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The Travel Behavior of People with Disabilities in the Era of Ridehailing

By

Abigail L Cochran

A dissertation submitted in partial satisfaction of the

requirement for the degree of

Doctor of Philosophy

in

City and Regional Planning

in the

Graduate Division

of the

University of California, Berkeley

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Summer 2020

The Travel Behavior of People with Disabilities in the Era of Ridehailing

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Abstract

The Travel Behavior of People with Disabilities in the Era of Ridehailing

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Abigail L Cochran

Doctor of Philosophy in City and Regional Planning

University of California, Berkeley

Associate Professor Daniel Chatman, Chair

People with disabilities use app-based ridehailing services, like Uber and Lyft, much less than the general population. In this research, I investigate why this may be the case, and otherwise explicate the travel behavior of people with disabilities in the era of ridehailing. Understanding the travel behavior of underrepresented groups is important for crafting nuanced, effective policies that serve the interests of a diverse public. I contribute to the empirical and theoretical literature on the role of disability in travel behavior and associated phenomena, including health, and address policy implications for professionals tasked with ensuring that transportation systems are accessible to people with disabilities.

The dissertation is structured as follows: First, in Chapters 1 and 2, respectively, I introduce my research and review relevant literature on disability and transportation in contemporary contexts. I then present three chapters documenting original studies in which I answer specific research questions related to the travel behavior of people with disabilities in the era of ridehailing. I conclude the dissertation by drawing implications from my findings for policy and planning practice looking ahead, and by offering future directions for research.

In Chapter 3, I investigate trends in the travel behavior of people with disabilities, specifically their use of conventional taxicabs and app-based ridehailing, using data from the 2017 U.S. National Household Travel Survey. I find that people with disabilities use app-based ridehailing at a much lower rate than the rest of the population. This is partly because people with disabilities are older, have lower incomes, and live less in larger cities. But even when controlling for these factors, having a disability predicts lower app-based ridehailing use, suggesting these new services may not be sufficiently accessible to people with disabilities.

How and why are people with disabilities using app-based ridehailing? I answer this question in Chapter 4. Using data from 32 in-depth interviews that I conducted with San Francisco Bay Area residents with disabilities, I explore what factors enable and hinder people with disabilities' transportation use. I find that attitudes towards and use of app-based ridehailing

services depends on respondents' prior experience using transportation and smartphones. Older adults and those who acquired disabilities later in life had difficulty using ridehailing because of perceived and experienced challenges hailing a ride using an app, finding the vehicle, and getting to their destination independently. Younger adults and those who had lived with their disabilities longer perceived ridehailing to be reliable and convenient, and found it relatively more affordable than conventional taxis. This was also true among respondents who used motorized wheelchairs, but they said that the availability and quality of wheelchair-accessible ridehailing services are presently lacking.

In Chapter 5, I again draw from my interview data to examine how people's experiences socializing while using transportation affect their travel behavior and health. I find that respondents' experiences interacting with others in transit influenced determinants of health including self-efficacy, stress, and perceived social isolation and connectedness. I also find that people with disabilities may change their travel behavior in response to feelings about transportation-related social interaction. Individuals with low transportation self-efficacy or who have experienced stressful interactions may limit travel. This might pose a health risk by contributing to feelings of perceived isolation. Difficulties completing transportation-related social tasks and related health consequences may be especially pronounced among individuals who acquired disabilities relatively recently and/or in old age. Individuals with high transportation self-efficacy or who feel socially connected while traveling may travel more. This might promote health.

I conclude the dissertation in Chapter 6 by explaining how my results can inform planning for disability accessibility in the era of ridehailing and beyond. Specifically, I describe what my findings suggest for the development of accessible ridehailing policies and partnerships. I outline broader issues in accessible transportation planning that emerged from my research as well as implications of these issues for policymakers and planners. These matters include meeting the needs of older adults—those over age 65—with disabilities, and providing accessible transportation in the wake of the COVID-19 pandemic. I suggest future directions for research on the travel behavior of people with disabilities in contemporary contexts, and finally, summarize my findings on the ridehailing use of people with disabilities and call on researchers, policymakers, and practitioners to seek greater understanding of barriers and facilitators to using transportation among people with disabilities.

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Chapter 1. Introduction

Being able to move freely around cities is fundamentally important for participating in society. This explains why fighting for equal access to transportation has been and remains central to the struggle for civil rights for people with disabilities in the United States (Shapiro 1994). In 1969, a group of students with disabilities at the University of California, Berkeley, successfully lobbied the City Council to renovate the area around campus to include more curb cuts—small, sloping ramps connecting streets and sidewalks. This, they argued, would make the area more accessible to people using wheelchairs and many others. In the years that followed, long before such “accessible” design features would be required by law, over one hundred new curb cuts were built around Berkeley, paving the way for the first planned, wheelchair-accessible pedestrian route in the country (Williamson 2012).

The development of transportation policy for people with disabilities during the last half-century has been a fraught process, riddled with debate regarding the best method for offering services in a nondiscriminatory manner. The primary argument stemmed from whether to take a “rights-oriented” or “effective mobility” approach (Katzmann 1986). A rights-oriented approach would have required all public transportation be made accessible to people with disabilities. An effectively mobility approach encouraged supplementing transit with special paratransit services for people with disabilities, thus promoting transportation access among this population while saving costs on retrofitting existing services. The Americans with Disabilities Act of 1990 (ADA) primarily follows the “effective mobility” approach. While it mandates that public transportation be made accessible at some level to people with disabilities, it also requires that complementary paratransit services be provided to transport passengers who cannot use fixed-route services.

In many ways, this debate reflected broader arguments in planning theory about what is required to work in the interest of a diverse public. In the interwar and postwar eras, dominant traditions of planning relied on “scientific” and “rational” approaches to identify and solve urban problems (Friedmann 1987). The public was something to be managed by expert technicians who relied on objective analyses to make decisions. As authors began to question singular notions of rationality and objectivity, theories of planning became more concerned with how to plan in political contexts. Recognizing the need for those involved in urban decisionmaking to understand and balance competing interests, theorists writing in the 1960s advanced notions that planners should shift their role and serve as public advisors. They encouraged planners and policymakers to engage with the democratic process, and to act as advocates for “plural,” contentious decisionmaking processes (Davidoff 1965). Authors of this period stressed the accountability of urban professionals to the communities that they served, elevating individuals, rather than monolithic populations, as the appropriate objects of planning.

The pluralistic planning tradition charted a course for more modern approaches that stress the importance of active public participation in the planning process, and recognition of the diversity and heterogeneity of stakeholder groups. Sandercock (2004) implored 21st century

planners to think critically about “for whom and for what to work” (135). Calling on practitioners to be politically tactful and reflective about their methods, Sandercock argued that as a discipline concerned with social outcomes, planners ought to think more about evaluating successes based on how well planning serves diverse social interests. This idea resonates with contemporary philosophies about planning for equity and social justice (see Fainstein 2010), as it positions uneven distribution of the benefits and burdens of planning across sociodemographic groups as a central issue.

While early debates about transportation policy for people with disabilities were progressive in the sense that they recognized people with disabilities as a stakeholder group that had unmet needs and deserved attention, these arguments highlight an important and persistent challenge of planning: balancing concerns about equity and economy. A rights-oriented approach prioritized mitigating transportation disparities between people with and without disabilities at all costs. Considering these costs, however, policymakers embraced an effective mobility approach, which is arguably less equitable.

Although the ADA and other disability rights laws have done much to make transportation and the environment at large more accessible to people with disabilities, this group continues to demonstrate persistent disadvantages in social, economic, and health outcomes. According to recent estimates from the U.S. Census Bureau, over 40.6 million American adults live with one or multiple disabilities. People with disabilities are significantly less likely to be employed, more likely to be impoverished, earn less, and respond more sensitively to economic conditions that might exacerbate joblessness than others (Lubin 2012). Individuals with a disability travel less than people without disabilities, and often express a desire to travel more than they do (BTS 2003; Mattson et al. 2010). A lack of access to adequate transportation is a known barrier to employment and participation in many social and community activities by people with disabilities (Bascom and Christensen 2017; Loprest and Maag 2001). Limited transportation has been shown to exacerbate health disparities observed between people with and without disabilities (Krahn et al. 2015).

Transportation issues aggravate a myriad of problems facing people with disabilities and other “mobility have-nots”—groups of individuals that have fewer opportunities to travel than others (Brown and Taylor 2018). Such individuals differ systematically from “mobility haves” by income, race, ethnicity, physical ability, and home location. Car ownership is a major driver of mobility inequities in the United States. Most people in the U.S. travel by car regardless of disability status, though people with disabilities travel by private vehicles for a smaller share of trips than people without disabilities (Brumbaugh 2018). Data from the 2017 United States National Household Travel Survey (NHTS) show that people with disabilities are nearly four times as likely to live in zero-vehicle households than people without disabilities. When traveling by car, people with disabilities take a greater share of trips as passengers, rather than as drivers (Brumbaugh 2018).

People without reliable access to a car have been historically forced to rely more on public transportation and taxicabs to get around. Taxis are disproportionately used by very-low-income

and carless travelers, as well as travelers with disabilities (Brown and Taylor 2018; NCD 2005). However, taxis are a relatively high-cost option, and are not available everywhere (Brown and Taylor 2018). Where taxi services are available, they can be unreliable (Smart et al. 2015). Furthermore, taxi services have historically neglected to provide service in low-income neighborhoods, and have demonstrated discrimination against black riders (Brown 2019a; Brown 2019b). Journalists and others have widely reported on taxi discrimination against riders using wheelchairs or traveling with a service animal, suggesting discrimination in the taxi industry extends to some riders with disabilities (Magestretti 2019; NCD 2005, 2015).

Despite these issues, people with disabilities continue to use taxis for a greater share of daily trips than people without disabilities (Brumbaugh 2018; Schaller 2018). People with disabilities also use public transit and complementary paratransit services significantly more than the rest of the population (2017 NHTS). Paratransit services, which are mandated by the ADA, offer accessible options to individuals with disabilities who cannot otherwise use available, fixed-route transit. In summary, people with disabilities have less car access, and rely more on public and shared transportation services.

App-based ridehailing services offered by transportation network companies (TNCs), like Uber and Lyft, directly compete with taxis, and in the last decade have contributed to substantial growth of the for-hire vehicle market in the United States. Though for-hire vehicles, including taxis and TNCs, still only account for a small share of all trips, data from the 2017 NHTS show that approximately 10 percent of Americans had used ridehailing in the past month. Provision and use of ridehailing is not uniform across geographies or demographic groups. TNCs are ubiquitous and particularly dominant in large, dense urban areas (Conway et al. 2018). Ridehailing users are typically younger, live in larger cities, and have higher incomes and educational attainment than the general population (see Grahn et al. 2019).

Ridehailing offers a very similar service model to taxis; riders hire a TNC vehicle on demand and purchase a point-to-point trip from their origin to a desired destination. Despite their similarities, TNCs are not regulated like taxis. Ridehailing services are not presently covered under ADA regulations that do extend to taxi services and other transportation companies (Reed 2017).

TNCs, in theory, could be particularly advantageous options for travelers with disabilities who have less car access and rely more on taxis or paratransit. TNCs often offer lower prices than taxis for comparable trips (Smart et al. 2015), and may better serve neighborhoods historically neglected by taxis (Brown 2019a). But while people with disabilities use taxis more than the rest of the population, they use ridehailing quite a bit less (Brumbaugh 2018; Schaller 2018). One would expect that people with disabilities would use ridehailing at a similar or even higher rate than people without disabilities if taxi trends were to hold with TNCs. This begs the question: how and why are people with disabilities using ridehailing?

In this dissertation, I explore this question and others related to the travel behavior of people with disabilities in the era of ridehailing. Understanding the travel behavior of people with disabilities and other historically underrepresented groups is critical for crafting effective policies

to alleviate transportation disadvantage and associated problems. A lack of such knowledge has historically resulted in what Blumenberg (2004) termed “policy mismatch,” or instances in which policies intended to remedy transportation-related issues have failed because they assume the transportation needs of some individuals represent those of a larger group. Blumenberg coined this term while writing about how policies intended to increase welfare participants’ access to employment by facilitating reverse commute travel were unlikely to benefit a large group of such participants: low-income women with children. She argued that a male-centered understanding of why inner-city residents were struggling to find and keep jobs—namely, a lack of access to suburban employment—was an inappropriate model on which to base knowledge of all welfare recipients’ needs. Consequently, transportation policies based on this model would not help working single mothers who had different considerations from men that influenced their employment decisions and travel behavior. Many welfare-to-work policies were, thus, Blumenberg concluded, not likely to meet goals of improving employment outcomes for low-income women.

The stated purpose of the ADA is to ensure that discrimination in employment, transportation, and many other domains of public life does not preclude individuals with disabilities from fully participating in all aspects of society. Transportation policies for people with disabilities are primarily designed to facilitate use of public transportation services, to presumably allow for such participation. Yet research has consistently shown that people who have less car access and/or are more reliant on public and shared transportation services, including people with disabilities and older adults as well as low-income individuals and minority populations, are at greater risk of experiencing poor social and economic well-being and adverse health outcomes (Lubin and Deka 2012; Mackett and Thoreau 2015). This is not to say that policies designed to make transit more accessible to people with disabilities are necessary ineffective, but that research on their efficacy and capability to promote social, economic, and health outcomes among people with disabilities is needed. So too is research on whether supply-side policies (i.e., making transportation services more accessible to people with disabilities) are more or less effective than user-side policies, like subsidy programs, in terms of meeting objectives. Clarifying the travel behavior of people with disabilities can reveal whether particularly policies are likely to improve transportation outcomes and affect related phenomena, like health, among this population. Conducting research with the understanding that people with disabilities are a population with mobility needs that deserve attention from planners and policymakers, but that this population is quite heterogeneous is important for elucidating for whom certain policies might work, or not.

