket, and for people who do not experience travel cost burdens to not own a private vehicle, but this is not the case for people with Black or African American racial identity by itself, for people in the lowest income bracket, and for people who experience travel cost burdens.

Going to sports fields, going to concert halls, and going to bars are generally rare activities. However, living in urban or suburban neighborhoods, depending on the activity, can make this less rare. Additionally, people with Black or African American racial identity by itself make going to the bar less of a rare activity.

Using buses, using trains, driving a relative's or friend's vehicle, using taxi services, and using TNC services are generally rarely-used modes. However, living in urban neighborhoods can make using public transit modes as well as using TNC services less rare, and living in suburban neighborhoods can also make using TNC services less rare.

We only considered independent variables that, in isolation, might flip the likelihood of a transportation-related binary independent variable or the frequency of using a mode or performing an activity from being rare to being no longer rare. There may be combinations of many independent variables that could produce the same flip even if those independent variables cannot produce that flip in isolation.

Table 56. Dependent variables, when all independent variables take on their reference values, whose intercepts are such that they are rare (meaning that the probability of a transportation-related binary independent variable being “true” as written in this table is less than or equal to 0.10 and the probability of performing a certain activity or using a certain transportation mode less than once per month or never is less than or equal to 0.10), and independent variables which can make those dependent variables not rare (pushing the corresponding probabilities above 0.10)

Rare dependent variable	Relevant independent variables that could make dependent variable less rare
Experiencing travel cost burdens	Female gender identity, disability (single binary independent variable), mental disability, other driving-preventing disability
Not owning a private vehicle	Black or African American racial identity by itself, lowest income bracket, experiencing travel cost burdens, disability (single binary independent variable), physical disability
Not having a driving license	Other driving-preventing disability
Never leaving home	[NONE]
Going to sports fields	Suburban neighborhood
Going to concert halls	Black or African American racial identity by itself, urban neighborhood, suburban neighborhood
Going to bars	Urban neighborhood, hearing disability
Using buses	Urban neighborhood
Using trains	Urban neighborhood
Driving a relative’s or friend’s vehicle	[NONE]
Using taxi services	[NONE]

Using TNC services	Urban neighborhood, suburban neighborhood

It is also possible to similarly consider the likelihoods of transportation-related binary independent variables, the usage of different transportation modes, or the performance of different activities, that are not rare but flip to being rare because of specific independent variables in isolation. We do not show this in a table because the vast majority of such dependent variables do not show such a flip with any independent variable in isolation. The only exceptions are that riding in a relative's or friend's vehicle, which is not rare, becomes rare for people with Asian or Pacific Islander racial identity by itself, and that using one's own bicycle, which is not rare, becomes rare for people in the lowest income bracket as well as for people with disabilities. Essentially, for most dependent variables that are not rare in the reference case, the size of a negative effect from a corresponding independent variable is too small, even if statistically significant, to qualitatively flip that dependent variable into being rare. That said, it may be possible for combinations of multiple independent variables to flip a dependent variable from being not rare to being rare.

In addition to our discrete choice modeling results showing the effects of disability, income, and other relevant independent variables on the frequency of performing different activities outside of the home and using different transportation modes, our descriptive statistical analyses show the effects of disability and income on the desires to perform different groups of activities or use different groups of modes more than currently (or at all if currently not). These results are summarized as follows.

Around 40% of people with disabilities and 30-35% of people without disabilities want to perform at least 2 basic activities more often than they currently do, and differences in these rates between people with versus without disabilities are significant in the middle and highest income brackets. This means that people with disabilities, who tend to travel less often using many modes than people without disabilities, are not performing these activities in the home or in alternative ways that would satisfy them, and they are not satisfied with their current rates of performing those activities outside of the home (which are lower than for people without disabilities). Applying discrete choice modeling to the results about desires to perform various activities will be the subject of future work. The survey asked respondents about problems that they have being in different activity places (but not about problems with getting to or from those places), so analyzing the extent to which lesser rates of performing these activities can be explained by experiencing such problems will also be the subject of future work. Additionally, the survey asked respondents about whether they want different activity places to be closer to or farther from where they live (or if they want the distance to remain unchanged or if they are indifferent to changes in distance), what problems they feel those places bring if they want those places to be farther away, and what benefits they feel those places bring if they want those places to be closer; analyzing the correlation of these desired changes in distance and of problems or benefits with these activity places with the frequency of doing the corresponding activity along with the other geographic and sociodemographic variables considered in this report will be the subject of future work.