Qualitative research techniques can be particularly effective in travel behavior research for assessing the sources of transportation problems and predicting the impacts of changes (Clifton 2003). I employ both quantitative and qualitative methods in research included in this dissertation to understand the travel behavior of people with disabilities in the era of ridehailing, and to discern implications for policy and planning. In Chapter 3, I analyze data from the 2017 National Household Travel Survey, which is the first large, national travel survey in the U.S. with data on

TNC use. Through descriptive and regression analyses, I identify and explain associations between having a disability and ridehailing use. In subsequent chapters, I draw on individuals' experiences, described during in-depth interviews conducted with 32 San Francisco Bay Area residents with disabilities, to understand what makes traveling easier or more difficult for individuals with disabilities using ridehailing. I identify barriers and facilitators to ridehailing use among people with disabilities in Chapter 4. In Chapter 5, I explore how socializing with others—an element of using transportation that is often overlooked, but may be particularly important to consider for rider groups with special mobility and communication needs—affects travel behavior and health among people with disabilities.

My dissertation contributes to understanding how the rise of app-based ridehailing is impacting the travel behavior and associated phenomena, like health, of people with disabilities. I find that people with disabilities use ridehailing less than the general population, which may be because some individuals, particularly those that are older and/or acquired their disabilities more recently, have difficulty using new technology and transportation services independently. These results suggest that the rise of app-based ridehailing will do little to close gaps in access to adequate transportation observed between people with and without disabilities. Furthermore, low ridehailing use and limited travel might very well exacerbate social, economic, and health disparities that disadvantage people with disabilities. In order to prevent this, policymakers and others responsible for regulating, planning, and operating transportation services for people with disabilities in the era of ridehailing require greater knowledge of barriers and facilitators to using ridehailing and other public and shared services. Results of this study suggest that policies premised on increasing the supply of wheelchair-accessible TNC vehicles in order to promote ridehailing use among people with disabilities are unlikely to improve transportation access for, or use by many individuals with disabilities. Instead, user-side policies, like subsidies, might more effectively facilitate ridehailing use among adults with disabilities. Such policies ought to be implemented in concert with training and education programs that address difficulties which, particularly, older adults with recently acquired disabilities encounter using transportation in the era of ridehailing.

Chapter 2. Disability and transportation in contemporary contexts

In the following sections, I review relevant literature on disability and transportation. I first explore debates concerning the conceptualization and measurement of “disability.” Then, I describe how disability is defined in the 1990 Americans with Disabilities Act. Subsequently, I provide background on the travel behavior of people with disabilities and ADA regulations that affect transportation and travel. Here, I review challenges that regulators and operators of different modes have encountered in serving riders with disabilities, as well as issues that people with disabilities have experienced using these modes. After reviewing the regulatory landscape in which they presently operate, I end by providing context on the growth of app-based ridehailing services. I review existing research on ridehailing use among people with disabilities. I identify outstanding questions regarding the travel behavior of people with disabilities in the era of ridehailing and implications for policymaking and planning.

2.1 Defining and measuring disability

Doing disability research, and engaging in policymaking or planning for people with disabilities necessarily requires grappling with what defines disability. Disability definitions connote goals, and guide approaches to measurement intended to reveal targets for action (Iezzoni and Freedman 2008). For instance, a policy seeking to improve transportation for people with disabilities will likely define disability based on conditions of an individual and/or their environment that make it difficult for them to use transportation services. In this case, as the goal is to improve transportation for people with disabilities, it is likely that people with functional impairments that keep them from using existing services in a comparable manner to people without these impairments will be considered to have disabilities. Disability is, thus, defined partly based on conditions of the individual (e.g., health conditions that result in functional impairments), and partly based on conditions of the environment that enable or hinder an individual from participating in activities, like using transportation.

This definition incorporates elements of three prevailing models of conceptualizing disability: the medical model, the functional model, and the social model (McDermott and Turk 2011). The medical model relies on diagnoses of health conditions by physicians to determine disability status. It remains prominent in medical and epidemiological research and literature, which track incidence and prevalence of such conditions (McDermott and Turk 2011). Disability definitions have shifted away from purely medical notions since the rise of the disability rights movement in the 1970s (Iezzoni and Freedman 2008). Prevailing models of disability in recent decades have focused on identifying problems that arise from functional limitations and/or barriers to participating in society, which exacerbate the negative effects of disability. Like the medical model, the functional model considers disability to be, primarily, an individual characteristic. Disability status is determined in the functional model based on an individual’s

ability to complete functional tasks such as moving a limb or hearing clearly. The functional model was popularized by the International Classification of Functioning, Disability and Health (ICF), which is the World Health Organization's framework for measuring health and disability. The social model considers disability to be an outcome of social and environmental barriers to people's participation, and ultimately, inclusion in society. Disability is positioned in the social model as an "attitudinal or ideological" issue requiring social change to address (Iezzoni and Freedman 2008).

Questions used in survey data to identify and measure disability at the individual and population levels produce different samples based on whether questions classify disability according to the medical, functional, and/or social model(s) (McDermott and Turk 2011), and based on question wording (Lauer et al. 2019). Grönvik (2009) reviewed how survey results employing functional, administrative (used to determine state benefit eligibility), and subjective (self-reported) definitions of disability identified very different populations. He found significant differences in gender, age, educational attainment, and participation in the labor force, as well as other variables of interest among people with disabilities measured using the different definitions. Lauer et al. (2019) compared disability prevalence and demographic variation estimates among populations of people with disabilities identified using two sets of questions in population-level surveys, both derived from the ICF: the American Community Survey (ACS) question set, and the Washington Group Short Set (WGSS) questions. These authors identified consistently different overall disability prevalence across age, sex, and race-ethnicity categories for surveys using ACS and WGSS measures. Though they found relatively similar demographic distributions among populations of people with disabilities identified by the question sets, they concluded that the variation in disability prevalence, even for surveys that used the same question set, presented "a complication for disability research and policy" (Lauer et al. 2019, 201).

Researchers have struggled with how to effectively study disability without a universal definition of the concept. McDermott and Turk (2011) suggested a new framework to "identify social, function, and medical issues that constitute a disability case definition" (3) for epidemiology using a parsimonious approach. These authors argued that while defining the disability by the medical model might be unpopular, self-reported functional definitions likely overrepresent the magnitude of disability in a population by capturing people with temporary impairments, obesity, and other chronic conditions, as well as those of advanced age, in addition to people with medical conditions who would fall under the traditional umbrella of disability. Similarly, they contested that while social model-based definitions are advantageous for monitoring societal trends, they allow "study of individuals from only a limited perspective" (2). They ultimately proposed an integrated model of disability, and crafted questions to determine disability using "self-report, service delivery, and medical records to identify level of function, a sense of participation in community, and identification of other health conditions" (5) for disability and health studies.

Burkhauser et al. (2014) examined the implications of identifying people with disabilities using different question sets that do or do not include work-activity limitation question(s) in

addition to functional limitation questions. They found that using the ACS question set or work-limitation question alone underestimated the size of the American working-age population with disabilities, and that using the six-question ACS set alone, versus this set plus a work-limitation question, overestimated employment rates and underestimated the share of people receiving government benefits for disability, including Social Security Disability Insurance or Supplemental Security Income-Disabled Adults. As these estimates are key to understanding the success of welfare and employment policies targeting the working-age population with disabilities, the authors concluded that it was imperative to include a work-limitation question in national surveys of disability prevalence and datasets generating data relevant to the Social Security disability programs (Burkhauser et al. 2014).

Providing an alternate perspective to Burkhauser et al. (2014), Altman (2014) argued that people with disabilities should not be measured according to whether or not they are able to “maintain their life roles in the current environment” (149), or participate in an activity such as working. She maintained that a more expansive definition of disability based on the functional model, which measures limitations with or without environmental or technological accommodations, is most likely to capture the population of people with disabilities that should be a target of disability policies, rather than a definition based on function as well as participation and/or receipt of benefits. Altman (2014) clearly summarized many of the issues with estimating disability,

“Except for persons with very severe limitations who would be identified as disabled on almost any type of measurement, prevalence estimates of disability are subject to the basis of the measurement (what types of functioning, activities, or participation are the point of focus), the person’s environmental situation at the point/time/place of measurement (are the weather, building structure, lighting, or many other characteristics of the environment supportive or restrictive), and the intent of the purpose for which the estimate is required (Are we attempting to ascertain the number of persons who will need fiscal support because they cannot work or are we identifying a group whose civil rights to access may be restricted or prevented?).” (149)

For policy purposes, she said, prevalence estimates should count everyone who could potentially benefit. Accordingly, she argued, researchers and policymakers should use measures that capture individuals who may be vulnerable to discrimination in access or opportunity on the basis of disability.

In order to craft policies to meet the needs of a particular group, group definition matters. Though nuance will inevitably be lost in deciding who is “in” and who is “out,” this is a limitation of all exercises in categorization. In the context of studying transportation for people with disabilities, the group of people with disabilities of interest to policymakers may vary, but should ultimately be determined based on combined individual and environmental factors that influence the ability of people with disabilities to use transportation. For instance, the population of “people

with disabilities” of interest to transportation researchers and policymakers may be those with physical, cognitive, or other impediments to travel. For example, in the National Household Travel Survey, respondents are asked whether they “have a condition or handicap that makes it difficult to travel outside of the home” (“2017 NHTS Data User Guide” 2018). This approach to measuring disability is participation-based, and will capture a sample of people with (travel-limiting) disabilities that is dissimilar from surveys that use other question wording to determine disability status.

In the United States, relatively few national surveys that collect data on disability also collect information on travel behavior, transportation use, activity participation, or environmental barriers to participation for individuals and/or households (Livermore et al. 2011). Information on disability and participation in benefits programs, education, and employment is relatively more common. For surveys that do collect disability data, specific measures of disability and wording of questions intended to elicit disability status or type of disability (i.e., visual impairment) differ significantly (Livermore et al. 2011). While the six-question disability series used in the ACS, the Current Population Survey (CPS), the American Household Survey (AHS), and some versions of the National Health Interview Survey (NHIS) might be used more widely to encourage more uniform disability data collection, this may not capture targeted groups for policymaking or determining eligibility for participation in benefits programs (e.g., Burkhauser et al. 2014). Accordingly, disability definitions used in policy studies should target individuals that cannot participate fully in some arena because of an impediment that keeps them from doing so in a typical way (Altman 2014).

2.2 The Americans with Disabilities Act

The development of transportation policy for people with disabilities in the last three decades has primarily revolved around compliance with the Americans with Disabilities Act of 1990. The ADA requires constructing conditions of “equal access” and “equal opportunity” for people with disabilities to use public facilities and services, including transportation, thereby protecting their “right to fully participate in all aspects of society” (42 U.S.C. § 12101). The ADA is intended to protect people from exclusion or discrimination in public transportation service provision on the basis of disability. ADA compliance requires that public agencies make transit services accessible to most people with disabilities, and that they provide complementary paratransit services. The ADA does not promise to provide services for people with disabilities that exceed levels of service offered to people without disabilities. In practice, this leads to serious transportation problems for people with disabilities in places where public transit services do not exist—notably in rural areas (NCD 2015). While the ADA has done much to improve people with disabilities’ access to and experience with public transportation, it is important to understand its limitations. In the following sections, I explain how “disability” is defined in the ADA and list ADA rules that apply to transportation. I then describe the structure of ADA enforcement, and limitations of the ADA that may impact transportation for people with disabilities.

Disability definition in the ADA

The 1990 Americans with Disabilities Act (ADA) defined “disability” as “a physical or mental impairment that substantially limits one or more major life activities of [an] individual; a record of such an impairment; or being regarded as having such an impairment” (42 U.S.C. § 12102). The ADA Amendments Act of 2008 (ADAAA) clarified this definition, and explained what qualified as “major life activities,” as well as the meaning of “regarded as having such an impairment.” Changes resulting from the ADAAA were intended to ensure that the ADA definition of disability is broadly construed, and that disability is applied without “extensive analysis” (42 U.S.C. § 12101 note). The current ADA definition of disability constructs disability in the spirit of a comprehensive model reflecting medical and social elements. “Major life activities” include actions like hearing, eating, sleeping, and standing, as well as working. According to the ADA, an “impairment” qualifying as a disability cannot be “transitory,” that is, lasting (or expected to last) 6 months or less.

Part I, Title II of the ADA outlines comprehensive architectural and public transportation protections for people with disabilities. These extend to public entities operating transit and paratransit services. Additionally, ADA regulations apply to elements of transportation facility design (e.g., station and vehicle design). Transportation offered by a private entity, such as taxis and private shuttles, is covered by Part I, Title III.

The Federal Transit Administration (FTA), an agency within the United States Department of Transportation (DOT), is responsible for enforcing transportation-related ADA requirements, and publishes information related to guidance and regulation on transportation and the ADA. Specifically FTA’s Office of Civil Rights oversees public transportation services’ compliance with the requirements of the ADA, which ensure nondiscriminatory transportation service provision for people with disabilities. Private entities engaged in the business of transportation while not receiving any federal public transportation monies may not be subject to DOT ADA regulations, but are responsible for complying broadly with ADA. The Department of Justice (DOJ) is responsible for evaluation and enforcement of nondiscrimination against people with disabilities under the ADA. If DOT and DOJ regulations are inconsistent with regard to regulating transportation providers, DOT ADA regulations are enforced (FTA Circular 4710.1).

The United States Access Board (Access Board) is responsible for developing and updating ADA Accessibility Guidelines (ADAAG) that are used by DOT and DOJ to set enforceable design and service standards. The Access Board was originally created in 1973 as the Architectural and Transportation Barriers Compliance Board, in accordance with Section 502 of the Rehabilitation Act of 1973, with the intent of coordinating and ensuring compliance with the Architectural Barriers Act of 1968. Today, the Access Board is an independent federal agency that represents and protects the interest of people with disabilities by coordinating among other agencies to ensure consistency in accessible design criteria required by the Architectural Barriers Act, the Rehabilitation Act, the ADA, and the Telecommunications Act of 1996. These criteria consider the built environment, transit vehicles, and information and communications

technologies. Current DOT and DOJ ADA standards are based on the Access Board's 2004 ADAAG update.

ADA enforcement and limitations

DOT cannot enforce ADA regulation beyond infrastructure that falls under their scope, which is predominantly restricted to vehicles and other technologies required to use transit (e.g., turnstiles, lifts, etc.). Where discrimination is perceived in other transportation-related cases for issues like inaccessible pedestrian infrastructure at or around transit stations, the obligation for ADA and Rehabilitation Act Section 504 anti-discrimination enforcement falls to DOJ. DOJ is broadly responsible for protecting people with disabilities from discrimination in public activities. This responsibility extends to regulating accessible infrastructure, including the built environment and, increasingly, digital environments (e.g., websites).