Around 40-55% of people with disabilities and 20-40% of people without disabilities want to use private vehicular modes more often than they currently do, and differences in these rates between people with versus without disabilities are significant in all income brackets. This means that people with disabilities, who use private vehicular modes less often than people without disabilities, are also more likely to be unsatisfied with their usage of private vehicular modes compared to people without disabilities. Around 55-65% of people with disabilities and 50-65% of people without disabilities want to use active modes more often than they currently do, but no difference in these sets of rates by between people with versus without disabilities is significant in any income bracket. Around 35-40% of people with disabilities and 25-35% of people without disabilities want to use public transit modes more often than they currently do, but the only significant difference by binary disability status is in the lowest income bracket, where people with disabilities are more likely to have unmet demand than people without disabilities; this may be more suggestive of differences in the service patterns of specific routes or in first-/last-mile connectivity for specific stops than of needs for improvements to general vehicles or information provision, though the survey does not capture enough information to test these hypotheses.

Taken together, these results paint the following picture. Private vehicle use, specifically driving one's own vehicle, is the dominant mode in California; many people also walk somewhat regularly, but the use of most other modes is generally quite marginal in comparison to driving one's own vehicle. In the context of such a car-oriented transportation landscape, people with disabilities, mostly but not exclusively involving people with physical disabilities likely due to the rarity and expense of private vehicles modified to accommodate wheelchairs, are less likely to own a private vehicle or have a driving license and are more likely to need financial assistance for transportation. They are less likely to travel for a variety of activities outside of the home, and though people with disabilities other than physical disabilities can mitigate transportation challenges to some degree by using other modes, this mitigation is not perfect, while people with physical disabilities struggle to find workable alternative modes and ultimately travel less overall. That said, performing activities outside of the home at a lower frequency is not the same as being permanently stuck at home; the latter is an extreme case that is not representative of the experiences of most people with or without disabilities. Additionally, people with disabilities very rarely use paratransit modes, including paratransit buses, paratransit cars or vans, and NEMT, that only they are eligible to use, and most people with disabilities rarely use public transit modes, including buses and trains, which people without disabilities are also eligible to use; instead, many people with disabilities use taxi or TNC services to travel even if they cannot drive at all or do not own their own vehicles. These effects hold after controlling for other sociodemographic and geographic variables, including neighborhood type, region in California, racial identity, gender identity, household income, and age.

Consistently, more than 25% of people with and without disabilities want to use private vehicular modes, active modes, and public transit modes more than they currently do; these percentages for people with and without disabilities controlling for income are similar in magnitude (though they show statistically significant differences by binary disability status for some income brackets in the cases of private vehicular modes and public transit modes). This suggests that improvements to public transit and active mode infrastructure and operations that benefit people with and without disabilities, as well as financial or technical support for people with disabilities to own their own private vehicles if they need such vehicles, can contribute to satisfying such unmet demand for people with and without disabilities. Additionally, consistently, more than 30% of people with and without disabilities want to perform basic activities more than they currently do, and higher income reduces unmet demand among people without disabilities but not among people with disabilities, which is consistent with transportation problems or problems with activity places particular to people with disabilities potentially persisting irrespective of income.

Limitations

The survey has several limitations that may hinder easy interpretation when analyzing its data. These are as follows.

The survey was administered in 2022 between April and July. During this time, the covid pandemic was still extant in the US. Because a few potential respondents asked how to answer various questions in this context, the survey clarified that questions about travel and activity performance should be answered according to the respondent's behavior in the second half of 2021 (July through December), when vaccines had become widely available in the US, case counts and hospitalizations were much lower, lockdown orders had ended, and many common in-person group activities had resumed. However, the continuation of the pandemic in the US through 2022 may still confound the data. This is especially important if it means that the frequencies with which people with or without disabilities perform many activities or use many modes are artificially lower and more similar to each other than they would have been in 2019 (before the pandemic in the US) or they would be now (after the pandemic in the US).

The survey was administered only online and only in English. This means that data collection disproportionately missed people who do not have Internet access and people who do not speak English, who constitute nontrivial fractions of the population of California.

The survey did not allow people without disabilities to respond to any questions about paratransit modes, namely, paratransit buses, paratransit cars and vans, and NEMT. This means that the survey fails to capture the travel and associated needs of many caregivers for people with disabilities. This is related to the broader omission in the survey of questions about the extent to which respondents may accompany others for those people's trips or may be accompanied for their own trips by other people, along with the reasons for accompaniment. The latter will be the subject of future work.

The survey did not allow people without driving licenses to answer questions about driving their own vehicles, driving relatives' or friends' vehicles, or driving carsharing vehicles. This meant that data collection would fail to capture the driving experiences of those without driving licenses, including many undocumented migrants in California.

Although the survey did not allow people without driving licenses to answer questions about driving their own vehicles, driving relatives' or friends' vehicles, or driving carsharing vehicles, and it did not allow people who do not own vehicles to answer questions about driving or riding as passengers in their own vehicles, the survey did not capture whether people have bus, train, paratransit, taxi, TNC, carsharing, bikesharing, or scooter-sharing services available in their neighborhoods or metropolitan areas and did not prevent people living in places where those services are not available from answering questions about those services. This may confound results about never using those modes, as there is a policy distinction between people never using a mode because it is not available where they live versus because they choose to not use that mode even if it is available where they live. Furthermore, of note to people with disabilities, the survey did not capture problems that people may experience with specific modes, making it harder to interpret reasons for low usage frequencies of certain modes.

Although the survey captured the extent to which people may wish to do various activities and use various modes more or less often than they currently do, it did not capture the reasons for such changes in frequency. This could pose problems for interpreting analyses of these desires, especially if repeated discouragement from performing certain activities or using certain modes leads respondents to report not wanting to perform such activities or use such modes more often than they currently do (implying that the survey data systematically underestimates unmet demand for activities and modes). Additionally, in some cases, problems with specific modes can reduce activity performance, and problems with specific activity places can reduce travel overall, so future analyses must account for the possibility of endogeneity in this context.

The survey did not capture additional information about seeking medical care outside of the home, making the interpretation of the frequencies and desires to seek medical care outside of the home harder. In particular, we expect that people may generally be less likely to report wanting to seek medical care more often than they currently do because of the implication that they would only do so if they experienced more severe or more frequent health problems. This may obscure the extent to which people who currently experience frequent or severe health problems may feel like they are not able to get medical care as often as they need.

Next steps

The survey captured many other independent variables that we have not included in the analyses in this report. These include generally needing help with getting around inside of the home, generally needing help with getting around outside of the home, housing type or homeless status, presence of others in the household, employment or student status, experiencing housing cost burdens (analogous to travel cost burdens), LGBTQ+ identity, number of years lived in the US, having lived in the US for at least 5 years during childhood, and type of the neighborhood where the respondent grew up. Many of these independent variables, especially the presence of others in the household, can shed light on modes that require a relative or friend to drive (the respondent’s own vehicle, another private vehicle, or a carsharing vehicle) and on any seemingly discrepant results involving the lowest income bracket and experiencing travel cost burdens (due to the difference between individual income versus household income).

Even some of the independent variables that we have considered in the analyses for this report could depend on other independent variables that we also considered for this report. It will therefore be useful to analyze correlations among those variables and characterize the extent to which these independent variables may be collinear. In particular, it will be useful to understand the racial, income, geographic, neighborhood type, gender, and age distributions of people with and without disabilities in the survey sample. For example, as women, just like people with disabilities, in the sample are more likely to experience travel cost burdens and less likely to perform certain activities or use certain modes, it would be useful to understand whether this might be because people with disabilities are overrepresented among women in the survey sample.

Most importantly, future analyses will make use of the survey having captured desires to perform various activities more often than currently, use various modes more often than currently, and have various activity places closer to where the respondent currently lives. We anticipate applying discrete choice modeling techniques for these dependent variables in which, in the cases of activity performance and mode usage (but not activity location), in addition to the independent variables that we have considered along with some of the aforementioned additional independent variables, we include the actual frequency of performing that corresponding activity or using that corresponding mode as an independent variable. This will help policymakers understand the extent of and develop strategies to meet currently unmet demand for activities or modes among people with or without disabilities after controlling for actual frequencies of performance or use as well as for other relevant independent variables. Additionally, results about desired changes to activity locations will help policymakers understand the extent to which people may or may not want more dense mixed-use developments that can affect mode availability, people’s mode usage patterns, and people’s activity performance patterns. It may be even more interesting to see how activity frequencies, desired changes to activity frequencies, mode usage frequencies, desired changes to mode usage frequencies, neighborhood types, and desired changes to activity locations may all affect each other and be affected by sociodemographic independent variables (including those related to disability), but we again emphasize the need to conduct such analyses carefully accounting for endogeneity.

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Data Management Plan

Products of Research

The study uses data collected for “Cross-sectional study of the effects of disability on the mismatch of desires versus choices for transportation modes and residential location”. The link from the uploaded database for that data for that project in Dryad is attached here.

Data Format and Content

The survey data file is in the CSV format.

Data Access and Sharing

The data can be accessed on Dryad using the DOI https://doi.org/10.25338/B8RP9M. The files are significantly redacted. Users must contact the authors of this report for more detailed data.

Reuse and Redistribution

The data files are public domain. Third party users should cite the work and send an email to Giovanni Circella (gcircella@ucdavis.edu) to inform about the use of the data. The data may be cited as follows:

Venkataram, Prashanth; Circella, Giovanni; Bhuiya, Md Musfiqur Rahman, Flynn, Justin (2023). Disability, Transportation, Activity Performance, and Neighborhood Features in California: Analyzing Data from a Survey [Dataset]. Dryad. https://doi.org/10.25338/B8RP9M