This divided regulatory structure poses challenges for people with disabilities seeking to use “accessible,” or DOT ADA-compliant transportation services that might not actually be reachable. For example, a transit station might be inaccessible due to sidewalk pavement deterioration outside transit agency property that prevents a wheelchair user from getting to the station entrance. In this example, the transit agency responsible for the station, but not the sidewalk, would not necessarily be in violation of the ADA. In this case it is likely that a municipal government would be responsible for maintaining the sidewalk in accordance with ADA design guidelines. Making the transit service actually accessible in this scenario would, then, require ADA enforcement by the DOJ working with the municipal government responsible for public rights-of-way. Similar intervention would be required in stations where transportation vehicles and other station technologies are accessible by DOT ADA accessibility guidelines, but people with disabilities are unable to enter vehicles, for example, because a level boarding platform is unavailable.

2.3 Travel and activity participation among people with disabilities

Travel surveys consistently show that people with disabilities travel less and for different purposes than people without disabilities, and that they express a desire to travel outside the home more often (Clery et al. 2017; Field and Jette 2007; Mattson 2012). Examining 2009 NHTS data, Mattson (2012) reported that people with disabilities took trips at about half the rate of people without disabilities. That trend has held over time. Analyzing 2017 NHTS data, Brumbaugh (2018) reported that working-age people with and without disabilities made 2.6 versus 3.6 trips per day, respectively. The gap is larger for older adults. 2017 NHTS respondents who were over age 65 with a disability made an average of 2.1 trips per day versus 3.5 trips for those without a disability (Brumbaugh 2018).

People with disabilities take significantly fewer trips using a personal vehicle and significantly more trips using transit and paratransit than people without disabilities (2017 NHTS; see Figure 1). However, trends in relative mode use observed between people with and without

disabilities in the 2017 NHTS are surprisingly similar. Again, most daily trips are made using a personal vehicle, followed by walking, using transit, and taking other modes for people with and without disabilities. This suggests that the sample of people with disabilities in the 2017 NHTS is likely quite heterogeneous in terms of a number of factors that influence travel behavior. People with disabilities are less likely to have access to a household vehicle than people without disabilities. In the 2017 NHTS, 19.1% of people with disabilities reported living in a zero-vehicle household compared to 5.1% of people without disabilities. People with disabilities are also less likely to be licensed drivers than others, and some people with disabilities, particularly individuals with acquired conditions, report limiting or giving up driving as a result of their disabilities (Henly and Brucker 2019).

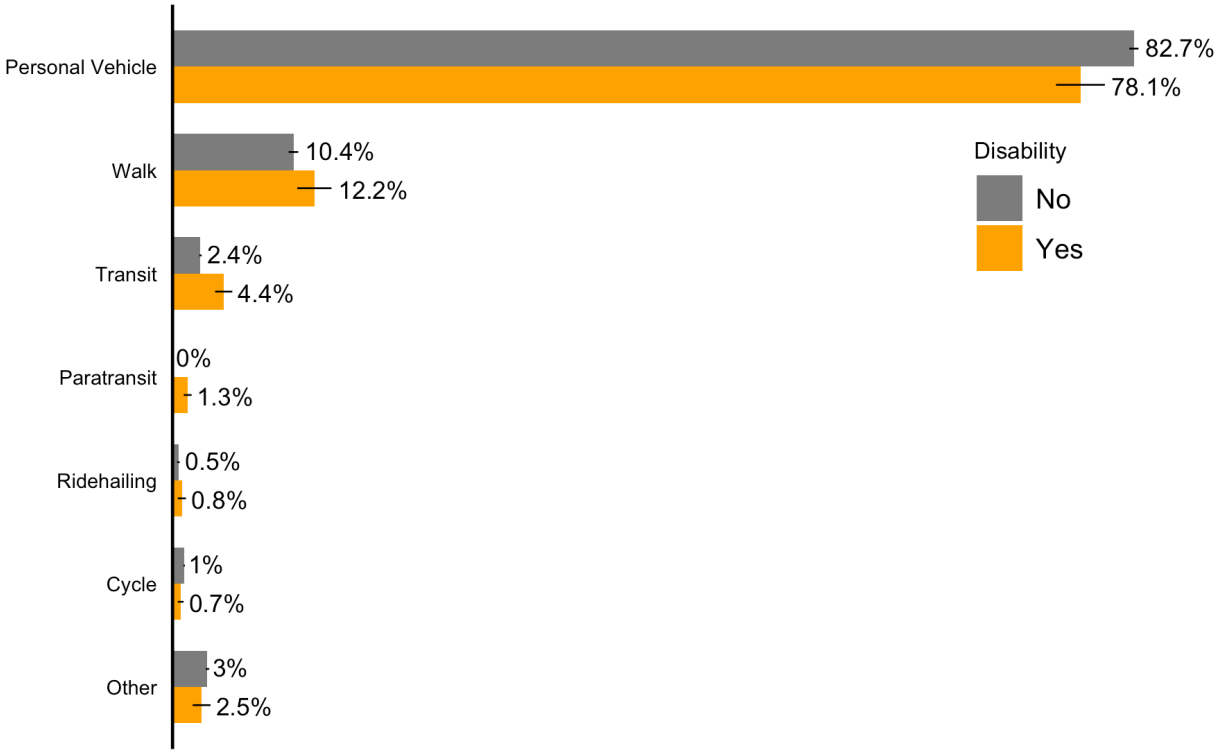


Figure 1. Percentage distribution of daily trips by mode and disability status. Black lines indicate 95% confidence intervals. *N* = 863,093 trips for respondents who reported not having a disability; weighted number of trips: ~349,153,044,408. *N* = 60,247 trips for respondents who reported having a disability; weighted number of trips: ~21,908,476,935.

Examining 2009 NHTS data, Mattson (2012) reported that people with disabilities with the ability to drive or use a private vehicle, as well as those who reported greater use of public transit, were more likely to leave the home in order to participate in activities than those who reported little access to or use of transportation technologies. While this suggests geographic access to public transportation and other opportunities may encourage travel and out-of-home activity participation among people with disabilities, some empirical evidence suggests low-

mobility populations are not locationally disadvantaged—in terms of proximity to transit services—relative to other groups (Casas 2007; Lubin 2012; Marston et al. 1997; Scott and Horner 2008). These findings are in accordance with Levinson (1999) and other studies suggesting sociodemographic characteristics are more predictive of people’s time expenditures on travel and other out-of-home activities than location characteristics, particularly for non-work trips (Zhang 2005).

Clery et al. (2017) analyzed data from England’s National Travel Survey, administered 2007-2014, and reported that disability was strongly explanatory of travel behavior, even when controlling for other socio-demographic characteristics that affect this phenomena (e.g., age, household income, etc.). Furthermore, people with disabilities devoted a greater proportion of travel trips to shopping trips, and a lesser proportion of trips to commuting and “personal business” trips than people without disabilities. Disability status deserves additional research as an independent determinant of travel behavior and activity participation.

Using 2017 NHTS data, Henly and Brucker (2019) found that having a disability was associated with lower odds of taking trips for shopping or to run errands, to socialize or for recreational reasons, or for going to work even after controlling for other factors. These authors notably found that travel behavior among people with disabilities differs based on time spent living with a disability. In the 2017 NHTS, adults with lifelong disabilities reported reducing or limiting their travel less as a result of disability than adults with acquired disabilities. This is unsurprising provided one would expect that more time spent living with a particular condition would allow one to adapt to that condition. Those with lifelong disabilities were more likely than people with acquired disabilities to make a trip for socialization, but less likely to make a trip for shopping. Henley and Brucker (2019) speculate, “This conflicting finding may be because socialization benefits from knowledge of these transportation resources whereas knowledge of different resources to avoid shopping (such as online shopping or delivery services for niche markets) may explain the reduced number of these trips for the lifelong disability population” (105). These authors highlight the importance of analyzing subpopulations of people with disabilities (i.e., groups with different durations of disability) to understand why some people with disabilities may experience barriers to using transportation while others might not.

Examining activity participation using data from the American Time Use Survey (ATUS), Shandra (2018) found that adults with disabilities spent less time in market work, roughly equivalent time in nonmarket work, and more time in “tertiary (health-related)” activities and leisure than adults without disabilities. Disentangling the effects of self-reported health and disability status on these outcomes, Shandra (2018) further reported that while health played a large part in tertiary activity participation, sociodemographic characteristics largely determined differences in time spent participating in market work and leisure activities. This supports the notion that a social model of disability may capture the lived experience of people with disabilities better than a medical model.

2.4 The rise of ridehailing & Ridehailing use among people with disabilities

Since 2012, app-based ridehailing services provided by TNCs have come to substantially supplement urban transportation services. TNCs more than doubled the size of the for-hire vehicle market—encompassing taxis and TNCs, as well as other short-term hireable vehicles like limousines—in the United States between 2009 and 2017 (Schaller 2018; Conway et al. 2018). According to data from the 2017 NHTS, for-hire vehicle trips still only account for 0.5% of all vehicle trips in the U.S; however, the percentage of all Americans who used app-based ridehailing in the previous month in 2017 was nearly 10% (Conway et al. 2018). It’s been estimated that TNC ridership now surpasses ridership on local buses (Schaller 2018).

The growth of ridehailing has not been uniformly distributed across geographies or demographic groups. Some population subgroups may have better access to and/or benefit more from these services than others. The greatest growth has been observed in mid-sized and large metropolitan areas (Conway et al. 2018), particularly in the largest, most densely populated cities (Schaller 2018). Numerous studies have found that TNC users tend to live in more urban areas, and to be younger, earn higher incomes, and have higher levels of education than others (Alemi et al. 2019; Brown 2018; Clewlow and Mishra 2017; Conway et al. 2018; Grahn et al. 2019; Rayle et al. 2016). These observations differ from past studies on characteristics of taxi users, which reported that this population included disproportionate representation from both high-income and low-income households (Pisarski 2006; Renne and Bennett 2014).

Analyzing data from web-based surveys deployed in eight large and mid-sized cities, Feignon and Murphy (2018) found that TNC users are more likely to commute using public transit, walking or biking than non-users (Feignon and Murphy 2018). This aligns with observations of greater TNC use in cities with greater population density, which have more expansive transit networks and greater overall connectivity, making walking and biking more attractive commute modes (Conway et al. 2018). The introduction of app-based ridehailing services in most large cities has coincided with a decline in the use of taxis and other existing for-hire vehicle services, including limousines and shuttles (see Cetin and Deakin 2019). TNCs and taxis operate in direct competition, particularly in large urban cores, and TNCs typically offer lower prices (Brown and LaValle 2020; Smart et al. 2015). It is likely that this relative affordability, combined with other advantages like faster response times and higher quality vehicles, makes TNCs more attractive than taxis (Rayle et al. 2016; Wallsten 2015).

Data from the 2017 NHTS suggest that most people who use TNCs purchase only a few rides a month, suggesting these services are used more for “special occasions” than routine trips (Grahn et al. 2019). People take TNC trips more often on the weekends or at night, when other transit services may be more limited and/or when driving a personal vehicle may be less attractive, for instance, because parking is more limited and/or expensive (Feignon and Murphy 2018). TNCs, thus, may fill transportation service gaps both in time and space, as observed in cases where travelers use TNCs to make first/last mile trips to transit stations. Examining Lyft

trips in Los Angeles, Brown (2019a) found that TNCs served areas of the city, including low-income and majority Black neighborhoods, which taxis have historically avoided. She concluded that ridehailing services may offer increased car access to travelers who may have been previously excluded by taxi and car share services.

Taxicabs have long represented an important transportation service for people with disabilities, as this group is less likely to own and drive private vehicles than people without disabilities (Rosenbloom 2003; NCD 2005, 2015). Recently, using data from the 2017 NHTS, Brumbaugh (2018) and Schaller (2018) reported that people with disabilities continue to use taxis for a much greater share of travel than people without disabilities. However, people with disabilities reported using TNCs less than the rest of the population (Brumbaugh 2018; NHTS 2017). There is very little written on how or why people with disabilities use app-based ridehailing services, so it is not known why people with disabilities may use TNCs less than the general population while using taxis more, despite their similar service models.

2.5 The state of transportation for people with disabilities post-ADA

The National Council on Disability (NCD) has released two reports since the passage of the ADA, in 2005 and 2015, reviewing the state of transportation for people with disabilities in the United States (*The Current State of Transportation 2005; Transportation Update 2015*). In both, authors reflect on how policies implemented since the ADA's passage have influenced transportation for people with disabilities. The reports rely on research studies, policy documents, and anecdotal cases as evidence of progress, or lack thereof. No standard measures of "progress" or achievement are presented to the reader, or are rigorously evaluated or discussed. Instead, these reports focus on where the NCD identifies areas for improvement in the implementation and enforcement of the ADA and other disability anti-discrimination legislation, in order to enhance the transportation available to people with disabilities. Drawing on these reports and other literature, in the following sections I describe the current state of transportation for people with disabilities in the U.S.

Fixed-route public transit

Despite advances made in making transit more physically accessible since the passage of the ADA in 1990, people with disabilities continue to experience widespread barriers to accessing public transportation services. Analyzing results from a large survey of transit riders with disabilities, Bezyak et al. (2017) found that many of these barriers were more attitudinal than physical in nature, arising from drivers' behavior. After an "Inadequate transit system," the most prevalent barriers to using public transportation that survey respondents cited were "Drivers not calling out stops" and "Inappropriate driver attitude." Many of the issues with fixed-route transit covered in the NCD reports similarly concerned failures of transit operators and employees to provide riders with disabilities with appropriate accommodations. DOT ADA accessibility guidelines require that fixed-route bus and rail services be made accessible to people with

disabilities to the extent that accessible modifications to these services do not “fundamentally alter” or disrupt service (NCD 2015). ADA requirements include provision and maintenance of accessible transit stations and vehicles, as well as driver training about how to accommodate passengers with disabilities. While I will not go into detail on all specific ADA guidelines that apply to fixed-route transit, I will note areas of improvement brought up in the NCD reports and other materials.

Bus transit

The 2005 NCD report cites issues with accessible bus transit related to the consistency and clarity of information about stops and on-board stop announcements, bus equipment maintenance (e.g., wheelchair lifts), driver training, and clarity in what types of mobility devices are eligible for accommodation. In the language of the original ADA Accessibility Guidelines, transit providers were responsible for accommodating the “common wheelchair”—a set of design specifications representing most wheelchairs. The 2005 report chronicles a number of cases revealing problems with this requirement because wheelchair technology evolved to accommodate more diverse body types and positionings. For instance, wheelchairs in a reclined position might fit the “common” standards by some specifications (e.g., width), but might not fit the standards in a reclining position. In these cases, drivers could refuse service to riders. In a 2011 amendment to the ADA Accessibility Guidelines, the DOT removed provisions regarding the “common wheelchair” and revised the Guidelines with the goal of accommodating a greater diversity of wheelchair types. In this way, policymakers intended to relax requirements such that any rider whose wheelchair fit on a vehicle and could be properly secured could be allowed to board.

Operators’ behavior was repeatedly referenced in the 2005 NCD report, suggesting drivers could really make or break a transportation experience. The authors profiled a number of cases in which bus services were not operating in compliance with the ADA because drivers were intentionally or unintentionally refusing service, or providing subpar service, to riders with disabilities. For example, drivers were observed driving past riders with visible disabilities, presumably to avoid the time and effort required to on-board, secure, and off-board these passengers. Drivers and operators were also frequently reported for failing to communicate stop announcements effectively to riders with disabilities, who often require audible or visual signaling. Furthermore, when these communications are provided they must be clear and understandable. Common complaints from fixed-route transit riders regarded drivers or rail operators “mumbling” or failing to consistently verbalize or display stop information.

Evidence from the 2015 NCD report suggests that while bus ridership had become more inviting to people with disabilities in the past decade, as evidenced by substantially increased ridership, problems persisted with announcements and communications about stops, routes, and delays in service. Bus boarding issues continued to be a challenge in some cities, and there was litigation alleging that local bus systems routinely denied boarding to people with disabilities despite having accessible equipment.

Authors of the 2015 report noted that these failures in service might be avoided by relying on a better process for making operators aware of and enforcing regulatory requirements. In many cases these requirements were instituted without transit agencies creating or advertising consistent, detailed policies for how this ought to be done for their systems and services. The authors argued that greater leadership on the part of transit oversight agencies in creating and enforcing in-house policies for complying with ADA regulations, and generally, providing sufficient or exceptional services for people with disabilities, would likely reduce confusion and violations.

Rail transit

The ADA “key station” mandate requires that operators only make accessibility modifications to select rail stations, in order to bring these stations into compliance with DOT ADA Accessibility Guidelines and ADA Design Standards administered by DOJ. Operators are not required to make architectural or technological modifications to other stations in order to accommodate people with disabilities. Both NCD reports cited the “key station” mandate as a major issue limiting rail transit accessibility for people with disabilities (Field and Jette 2007; NCD 2005, 2015). The federal government does not provide operators with any funding to meet even “key station” requirements, which is problematic, as it certainly does not assist with “key station” compliance, let alone incentivize maximizing rail station accessibility (Field and Jette 2007). A 2018 report from the Office of New York State Senator Michael Gianaris, using data from the Federal Transit Administration, ranked the accessibility of fourteen of the country’s major rail systems by percentage of ADA-compliant stations (“Breaking Barriers” 2018). Seven of these systems boasted 100% ADA compliance with all accessible stations, including Metro in Washington, DC, and BART in the San Francisco Bay Area. In contrast, though it is the largest transit system in the country, only 23% of New York City Subway stations were ADA-compliant.

At accessible stations, maintenance of accessible infrastructure—elevators, in particular—is a persistent concern (NCD 2005, 2015). This has become a popular topic in media coverage of the country’s major rail systems. A 2017 publication from TransitCenter entitled, *Access Denied*, reported that at New York City’s 111 ADA-compliant subway stations, “elevators break down often, rendering fewer stations accessible to those with mobility impairments” (“Access Denied” 2017, 4). Uncertainty about whether an ADA-compliant, or “accessible,” station is actually accessible to a person with a disability on a given day at a given time poses difficulties for trip planning, and likely contributes to lower use of these systems by people with disabilities.

Other accessibility issues in rail transportation manifest in platform design and infrastructure. For example, gaps between rail cars and the platform can be difficult for people with disabilities to cross, and some systems only have sections of boarding platforms and/or particular rail cars that are accessible to people with disabilities. The 2015 NCD report described progress in making platform boarding more broadly accessible across US rail systems since 2005, with full-length platform level boarding becoming more common. This progress was attributed to

a 2011 update to DOT ADA Accessibility Guidelines requiring level boarding for any accessible passenger rail car.

Paratransit

The ADA requires that complementary paratransit services be provided to eligible travelers with disabilities where transit services are provided to the general public. Paratransit services are intended to ensure people with disabilities' level of transit access and service is equivalent to that offered to people without disabilities by filling in gaps that may render transit services inaccessible to riders with particular needs. Minimum service requirements for complementary paratransit (CFR 37.131 § 37.131) stipulate that these services must operate within a corridor three-fourths of a mile wide around fixed-route bus and rail corridors, and in the areas between these corridors. Operators must provide service to passengers who make requests for paratransit rides at least a day in advance. Fares cannot exceed two times the full fare for a similar fixed-route transit trip. This rate applies similarly to guests using paratransit services with eligible riders, with the exception of personal attendants, who are not required to pay a fare for riding. Paratransit services must operate during the same hours as partner fixed-route services. Paratransit cannot limit capacity for eligible passengers who book in advance, which ensures passengers cannot be "waitlisted" (Kaufman et al. 2016). Furthermore, providers cannot restrict or prioritize trips based on purpose, or limit the number of trips any individual can make.

Paratransit passengers who have scheduled a trip are typically given a 30-minute pickup window (Kaufman et al. 2016). Once the driver has arrived at the pick-up address, riders must meet the driver within 5 minutes to avoid being marked as a "no show," at which time the driver will depart from the pick-up site. Whether paratransit trips are provided "door-to-door" or to the nearest accessible transit stop to complete the trip ("curb-to-curb") depends on the determined needs of the paratransit user, outlined in their user's evaluation. Door-to-door service was not required by the original ADA paratransit mandate, but a 2015 DOT ruling (80 FR 13253) clarified that transit agencies must make "reasonable modifications/accommodations" to transportation services to avoid discrimination, in accordance rules under the ADA and section 504 of the Rehabilitation Act. Door-to-door service for certain passengers constitutes a reasonable accommodation.

Paratransit challenges

The Federal mandate requiring transit operators to provide complementary paratransit is unfunded. Thus, oversight agencies and paratransit providers are often strained to provide quality, yet cost-effective, service. A 2012 report on paratransit operations by the Government Accountability Office found that since the ADA passed in 1990, demand for paratransit trips had increased, and the costs for providing these trips remained very high. In 2010, the average cost of providing an ADA paratransit trip was \$29.30, nearly 3.5 times the cost of a comparable fixed-route transit trip at \$8.15 (GAO 2012). This was a 10% increase from the cost of providing paratransit in 2007.

Examining data from the National Transit Database, the American Public Transportation Association reported that use of demand responsive services—including paratransit and dial-a-ride services—represented 2% of all transit trips and 3.5% of passenger miles traveled on transit in 2015 (APTA 2018). Operating these services cost an estimated \$5.3 billion, representing 11.8% of all transit operating expenses, yet these services generated only about 3% of transit fares collected. Because demand responsive services serve very few riders and cannot raise fares above two times that of a comparable fixed-route trip, these services require the highest subsidies per passenger, and demonstrate the lowest farebox recovery ratio (the fraction of operating expenses paid by passenger fares) of all transit modes.

The greatest challenges of providing paratransit thus lie in providing eligible riders with ADA-compliant service, let alone quality service, in the face of enormous cost burdens. Providing paratransit involves high, ongoing operating costs, which are not easily recouped in fares. Increasing farebox recovery for paratransit service is not easy, even with increased demand for trips, as it is difficult to optimize paratransit trips to take advantage of economies of scale (Field and Jette 2007). The larger and lower-density a paratransit service area is, the less likely an operator will be able to group trips while operating at a level that provides comparable service to transit. Paratransit systems are not allowed to have capacity constraints—they must operate within the requirements of the 1990 mandate described previously, and serve every requested trip. Operators cannot refuse or prioritize trips based on purpose, time, length, characteristics of the rider, etc., as long as the trip falls within the service area. Thus, though these services disproportionately require many transit dollars for very few trips—placing a serious burden on transit operators—they cannot cut back on service in order to cut back on costs.

This puts both paratransit providers and riders in difficult positions. Because providing paratransit is so resource-intensive, there is little incentive for providers to expand service beyond what is required for ADA compliance. Transit agencies have responded to the challenges of providing paratransit services, generally, by trying to divert more trips to fixed-route systems. While this may require high, up-front capital expenditures to make these systems more accessible for people with disabilities, this approach is intended to reduce operating costs in the long term. Other changes agencies have enacted to cut paratransit costs include restricting service areas to the minimum required, improving the operational technology behind paratransit reservations and routing, and tightening eligibility criteria for riders (GAO 2012).

Exploring the potential for paratransit systems to be made more “intelligent,” by leveraging technological upgrades to “reduce costs, improve efficiency, and create a better customer experience” (6), Kaufman et al. (2016) identified four main areas for improving service: onboarding, reservations, dispatching and routing, and user experience. Many of these authors’ suggestions for improvement hinge on leveraging digitalization and database management, as well as innovations in information and communications technologies (ICTs) to make paratransit operate more like private on-demand services. The authors also suggested that transit operators should pursue partnership agreements with TNCs to provide on-demand paratransit, or a comparable hybrid service. While partnership strategies might be advantageous where private

companies can offer the infrastructure to cheaply accommodate on-demand trips, issues in these arrangements may arise in meeting particular ADA requirements—for instance, those related to accessible vehicles and providing door-to-door service as a reasonable accommodation.

Though demand for ADA paratransit has increased and may continue rising, riders have long reported frustrations with using paratransit. A 2016 audit of New York’s Access-A-Ride Program (AAR) found that the Metropolitan Transportation Authority failed to monitor AAR contractors’ compliance with contract requirements for basic minimum paratransit service, and “customers suffered from unreliable and unsatisfactory service” (Landa 2016, 2). Anecdotally, riders across the country have reported that paratransit services often arrive inconsistently within the pick-up window—if they arrive at all, “no shows” are frequent complaints—and do not wait the required time for onboarding. Furthermore, riders complain that trips take too long, which may result in missed appointments (Goodrich and Sterling 2018). Problems using trip reservation systems, unsatisfactory response to complaints by oversight agencies, insensitive drivers, dangerous driving, and sexual harassment of riders have also been covered in recent reports and news about paratransit (see Kaufman et al. 2016). Difficult working conditions for paratransit drivers, who have reported sexual harassment from passengers, as well as long and physically demanding work hours, are also in the news (Kenoyer 2018). ADA paratransit provides “a crucial safety net” for many people with significant disabilities who may not be able to use fixed-route services regardless of accessibility improvements (NCD 2015, 73). Yet, paratransit service can be difficult and frustrating to use, there is little incentive for operators to provide a level of service quality beyond minimum standards, and many transit agencies are not even meeting minimum standards to be in compliance with the ADA (GAO 2012).

Private transit: Taxis and transportation network companies

Private entities providing taxi services are not required by the ADA to have a minimum number of wheelchair-accessible vehicles in their fleet, nor are they required to purchase or lease sedan-type accessible vehicles. Taxi services that purchase non-sedan-type vehicle(s) (i.e., vans) are required to ensure that these vehicles are accessible to people with disabilities, with few exceptions (Capozzi 2011). ADA regulations stipulate that private entities providing taxi service cannot discriminate against individuals with disabilities who can use standard taxi vehicles and who travel with a service animal. Furthermore, taxi drivers cannot refuse assistance to a passenger with a disability who requires reasonable assistance stowing a mobility device (e.g., a folding wheelchair) in the vehicle, nor can they charge passengers traveling with mobility devices or medical equipment higher fares than other passengers.

Transportation network companies (TNCs), like Uber and Lyft, are not presently subject to regulation under the ADA. TNCs have consistently argued that they are “technology companies” rather than “transportation companies,” and, as such, should not be governed under Title III, because, they say, their primary business is providing a platform to connect drivers and riders, not providing rides (Reed 2017). As long as this platform is accessible to people with disabilities, they claim to be in compliance with the ADA.

Challenges of providing and operating accessible taxi services

There is little incentive for private transit operators to make their services accessible to people with disabilities. Some states and cities have gone beyond what's required by federal regulations, mandating that some percentage of permitted taxi fleets be ADA-accessible vehicles (CTS 2010). Providing accessible transportation services increases costs for taxi companies significantly, which they may bear with little public financial support (CTS 2010). ADA-accessible vehicles are more expensive to purchase and operate than standard vehicles. Providing ADA-compliant service may also require investing in more extensive driver training and liability insurance. ADA-accessible trips are inherently costlier than other trips because vehicles are more expensive to operate, and trips may be longer when riders require assistance on ingress or egress, and/or with wheelchair securement or stowing mobility devices or other medical equipment. It follows that accessible taxicab programs are typically more successful when public entities provide financial assistance and incentives to offset these costs. More difficulties with these programs arise when independent contractor drivers are not also provided with incentives to drive accessible vehicles and accept potentially costlier, ADA-compliant trips that might be purchased with a voucher or other form of subsidy (CTS 2010; NCD 2015).

Despite their challenges, ADA accessible taxi programs have grown in recent decades. The NCD (2015) reported that while wheelchair-accessible taxis had become more available, particularly in larger cities, across the U.S. than ever before, often these vehicles are “not available in adequate numbers and, in some cases, not at all” (NCD 2015, 264). This may be because vehicles may be locked up in contracts to provide ADA paratransit or other services. Accessible vehicles left “on the street” may not necessarily transport riders who require a wheelchair-accessible vehicle when they can make more money targeting riders who require larger vehicles, like large groups of travelers with luggage. Thus, accessible vehicles may be less available when drivers choose to use these vehicles for more lucrative, non-ADA trips. The NCD (2015) found that entities responsible for enforcing taxi accessibility regulations sometimes “understand the needs of the taxi industry better than the needs of people with disabilities and are not sympathetic to demands for accessible service.” The authors concluded, “While there are always exceptions, without special education, local taxi regulators generally do not ensure that accessible vehicles are on the road at all, let alone providing appropriate service to people with disabilities” (268). The NCD (2015) authors suggested that riders and communities must try to monitor the level and quality of accessible taxi services in an area themselves, and make poor service known to regulators.

DOT ADA regulations for transit operators extend to private transit services when they partner with a public entity to implement a user-side subsidy program (e.g., a voucher programs). To ensure that these subsidy programs do not discriminate against people with disabilities, public entities are responsible for managing their private transit partners, including taxi companies, such that they provide equivalent service to people with disabilities, including individuals who require a wheelchair-accessible vehicle (NCD 2015). This is true even if the subsidy programs are not specifically targeted at people with disabilities. For instance, public subsidy programs for seniors

or people with a low income cannot discriminate against seniors or low-income individuals with disabilities, respectively, under the ADA. Thus, public entities overseeing these programs can require that private partner(s), including taxi services and TNCs, have enough accessible vehicles in their fleet or on their platform, respectively, to provide equivalent service—in terms of response times, geographic areas of service, fares, etc.—to riders that require such vehicles (NCD 2015).

Accessible TNC services

Transit agencies across the country are exploring partnerships with TNCs to identify areas of mutual benefit, and potentially augment traditional services to make public transportation more demand responsive (Grossman and Lewis 2019; Moran et al. 2017; Westervelt et al. 2018). One such area has been identified in providing ADA paratransit services, which are notoriously costly (Puentes 2016; Turmo et al. 2018). An outstanding challenge associated with developing and executing transit agency-TNC partnerships lies in requiring that TNC services adhere to transit agencies' nondiscrimination and accessibility policies (Moran et al. 2017).

The San Francisco Municipal Transportation Agency (2019) recently reported on the state of TNCs and disabled access broadly, with the intent of identifying opportunities and barriers that app-based ridehailing services present for people with disabilities in San Francisco. They reviewed “case study” relationships between public entities and TNCs in the U.S., where cities and transit agencies have attempted to leverage relatively inexpensive, abundant, convenient TNC services to meet public goals while ensuring or incentivizing equal access to these services for people with disabilities. The authors identified a couple of primary mechanisms by which public entities either regulate or work with TNCs to improve the accessibility of these services to people with disabilities, including taxation and other forms of regulation and partnership.

Select cities and the state of California have passed legislation to levy taxes and fees on TNCs in aim of improving access to on-demand transportation services for people with disabilities. California, Chicago, Seattle, and Portland have policies in place that collect fees on TNC rides for funds that are distributed to on-demand providers to offset the cost of providing improved wheelchair-accessible services (Kim and Puentes 2018). In California, TNCs are regulated at the state level by the California Public Utilities Commission (CPUC). In addition to existing state regulations, TNCs are required to adhere to local business registration requirements and airport permit requirements in some areas of the state (SFCTA 2017).

In 2019, California State Senate Bill 1376: The TNC Access for All Act (SB 1376, Hill) went into effect. SB 1376 provides the CPUC with the mandate to improve access to TNC services for wheelchair users and other people with disabilities. Rulemaking for this legislation has allowed CPUC to assess a 10-cent fee on all TNC trips in the state since July 1, 2019, in order to fund on-demand accessible transportation services—specifically, wheelchair-accessible vehicle services. While TNCs may be subject to further regulation in coming years that will influence accessibility requirements, TNCs are not presently subject to provisions of the ADA that apply to transportation providers or public accommodations (Reed 2017; Barnett 2019).

Whether SB 1376 improves wheelchair-accessible TNC services in the state and meets other stated goals remains to be seen.

Transit agency-TNC partnerships are in their infancy, but are growing across the country. The American Public Transportation Association identified over 20 partnerships between transit agencies and TNCs (as well as taxi companies, in some cases) that were formerly piloted, or are currently running in the United States as of June 2020 (APTA 2020). Several cite providing alternatives to traditional paratransit services to people with disabilities, or otherwise serving disabled riders, as a goal.

The Massachusetts Bay Transportation Authority (MBTA) has been running an on-demand paratransit pilot program in addition to its existing paratransit van services since 2016. It's presently working with Uber, Lyft, and Curb Mobility to provide paratransit-eligible riders with on-demand standard or wheelchair-accessible rides that do not exceed set prices. As of 2019, on-demand rides represented approximately 10 percent of total monthly MBTA paratransit trips. An average TNC trip costs the MBTA approximately \$17, while a traditional paratransit van trip costs approximately \$41. Customers have taken more trips using the TNC services since the program's launch, increasing the usage of MBTA's paratransit services overall. However, given the relatively low cost of providing a TNC versus traditional paratransit trip, the pilot program has remained cost-neutral (Barnett 2019). The goals of the program were to reduce the costs of providing paratransit, while improving mobility and flexibility for riders. Riders report that the program has increased their mobility—allowing them to take more trips for socializing, work, and healthcare, among other purposes—and that they are more satisfied with paratransit service than they were before the on-demand pilot program launched (Barnett 2019). Surveys revealed that riders were particularly pleased with the convenience and travel time savings derived from the pilot program.

The benefits of the program have not been distributed to all users equally, it seems, as participation in the program by riders who require a wheelchair-accessible vehicle has been very low compared to participation by riders who do not require an accessible vehicle. This may be due to low availability of wheelchair-accessible vehicles, or poor response times when riders hailed these vehicles (Barnett 2019). In April 2019 a subsidy pilot was initiated by the Massachusetts Department of Transportation and the MBTA to provide a fixed per-hour subsidy (expected to cover about half the cost of supplying wheelchair-accessible vehicles) for each hour that partner TNCs have wheelchair-accessible vehicles available on their platforms. The effect of subsidizing more wheelchair-accessible vehicle service hours will be revealing for future transit agency-TNC partnerships seeking to improve, in particular, on-demand, wheelchair-accessible services for riders with disabilities.

TNCs that are not working with public agencies or receiving public money do not need to comply with ADA regulations for transportation providers. They must, however, ensure that they do not violate federal laws, including the ADA, and state and local laws that protect people from discrimination based on disability. This means that their products, being the mobile apps and websites that riders and drivers on their platform use, must be accessible to everyone, including

people with disabilities who may use accessibility features such as screen reader software. Furthermore, drivers on TNC platforms must comply with state, federal, and local laws protecting disabled riders. Accordingly, drivers are responsible for reasonably accommodating riders traveling with mobility aids (e.g., walkers, folding wheelchairs) and cannot deny service to riders traveling with service animals (NCD 2015).

The two largest TNCs in the U.S., Uber and Lyft, both offer services within their apps specifically to riders with disabilities, or those who might otherwise require special assistance in travel, in some cities. These may or may not be available in addition to wheelchair-accessible vehicle service options (e.g., UberWAV) depending on the service area. UberAssist, which launched in 2015, is a service designed to connect riders who might require assistance with stowing mobility devices or getting in and out of a vehicle. UberAssist drivers have completed independent training from a third-party organization on how to help riders into and out of vehicles and can help load and unload assistive devices that can fit into the trunk of a standard sedan (John 2019). Lyft’s “Access Mode,” which can be enabled in their app, allows passengers in certain markets to request a wheelchair-accessible vehicle. Where those vehicles are not available, information regarding local accessible vehicle dispatches (including paratransit services) is sent directly to the passenger via a text when the “Access” ride is requested (Lyft n.d.). These local accessible vehicle dispatch services operate independently from Lyft, and some, including many ADA paratransit services, may need to be booked at least 24 hours in advance or require riders to be enrolled to use them.

Challenges for taxi/TNC riders

Taxis, and potentially TNCs given their similar service model, may be particularly important transportation options for some people with disabilities who do not have access to other convenient and reliable options like a private vehicle. However, problems of discrimination reported by people with disabilities—in particular by wheelchair users, and those using a white cane or traveling with a service animal—continue to plague these services (NCD 2005, 2015; Magistretti 2019). Riders have reported getting “passed up” (NCD 2005, 125) or stranded by taxis that drive away when they observe a rider traveling with an assistive device and/or a service animal. Taxi discrimination against riders by race and neighborhood has also been documented. Brown (2018) recently reported high levels of racial discrimination by taxi drivers in Los Angeles against black riders. She also found that racial discrimination affected the frequency of TNC trip cancellations and wait times (Brown 2018). People with disabilities have also reported issues with taxis related to quality of service, like rude or insensitive drivers and poor vehicle quality, as barriers to use (Brown and LaValle 2020; NCD 2005).

A lack of available wheelchair accessible vehicles has also been cited as an obstacle to taxi travel for people with disabilities (NCD 2005, 2015). This phenomenon may arise from simply having too few accessible vehicles available, from available vehicles being used for contract services as opposed to traditional taxi services, from accessible vehicle drivers pursuing potentially more lucrative non-ADA trips, or some combination. Evidence from San Francisco

suggests that the rapid expansion of TNCs and resulting disruption of the taxi industry may also have reduced the availability of accessible taxis, as former accessible taxi drivers have transitioned to driving on TNC platforms (Barnett 2019). As TNCs are not held to city regulations for taxis, these drivers are not obligated to use accessible vehicles for ADA-trips as part of the city's paratransit taxi program or otherwise.

Outstanding questions

Growth of TNCs in U.S. cities has far outpaced the establishment of regulatory frameworks for managing these app-based ridehailing services. Accordingly, state and local governments are now considering how to maximize the mobility benefits of these private services while minimizing externalities and protecting particular socioeconomic goals, like equitable service provision (Cetin and Deakin 2019; Circella and Alemi 2018). Understanding whether and how people are using ridehailing is the first step to understanding whether the benefits of these services are distributed equitably. Research is needed on how and why ridehailing use differs between people with and without disabilities, and among people with disabilities. Study of people with disabilities' ridehailing use ought to be situated in a more general inquiry of facilitators and barriers to travel among people with disabilities in contemporary contexts. Only by understanding people with disabilities' mobility experiences and needs, and the challenges that individuals face meeting these needs, will policymakers and planners be able to provide adequate transportation services to this population.

Chapter 3. Use of app-based ridehailing services and conventional taxis by adults with disabilities

In this chapter, I analyze data from the 2017 National Household Travel Survey (NHTS) to explore how people with disabilities use ridehailing nationally, and to identify what factors may explain observed trends in ridehailing use. In line with other works (Brumbaugh 2018; Schaller 2018), I find that people with disabilities use app-based ridehailing at a much lower rate than the general population. This is partly because people with disabilities are older, have lower incomes, and live less in larger cities. But even when controlling for these factors, having a disability predicts lower app-based ridehailing use, suggesting these new services may not be sufficiently accessible to people with disabilities. I consider why this may be the case, and discuss implications for policy.

3.1 Chapter summary and contribution

The importance of reliable transportation as a means to access opportunities, like gaining employment or interacting with others, cannot be understated, particularly for low-mobility groups such as people with disabilities (Brown and Taylor 2018; Rosenbloom 2007). Since 2012, app-based ridehailing services provided by transportation network companies (TNCs), like Uber and Lyft, have come to substantially supplement urban transportation services, with national ridership of TNCs projected to surpass that of public transit buses by the end of 2018 (Schaller 2018). Understanding how people use app-based ridehailing is critical for developing transportation policies and plans that ensure equitable transportation service provision across demographic groups (Circella and Alemi 2018).

In this study, I examined ridehailing use among people with disabilities using the 2017 NHTS, which is the first large, national travel survey in the U.S. with data on TNC use. I use “ridehailing” in this chapter to describe conventional taxicabs as well as on-demand car services including TNCs. TNCs are called “ridesourcing” services in some other publications (e.g., Rayle et al. 2016). I investigated how and whether adults with disabilities, defined as those who reported having a “condition or handicap” that makes it difficult to travel, used ridehailing services. I also sought to understand what other factors, like age, income, smartphone use, and location within urban areas, appeared to affect patterns of ridehailing use. I distinguished between TNC and taxi use when possible with the data.

Confirming the results of other authors, I found that adults with disabilities have much lower monthly TNC use than the general population, while having higher daily ridehailing use including both taxis and TNCs (Brumbaugh 2018; Schaller 2018). I found that adults with disabilities, on average, are older, have lower incomes, use smartphones less, and live relatively more outside of metropolitan areas than adults without disabilities, which partially explains their lower TNC use. But I also found that the relationship between disability and TNC use remained statistically significant even when controlling for other factors that correlate with disability

status—a remarkable result suggesting that disability alone influences ridehailing use. However, I also found that people with disabilities have greater reliance on taxis, on average. Conventional taxis may be currently more accessible to people with disabilities than TNCs are.

I conclude that latent demand for app-based ridehailing is likely high among people with disabilities, and that there may be some impediment to people with disabilities' use of TNCs with implications for government policy to improve access to these services. I offer recommendations for transportation planners and policymakers to make the transportation system accessible to, and inclusive of, people with disabilities, focusing on removing barriers to accessing and using TNCs. This analysis of ridehailing among people with disabilities contributes not only to growing bodies of literature on travel behavior and transportation policymaking in the TNC era, but also to work on disability in planning literature, which remains somewhat scarce (McCormick et al. 2019).

3.2 A review of relevant literature on the travel behavior of people with disabilities

According to recent data from the U.S. Census Bureau, more than 10 percent of American adults aged 18–64 have one or more disabilities. About 8 in 10 people with disabilities are not in the labor force, compared to 3 in 10 people without disabilities (BLS 2020). The Bureau of Labor Statistics reported that in 2019 the proportion of the population in the labor force that was employed was 19.3% for people with disabilities versus 66.3% for people without disabilities. Workers with a disability were more likely to work part-time than those without disabilities (32% versus 17%, respectively). This “disability employment gap” remains pronounced. People with disabilities are employed at less than half of the rate of people without disabilities, despite gains for people with disabilities in recognition, accommodation, and participation that have emerged since the passage of the ADA in 1990 (Schur 2002; Sevak et al. 2015). Difficulty accessing transportation among people with disabilities is a known barrier to employment and to participation in other activities (Loprest and Maag 2001; NCD 2015).

Travel surveys consistently show that people with disabilities travel less and for different purposes than people without disabilities, and that people with disabilities express a desire to take more trips than they do (Brumbaugh 2018; Marston and Golledge 2003; Mattson 2012; Rosenbloom 2007; Shandra 2018). Examining data from the 2009 NHTS, Mattson (2012) reported that people with disabilities took trips at about half the rate of people without disabilities. Brumbaugh (2018) found a similar disparity using 2017 NHTS data.

Conventional taxicabs have long represented an important transportation service for people with disabilities, because people with disabilities are quite often less able to own and operate a personal vehicle (NCD 2005, 2015; Rosenbloom 2003). Using 2017 NHTS data, Schaller (2018) reported that people with disabilities make twice as many for-hire vehicle trips annually as people without disabilities. Making taxis more accessible to people with disabilities, and potentially reducing ADA paratransit costs, has been the goal of a number of transportation policy interventions aimed at improving transportation services for people with disabilities. These

include supply-side programs aimed at retrofitting taxi fleets to include more wheelchair-accessible vehicles, and voucher- and subsidy-based user-side programs intended to make taxis more affordable for riders with disabilities (NCD 2015).

While people with disabilities generally use taxis for a greater share of travel than the rest of the population, they use TNCs less (Brumbaugh 2018; Schaller 2018). App-based ridehailing services are not required to comply with ADA regulations for public transportation providers, unless they participate in voucher or subsidy programs that are publicly funded or otherwise contract with a public entity to operate transit services. Taxis are required to comply with limited ADA regulations as private entities primarily engaged in the business of transportation. These do not require that taxi companies include accessible vehicles in their fleets, but do put requirements on new, non-sedan-type vehicle purchases.

3.3 Data and methods

For this study, I examined data from the 2017 NHTS to investigate how people with disabilities use ridehailing services, including both conventional taxicabs and TNCs. I was particularly interested in comparing use of ridehailing services among people with disabilities and the general population, isolating the effect of disability status on ridehailing use, and understanding what factors may also play a role in the lower use of app-based ridehailing services by people with disabilities. I analyzed how various factors, like location within metropolitan areas, smartphone use, and other sociodemographic characteristics, affect ridehailing use among people with and without disabilities. I then examined the independent correlation of disability status with ridehailing use when controlling for these other factors.

The National Household Travel Survey

The NHTS is a large, nationally-representative travel survey conducted by the Federal Highway Administration (FHWA), representing the primary source of data on household travel behavior in the U.S. The most current version of this survey, the 2017 NHTS, is the eighth in a series of national travel surveys spanning nearly 50 years back to 1969 (“2017 NHTS Data User Guide” 2018). The 2017 NHTS was collected from a stratified random address-based sample of U.S. households between March 2016 and May 2017. The dataset consists of completed surveys from 264,234 individuals aged 5 and over in 129,696 households.

The NHTS did not include questions specifically about whether or not respondents have a disability. However, the survey asked whether respondents “have a condition or handicap that makes it difficult to travel outside of the home.” Answers to this question were coded to a variable labeled MEDCOND in the dataset. This was the variable that we used as a proxy to indicate disability. If respondents answered “Yes” to the MEDCOND question, then they were asked additional questions about how long they have had the condition, as well as questions about whether and how they have adapted their travel behavior as a result of the condition. Respondents who responded “Yes” to MEDCOND were also asked whether or not they used a selection of

medical assistive devices such as wheelchairs and white canes. Brumbaugh (2018), Henning-Smith et al. (2018), and Mattson (2012) also used the MEDCOND variable as a proxy for identifying disability. Brumbaugh (2018) notes that the population of people who reported having a condition that makes it difficult to travel in the NHTS may not include respondents with disabilities who do not consider their condition to be “travel-limiting.” Thus, NHTS estimates of disability differ from estimates derived from other sources, like the American Community Survey.

The 2017 NHTS included two questions that I used to identify and quantify ridehailing use in this study. The first question, appearing on the daily travel diary, allowed respondents to select for each reported trip whether they took it by a selection of mode choices including “Taxi/Limo (including Uber/Lyft).” Conway et al. (2018) note that this specific reference to Uber and Lyft may have resulted in an underreporting of TNC trips made with other companies. However, given that Uber and Lyft dominate the app-based ridehailing market (e.g., Bliss 2017), this effect is likely negligible.

The second question, asked of respondents who were at least 16 years of age, collected information on how many times in the past 30 days they “purchased a ride with a smartphone rideshare app (e.g. Uber, Lyft, Sidecar).” Since people can take rideshare trips purchased by others, the wording of this question may have resulted in an underreporting of TNC trips made by people who took TNCs, but did not purchase the trips themselves. I believe this is unlikely to have a large effect on the results presented here.

Methodology for analyzing ridehailing use

I conducted a two-part analysis to identify trends in ridehailing use among people with and without disabilities, and to quantify the independent effect of disability status on ridehailing use. First I generated descriptive statistics to understand the distribution of characteristics thought to influence ridehailing in the sample, including disability status and other factors known to be associated with ridehailing use. I then conducted logistic multivariate regressions to investigate whether factors other than disability status seemed to be playing a role in explaining differences in ridehailing use observed among people with disabilities, as well as to better understand the independent correlation of disability status with ridehailing use.

I confined the analysis to adults (respondents aged 16 to 64) because the question about monthly app-based ridehailing use was asked only of respondents aged 16 and over. Also, this group represents the target population of most policymaking intended to affect transportation and employment outcomes, and is likely to include most app-based ridehailing users. For all descriptive statistics, I generated and analyzed weighted estimates using weights provided in the NHTS dataset. All descriptive statistics were estimated using nonmissing data (i.e., we performed no imputation or editing of data).

I used standard errors for weighted estimates derived from replicate weights available in the NHTS dataset to calculate 95% confidence intervals for estimates. Unweighted estimates were used for generating regression models. These methods closely track those used by other authors to

analyze travel trends using the NHTS, including Brumbaugh (2018), Conway et al. (2018), and Mattson (2012).

3.4 Descriptive analysis of disability and ridehailing use

Disability demographics in the NHTS

Approximately 6.6% of all adult respondents in the 2017 NHTS reported having a disability. The age distribution for adults with disabilities skewed older than for adults without disabilities; 20.9% of respondents with disabilities were aged 16 to 34, in contrast to 40.7% of respondents without disabilities. A greater percentage of adults with disabilities reported their sex as female than male (53.7% versus 46.3%, respectively). Adults without disabilities had approximately equal percentages of female- and male-identifying respondents. 19.9% of adults with disabilities reported working full- or part-time, versus 74.4% of adults without disabilities. People with disabilities lived more in households with lower incomes; 50.4% of adults with disabilities reported annual household incomes of less than \$25,000, versus 15.5% of adults without disabilities.

Adults with disabilities less frequently reported using mobile devices to access the internet, including smartphones and tablets. 66.5% of adults with disabilities reported using a smartphone daily, in contrast to 86.6% of adult respondents without disabilities. As purchasing app-based ridehailing trips relies on using these devices, lower smartphone and tablet use likely contributes to low TNC use among adults with disabilities.

As shown in Figure 2, adults with disabilities were more likely to live outside of a metropolitan area compared to adults without disabilities, and were less likely to live in a large metropolitan area.

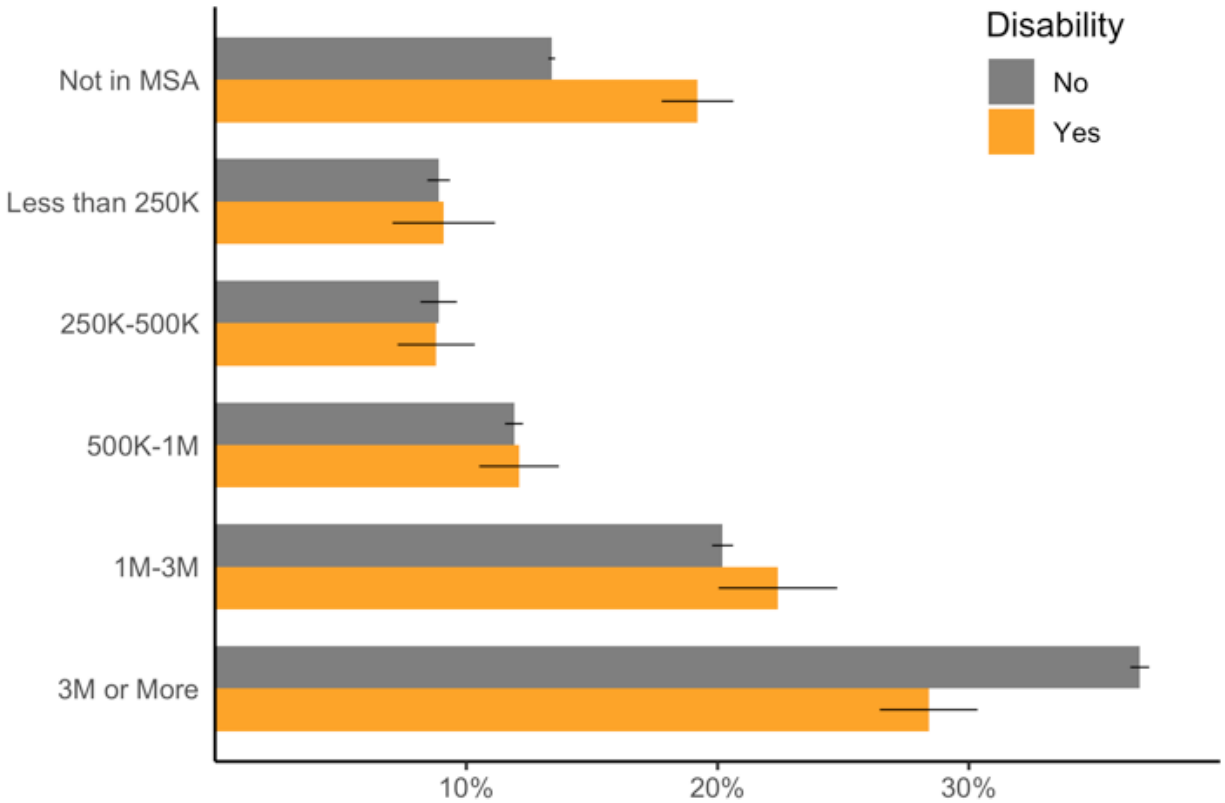


Figure 2. Percentage distribution of respondents’ home metro area size by disability status. *Black lines indicate 95% confidence intervals. N = 151,631 for respondents who reported not having a disability; weighted population size = ~194,269,400. N = 10,779 for respondents who reported having a disability; weighted population size = ~13,632,930.*

A majority of adults with disabilities reported that they did not use a medical assistive device for traveling (53.6%). Of those who did, the majority used devices that aid in walking, including support canes, walkers, wheelchairs and scooters, and crutches. A small percentage of respondents reported using mobility aids for people with visual impairments, including dog assistance and white canes (1.4% and 1.2%, respectively).

Trends in ridehailing use

Nationwide, 11.6% of adult respondents reported having used TNCs in the last month. More adults used TNCs in larger metropolitan areas. Nearly 1 in 5 adults in the largest metro areas (19.6%) reported having used app-based ridehailing services. Taxi/TNC trips represented approximately 0.6% of all daily trips for adults. Taxi/TNC trips constituted a greater share of trips in the largest metropolitan areas—those with 3 million people or more—than in smaller metro areas (1.1% versus <0.5%, respectively). 4.5% of adult respondents with disabilities reported using TNCs in the last month, compared to 12.1% of adults without disabilities. App-based ridehailing use appeared to be highest among people who used white canes and crutches, and

lower among people who used other mobility aids, including service animals and wheelchairs, but these differences were not statistically significant with 95% confidence, likely due to small sample sizes. People with disabilities consistently used TNCs less than people without disabilities across metro areas of all sizes (Figure 3).

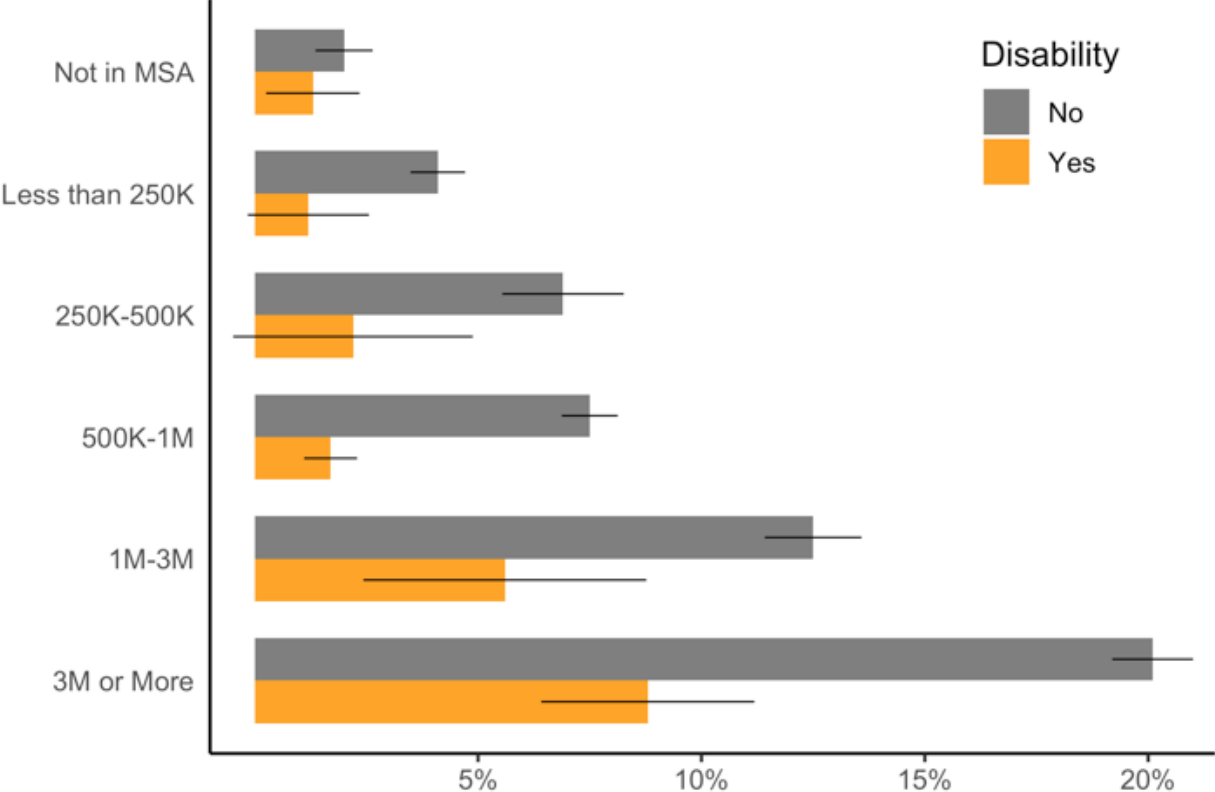


Figure 3. TNC use among adults by disability status and metropolitan area size. *Black lines indicate 95% confidence intervals. N = 15,626 for respondents who reported not having a disability; weighted population size = 23,403,977. N = 372 for respondents who reported having a disability; weighted population size = 614,087.*

People with disabilities used ridehailing services more for daily trips than the general population. Adults with disabilities reported 1.1% of daily trips in the taxi/TNC category, versus 0.6% reported by adults without disabilities. I did not observe statistically significant differences with 95% confidence in the daily mode share of taxi/TNC trips among adults by disability status based on whether or not respondents were located in a metro area, or based on metro area size.

3.5 Regression Analysis of the Relationship Between Disability and Ridehailing Use

Results of my binomial logit models confirm descriptive trends. I found that adults with disabilities in the NHTS were more likely to be older, female, lower-income, and to live in smaller metro areas than adults without disabilities, and that these factors decreased the probability of using TNCs. Having a disability also decreased the probability of using TNCs even when controlling for these other factors.

In simple regression analyses where I regressed ridehailing use on disability status, I found that the odds of using TNCs were 69% lower for people with disabilities, while the odds of taking a taxi/TNC trip were 77% higher for people with disabilities. After controlling for other factors correlated with disability status in multivariate models, I found that having a disability decreased one's odds of using TNCs by 21%. Odds of taking a daily taxi/TNC trip did not significantly change between simple and controlled models, but did remain higher for people with disabilities.

Looking more closely at the controlled model of TNC use in the last month shows that use of TNC services decreased significantly with age, particularly for those aged 35 or older (Table 1, column 1). As people with disabilities are older than people without disabilities, this provides a partial explanation of their lower TNC use. TNC use also decreased significantly for those with annual household incomes of less than \$100,000, and increased significantly for those with annual household incomes of more than \$100,000. Having lower income contributed to relatively lower TNC use among people with disabilities. Those who had higher degrees were more likely to use TNCs. This contributed to lower use of TNCs among people with disabilities, as individuals with disabilities have lower educational attainment than the general population (BLS 2020). Having worked in the last week was associated with greater use of TNCs. People with disabilities are much less likely to be employed than people without disabilities (BLS 2020), which further contributed to their low use of TNCs.

Being female was associated with lower use of TNCs. This may also provide a partial explanation of lower TNC use among adults with disabilities in the sample analyzed. An absence of children in one's household was significantly associated with greater TNC use. 67.3% of adults with disabilities in the NHTS reported having no children in their household, compared to 47.4% of people without disabilities. Considered alone, living in households without children might contribute to greater use of TNCs. These regression results suggest that the odds of using TNCs are lower among people with disabilities regardless. I did not find significant relationships among race and Hispanic status predictors and TNC use, with the exception that Asian individuals were slightly less likely than whites to use TNCs.

Finally, use of TNCs remained significantly associated with home metro area size in the controlled model. The magnitude of this relationship was markedly higher for the largest metro areas. This accounts for part of the relationship between TNC use and disability status in the sample, as I found that people with disabilities reported living less in metro areas and, especially,

in large metro areas than people without disabilities. This offers additional explanation for why people with disabilities used TNCs less than people without disabilities.

Turning attention to the model for daily taxi/TNC trips (Table 1, column 2), which has lower statistical significance due to small numbers of reported daily taxi/TNC trips. People over the age of 35 were less likely to take a daily taxi/TNC trip than younger riders. Adults with disabilities in the NHTS were generally older than adults without disabilities. The probability of taking a taxi/TNC trip remained higher for adults with disabilities regardless. Daily taxi/TNC trips were significantly lower for those with a household income of less than \$200,000. This, too, would suggest that people with disabilities should use taxi/TNCs less, since they have lower incomes than people without disabilities. However, I did not find that people with disabilities had lower daily taxi/TNC use.

Daily taxi/TNC use was not significantly related to either educational attainment or sex. Moreover, no clear relationships were observed among race and Hispanic status predictors and daily taxi/TNC use. Worker status also did not correlate significantly with daily taxi/TNC use. Households without children were significantly more likely to have made a daily taxi/TNC trip, which might contribute to people with disabilities' greater odds of taking a taxi/TNC trip.

Odds of making a daily taxi/TNC trip significantly increased for those living in metro areas with more than 1 million people. People with disabilities tended to live more outside of metro areas and relatively less in large metro areas. I nevertheless found that the odds of taking a daily taxi/TNC trip were higher among people with disabilities.

Table 1. Logistic regression results.

	Used TNC in the last month	Made Taxi/TNC trip on travel day
Disability status (base: Has no disability)		
Has a disability	0.794*** (0.703, 0.885)	2.187*** (1.707, 2.667)
Age (base: 16-24)		
25-34	0.912*** (0.852, 0.973)	1.115 (0.886, 1.344)
35-44	0.557*** (0.519, 0.596)	0.735*** (0.575, 0.895)
45-54	0.304*** (0.283, 0.326)	0.482*** (0.377, 0.587)
55-64	0.160*** (0.149, 0.172)	0.345*** (0.270, 0.420)
Household Income (base: Less than 25K)		
25K to 50K	0.798*** (0.733, 0.864)	0.406*** (0.315, 0.497)
50K to 100K	0.898*** (0.833, 0.963)	0.506*** (0.412, 0.599)
100K to 200K	1.328*** (1.232, 1.424)	0.601*** (0.488, 0.714)
Over 200K	2.997*** (2.756, 3.239)	1.607*** (1.286, 1.928)
Education (base: Less than a high school graduate)		
High school graduate or GED	1.364*** (1.175, 1.553)	0.892 (0.631, 1.152)
Some college or associates degree	2.582*** (2.251, 2.912)	0.750** (0.538, 0.961)
Bachelor's degree	4.800*** (4.182, 5.419)	1.135 (0.814, 1.455)
Graduate degree or professional degree	5.602*** (4.868, 6.336)	1.260 (0.894, 1.625)
Sex (base: Male)		
Female	0.859*** (0.828, 0.889)	1.013 (0.902, 1.124)
Race (base: Non-Hispanic White)		
Non-Hispanic Black	1.008 (0.932, 1.083)	1.251** (0.999, 1.503)
Non-Hispanic Asian	0.830*** (0.773, 0.887)	0.989 (0.784, 1.193)
Non-Hispanic Other	1.119** (1.017, 1.220)	1.287* (0.960, 1.615)
Hispanic status (base: Non-Hispanic)		
Hispanic	1.080** (1.015, 1.145)	1.039 (0.845, 1.234)
Worker Status (base: Did not work in last week)		
Worked in last week	1.384*** (1.315, 1.453)	0.997 (0.853, 1.141)
Children in Household (base: Children in household)		
No children in household	2.144*** (2.057, 2.231)	2.353*** (2.034, 2.672)
Home MSA Size (base: Not in MSA)		
250K or less	1.687*** (1.489, 1.884)	1.215 (0.850, 1.580)
250K-500K	3.228*** (2.856, 3.600)	1.193 (0.796, 1.589)
500K to 1M	2.968*** (2.641, 3.294)	1.040 (0.715, 1.365)
1M-3M	4.759*** (4.257, 5.261)	2.019*** (1.465, 2.573)
3M or more	6.768*** (6.083, 7.454)	3.437*** (2.570, 4.304)
Constant	0.008*** (0.007, 0.009)	0.005*** (0.003, 0.006)
Observations	158,284	161,953
Pseudo R2	0.18	0.08

*p<0.1; **p<0.05; ***p<0.01

Note: Odds ratios reported, followed by 95 percent confidence intervals in parentheses.

3.6 Conclusions and policy implications

My analysis of data from the 2017 National Household Travel Survey—the first large, national travel survey with data on TNC use—reveals that a number of factors related to sociodemographic and built-environment characteristics influence ridehailing use among people with and without disabilities, but that controlling for other factors does not change the fact that having a disability is statistically associated with lower monthly TNC use and higher daily taxi/TNC trips. This study is the first in ridehailing literature to isolate and explicate the

relationship between disability status and use of ridehailing services, including both conventional taxis and TNC services. Results confirm that disability status independently correlates with ridehailing use, and clarify how other factors influence use of app-based ridehailing services and of conventional taxicabs among people with disabilities.

These results are consistent with descriptive trends which indicate that people with disabilities use taxis for a greater share of travel than people without disabilities, but use TNCs less than people without disabilities. They further suggest that other predictors of travel behavior influence people with disabilities' ridehailing use, including age, income, educational attainment, employment status, household size, and home metro area size.

The finding that combined taxi and TNC use constitutes a larger share of daily trips for people with disabilities is not new (Brumbaugh 2018; Schaller 2018); nor is it surprising given ample evidence that taxis are an important transportation mode for people with disabilities (NCD 2005, 2015; Rosenbloom 2003). Since I found that people with disabilities used TNCs less than the general population, it follows that conventional taxi trips likely represented the large majority of daily taxi/TNC trips made by people with disabilities. The finding that people with disabilities use ridehailing services more than the general population in the day-to-day suggests that there exists a relatively high latent demand for on-demand, curb-to-curb transportation service among this group. It is surprising, then, that people with disabilities use TNCs less than the general population, considering TNCs operate with a similar service model to taxis.

What, then, are barriers to greater TNC use among people with disabilities? Lack of awareness of these services; affordability concerns; smartphone ownership, access, and/or use; inaccessible applications and vehicles; and driver discrimination against riders with visible disabilities are all likely to play a role. Since adults with disabilities live more outside of metropolitan areas than people without disabilities, this group may also have less access to TNC services simply because they are less available in rural areas. Though not significant at 95% confidence, likely due to small sample sizes, I observed that ridehailing use was higher among people who used white canes and crutches, and lower among people who used other mobility aids, including service animals and wheelchairs. This evidence supports anecdotal reports that driver discrimination against wheelchair users and those traveling with service animals may deter these individuals from using TNCs. Furthermore, motorized wheelchair and scooter users cannot ride in standard vehicles, and transferring to standard vehicles may be difficult for some people with disabilities. This presents an enormous challenge to using TNC services, which do not own the vehicles or employ the drivers that serve their platforms.

TNCs, and policymakers and planners responsible for regulating conventional and emerging transportation services, should aim to make app-based ridehailing more accessible to people with disabilities as the ridehailing market continues to grow. With this objective in mind, several state and local governments have proposed, and in some cases, passed legislation aimed at improving TNC accessibility (Barnett 2019). For example, in September 2018, California passed State Senate Bill 1376, the "TNC Access for All Act." Beginning in July 2019, SB 1376 required that TNCs pay a fee to the state—which is collected from riders at a value of 10 cents per ride—

that contributes to an “Access Fund.” Money from the Access Fund will be redistributed to TNCs and other entities to provide improved on-demand transportation services to people with disabilities across the state. This fee model, which has been similarly used to regulate TNCs elsewhere in the U.S., is one policy instrument that might improve people with disabilities’ access to on-demand transportation on the supply side.

While this policy approach may make ridehailing more accessible to people with disabilities by increasing the availability of accessible, on-demand vehicles, it does not address people with disabilities’ user-side barriers to using TNCs, like transportation affordability, or smartphone or TNC app accessibility. Results of this research show that individual characteristics, including disability status, are important predictors of ridehailing use. And that TNC use is lower among people with disabilities, but that taxi use remains relatively higher.

Learning more about the complex barriers to greater TNC use may require working closely in collaboration with individuals with disabilities and disability advocacy groups—those who best understand the lived experience of using transportation with a disability (Simon et al. 2013). Ethnographic investigation into this subject could also help policymakers understand what factors contribute to individuals with disabilities’ travel choices and broader group travel trends (Clifton and Handy 2001). Crafting policies to eliminate these barriers may necessitate not only regulating TNCs, but also enforcing disability accessibility more broadly across modern transportation infrastructure and services, which include physical road and vehicle infrastructure but also, increasingly, digital infrastructure (e.g., mobile apps) required for planning and purchasing trips (Gebresselassie and Sanchez 2018).

Reducing the cost of transportation for people with disabilities using vouchers and subsidies represents a promising direction for policies aiming to improve access to on-demand transportation services. Samuel et al. (2013) found that a transportation voucher program in Michigan effectively increased people with disabilities’ out-of-home travel, community participation, and other measures of well-being. Vouchers have also been used effectively with public and private transportation providers to offer rural transportation to people with disabilities (Gonzales et al. 2006). In San Francisco, taxis serve approximately one-third of paratransit trips through subsidized rides (Williams 2014). There are opportunities for transportation oversight agencies to partner with on-demand service providers, like taxis and TNCs, to provide subsidized rides for people with disabilities (Mulley and Nelson 2016). Making TNCs more affordable to people with disabilities might make them more feasible and attractive options.

Results of this research suggest that inclusive transportation policies in the era of ridehailing should acknowledge and address nuance in the relationship between disability and ridehailing use. It seems people with disabilities are older, have lower incomes, use smartphones less, and live in more rural areas than people without disabilities, offering a partial explanation of their lower TNC use. More research is needed on why and whether individuals with disabilities use or do not use ridehailing, among other services. Clarifying enablers and barriers to traveling for this population could reveal where to target specific policy interventions for disability accessibility and how to promote their efficacy.

Chapter 4. How and why do people with disabilities use app-based ridehailing?

In this chapter, expanding upon findings from Chapter 3, I draw on qualitative insights to identify and explain barriers and facilitators to using app-based ridehailing among people with disabilities. Analyzing in-depth interviews with a diverse sample of 32 individuals with disabilities living in the San Francisco Bay Area, I find that attitudes towards and use of app-based ridehailing services, like Uber and Lyft, depend on respondents' prior experience using transportation and smartphones. Older adults and those who acquired disabilities later in life had difficulty using ridehailing due to perceived and experienced challenges hailing a ride, finding the vehicle, and getting to their destination independently. Younger respondents and those who had lived with their disabilities longer perceived app-based ridehailing to be reliable and convenient, and found it relatively more affordable than conventional taxicabs. They liked having app-based ridehailing as an available option. This was also true among respondents who used motorized wheelchairs, but they said that the availability and quality of wheelchair-accessible ridehailing services are presently lacking. Subsidizing app-based ridehailing may encourage greater use of these services among some people with disabilities; however, this approach, as well as new policies aimed at improving wheelchair-accessible ridehailing services, does not address expressed barriers to ridehailing use among older adults with disabilities.

4.1 Chapter summary and contribution

In the last decade, app-based ridehailing services have become ubiquitous in hundreds of U.S. cities, which poses opportunities and challenges for policymakers and regulators (Moran et al. 2017). Transit agencies across the country are exploring partnerships with TNCs to identify areas of mutual benefit, and potentially augment traditional services to make public transportation more demand responsive (Grossman and Lewis 2019; Moran et al. 2017; Westervelt et al. 2018). One such area identified is providing ADA paratransit services, which are notoriously costly (Puentes 2016; Turmo et al. 2018). In 2010 the average cost of providing a paratransit trip was nearly \$30, compared to an average cost of just over \$8 to provide a fixed-route transit trip (GAO 2012).

An outstanding challenge associated with developing and executing transit agency–TNC partnerships lies in passing legislation that obligates TNC services to adhere to nondiscrimination and accessibility policies that apply to public transportation providers (Moran et al. 2017). App-based ridehailing services are not required to comply with ADA regulations for transportation providers. Conventional taxicabs are required to comply with limited ADA regulations, and must comply with additional regulations in cases where transit agencies contract with taxi companies to provide paratransit services (Peciak 2019).

Select cities and the state of California have passed legislation to levy taxes and fees on TNCs with the goal of financing programs to make TNC services more accessible to people with

disabilities. California, Chicago, Seattle, and Portland have policies in place that collect fees on TNC rides for funds that are distributed to on-demand providers to offset the cost of providing wheelchair-accessible services (Hill 2018; Kim and Puentes 2018).

To meet stated goals of improving on-demand transportation services for people with disabilities, TNC–paratransit partnerships and new accessible ridehailing policies must make TNCs more accessible to people with disabilities. This requires making TNC services easier for people with disabilities to use. But what makes it easy or difficult for people with disabilities to use app-based ridehailing?

In this study I draw from 32 in-depth interviews conducted with people with disabilities living in the San Francisco Bay Area to identify key characteristics, experiences, and considerations that influence their decisions to use app-based ridehailing. Qualitative methods are well suited to researching the complexities of travel behavior (Clifton and Handy 2001). Understanding why people make transportation decisions can help policymakers and planners predict how different groups of interest will respond to changes in transportation policies and operations. Findings of this study shed light on how TNC–paratransit pilot programs and new wheelchair-accessible ridehailing policies may affect travel behavior, and whether these initiatives are poised to meet stated goals.

To my knowledge, no other transportation studies have used in-depth interviews with people with disabilities in the U.S., or any other population of interest to transportation professionals, to better understand choices surrounding individuals’ ridehailing use. Authors have published studies on ridehailing in transportation and planning journals that rely on ethnographic methods to understand drivers (Anderson 2014; Attoh et al. 2019), and survey-based methodologies (e.g., Rayle et al. 2016) as well as secondary analysis of travel surveys to understand riders (e.g., Alemi et al. 2018; Henly and Brucker 2019). Analyzing semi-structured interviews conducted with 14 frequent taxi and ridehailing users in Los Angeles, Brown and LaValle (2020) recently found that travelers perceived ridehailing services to be more affordable, reliable, and accountable—in terms of responding to passenger complaints and service issues—than taxis.

Scholars writing about human-computer interactions (HCI) and computer-supported cooperative work (CSCW) have used interview-based methodologies to understand how groups of interest, including people with disabilities, older adults, and low-income populations, use ridehailing, and how ridehailing facilitates particular experiences and interactions. In these studies, riders found app-based ridehailing services to be reliable and convenient, and benefited from interacting positively with drivers (Dillahunt et al. 2017; Kameswaran et al. 2018a, 2018b). Glöss et al. (2016) reported that Uber riders in San Francisco and London felt that app-based ridehailing was a more affordable, comfortable, and safer option than taxis. Kameswaran et al. (2018b) found that being able to hail a TNC ride on one’s own fostered feelings of independence among a sample of people with visual impairments in metropolitan India where other modes are largely inaccessible. Meurer et al. (2014) found that ridehailing made some older adults in Germany feel less dependent on others for meeting their mobility needs when they did not have

access to other reliable and convenient forms of transportation, like their own car or public transportation.

This study makes a unique contribution to transportation research by investigating how and why people with disabilities use, or do not use, app-based ridehailing in the United States. I find that ridehailing behavior differed among respondents based on their age and their past experiences using transportation and smartphones with a disability. Respondents who were older and acquired a disability later in life had difficulty using app-based ridehailing, as they found hailing a ride, finding the vehicle, and getting to their destination independently to be challenging. Younger respondents and those who had lived with their disabilities longer perceived app-based ridehailing to be reliable and convenient, and said that they found it relatively more affordable than taxis. They liked having TNC services as an available option. This was also true among respondents who used motorized wheelchairs, but they said that the availability and quality of wheelchair-accessible TNC services are presently lacking. My findings suggest that subsidy programs and policies aimed at improving wheelchair-accessible ridehailing services are unlikely to facilitate ridehailing use among older adults who acquired disabilities later in life and face additional barriers to using technology and transportation.

4.2 Review of qualitative literature on the travel behavior of people with disabilities

In 2002, the Bureau of Transportation Statistics conducted a national survey “to identify the impact of transportation on the work and social lives of people with disabilities” (BTS 2003, 1). Respondents were asked about what types of transportation they used for local and long-distance travel, as well as their attitudes towards these services and barriers that kept them from using transportation. Over half a million people with disabilities who reported never leaving the home said that they experienced transportation difficulties. No or limited access to public transit was the most cited difficulty to accessing transportation among people with disabilities, followed by not having a car, experiencing challenges using transportation as a result of disability, and having “no one to depend on” to assist with transportation.

According to the survey, people with disabilities did not have fewer transportation services available to them than people without disabilities based on where they lived. However, in this survey and others conducted since, people with disabilities reported greater difficulty accessing adequate transportation than people without disabilities, or transportation that is both usable and useful for getting people where they want to go, when they want to travel (e.g., Bezyak et al. 2017; Lubin and Deka 2012; Mattson et al. 2010). For instance, using a survey of people with disabilities in North Dakota, Mattson et al. (2010) found that respondents desired more trips than they were currently taking, and were dissatisfied with public transportation options available to them because of unavailable or insufficient weekend or holiday hours and long waiting times, among other concerns.

Based on a large online survey of people with disabilities disseminated through the National Network of ADA Centers, Bezyak et al. (2017) found that the difficulties people with disabilities encounter in using public transit and complementary paratransit systems vary based on the nature of people's disabilities. For example, people who are blind or have low vision reported encountering problems related to accessing wayfinding information, like drivers not calling out stops, significantly more than people with other types of disabilities. Respondents with mobility disabilities encountered a greater variety of obstacles to using public transit than other respondents, many related to inaccessible infrastructure and equipment. People who were blind or have low vision and those with mobility disabilities reported more problems with drivers related to inappropriate attitudes and lack of knowledge about accommodating riders with disabilities than other respondents.

People with disabilities also experience different difficulties related to accessing and using private vehicles based on the nature of an individual's disability and other sociodemographic characteristics. For instance, using an online survey of people with disabilities and caregivers of people with disabilities in Australia, Darcy and Burke (2018) found that people who had their disabilities since birth perceived costs related to owning and/or modifying a private vehicle to be more significant barriers to modified vehicle ownership than people with acquired disabilities. While people with disabilities do use public transportation at a greater rate than the rest of the population, people with and without disabilities still use private vehicles for most trips (Brumbaugh 2018). It is therefore important to understand people with disabilities' use of and attitudes towards for-hire vehicle services, like TNCs, as well as public transit to get a full picture of transportation accessibility for this population.

Reviewing secondary sources like news reports, and drawing from primary interviews with accessible transportation stakeholders from around the U.S., the National Council on Disability (NCD) evaluated how taxicabs and TNCs are serving people with disabilities. They identified convenience as the major benefit of these on-demand services. The NCD (2015) cited inaccessible vehicles and anecdotal evidence of unlawful discrimination against riders with visible disabilities as major issues with taxis and TNCs. The report also raised concerns related to foreseen difficulty regulating TNCs in a manner that would guarantee people with disabilities equivalent levels of service (e.g., comparable waiting times) to those received by people without disabilities. Furthermore, authors worried about TNCs crowding out conventional taxis, which, unlike app-based ridehailing services, must comply with the ADA as well as additional accessibility regulations in many jurisdictions.

Using data from the 2017 National Household Travel Survey (NHTS), and confirming results of other authors (Brumbaugh 2018; Schaller 2018), I found that people with disabilities use taxis for a greater share of travel than people without disabilities (Chapter 3). This is expected given the past documented reliance on taxis by people with disabilities (Rosenbloom 2007). But people with disabilities use TNCs much less than the rest of the population. Results of this research shed light on why this may be the case.

4.3 Accessible transportation in the San Francisco Bay Area

Transit agencies in San Francisco and other Bay Area cities have long-expressed commitments to providing accessible transportation for people with disabilities, even before the passage of the ADA in 1990. The San Francisco Municipal Transportation Agency (SFMTA) has operated paratransit programs for people unable to use Muni fixed-route transit services since 1978 (Barnett 2019). Today, SFMTA's Taxi & Accessible Services Division (TAS) is responsible for ensuring people with disabilities can access all transportation modes in the city including Muni and SF Paratransit, as well as taxis and emerging services like app-based ridehailing and shared scooter services, among others.

The Bay Area region's transportation system includes transit services provided by more than 20 different agencies (MTC 2015). Wherever transit services exist, complementary ADA paratransit services must also be provided for eligible riders. In most cities in the Bay Area, paratransit trips must be reserved one to two days in advance.

Both Uber and Lyft, the largest app-based ridehailing companies in the U.S., are headquartered in San Francisco, and have operated in the Bay Area since 2013. Taxis and TNCs operate all over the Bay Area. Taxis are licensed and regulated by municipal agencies. TNCs are regulated and overseen at the state level in California, by the California Public Utilities Commission (CPUC). In addition to existing state regulations, TNCs are required to adhere to local business registration requirements and airport permit requirements in some areas of the state (SFCTA 2017).

In 2019, California State Senate Bill 1376: The TNC Access for All Act (Hill 2018) went into effect. SB 1376 provides the CPUC with the mandate to improve access to TNC services for wheelchair users and other people with disabilities. Rulemaking for this legislation has allowed CPUC to assess a 10-cent fee on all TNC trips in the state since July 1, 2019, in order to fund wheelchair-accessible TNC services. While TNCs may be subject to further regulation in coming years that will influence accessibility requirements, TNCs are not presently held to provisions of the ADA that apply to transportation providers or public accommodations (Barnett 2019; Reed 2017).

4.4 Interviews of people with disabilities

I conducted 32 in-depth interviews of people with disabilities in the San Francisco Bay Area in September and October 2019, exploring how and why people with disabilities use app-based ridehailing services. Respondents were age 18 and older, living in the nine county San Francisco Bay Area, and self-reported having a disability. I employed a combination of purposive and snowball sampling techniques to reach respondents. I initially distributed solicitations for research participants through two Bay Area organizations serving people with disabilities: LightHouse for the Blind and Visually Impaired and The Center for Independent Living. Both of these organizations offer education, training, and social programs for people with disabilities, and provide advocacy for the local community of people with disabilities. As individuals come to

these organizations through many avenues, including referral by state rehabilitation counselors, those seeking services are quite diverse.

People who received the research solicitation through these organizations' communication channels were invited to pass it along to others. After responding to my solicitation for research participants via email, potential respondents were sent a message to schedule an interview. In this message I suggested some interview locations, including space at supporting agencies' offices in San Francisco and Berkeley, as well as at the University of California, Berkeley. Many respondents chose to complete interviews at these locations, which are easily accessible by Bay Area Rapid Transit (BART), and other transit and paratransit services. All respondents were allowed to ultimately choose the location and times of their interviews, so some interviews were conducted at respondents' homes.

I used a pre-approved protocol (see Appendix A) to structure and guide interviews. Interviews were audio recorded with respondents' permission. Discussions ranged from 22 to 62 minutes in length.

My sampling strategy was not intended to produce a sample that is representative of any larger population of people with disabilities. However, I did try to capture a relatively heterogeneous sample of people based on sociodemographic characteristics like age and gender, as well as based on disability type. Select sociodemographic information for respondents is summarized in Table 2. The median age of respondents was 64 years old. 56.3% of respondents were female, and 43.8% were male. A majority of respondents reported being blind or having low vision as their primary disability.

Table 2. Summary characteristics of respondents.

<i>N</i> = 32	
<i>Age</i>	
29-64	17 (53.1%)
65-93	15 (46.9%)
<i>Gender</i>	
Female	18 (56.3%)
Male	14 (43.8%)
<i>Disability status</i>	
Blind/low vision	18 (56.3%)
Deaf/hard of hearing	1 (3.1%)
Mobility disability	5 (15.6%)
Multiple disabilities	4 (12.5%)
Chronic illness	4 (12.5%)

Most respondents in this study reported using a mobility aid when traveling outside of the home. Respondents with visual impairments or who have multiple disabilities used a white cane and/or a service animal. Respondents with hearing impairments used hearing aids. Respondents

who had mobility disabilities or multiple disabilities used support canes, walkers, and manual and motorized wheelchairs.

While I attempted to recruit participants for this study from all over the Bay Area in order to capture perspectives from residents living in areas with different built environment characteristics and transportation conditions, most respondents lived in the East Bay. A map of respondents' reported cities of residence is shown in Figure 4. Also shown are routes for regional and local transit systems that respondents mentioned in interviews.

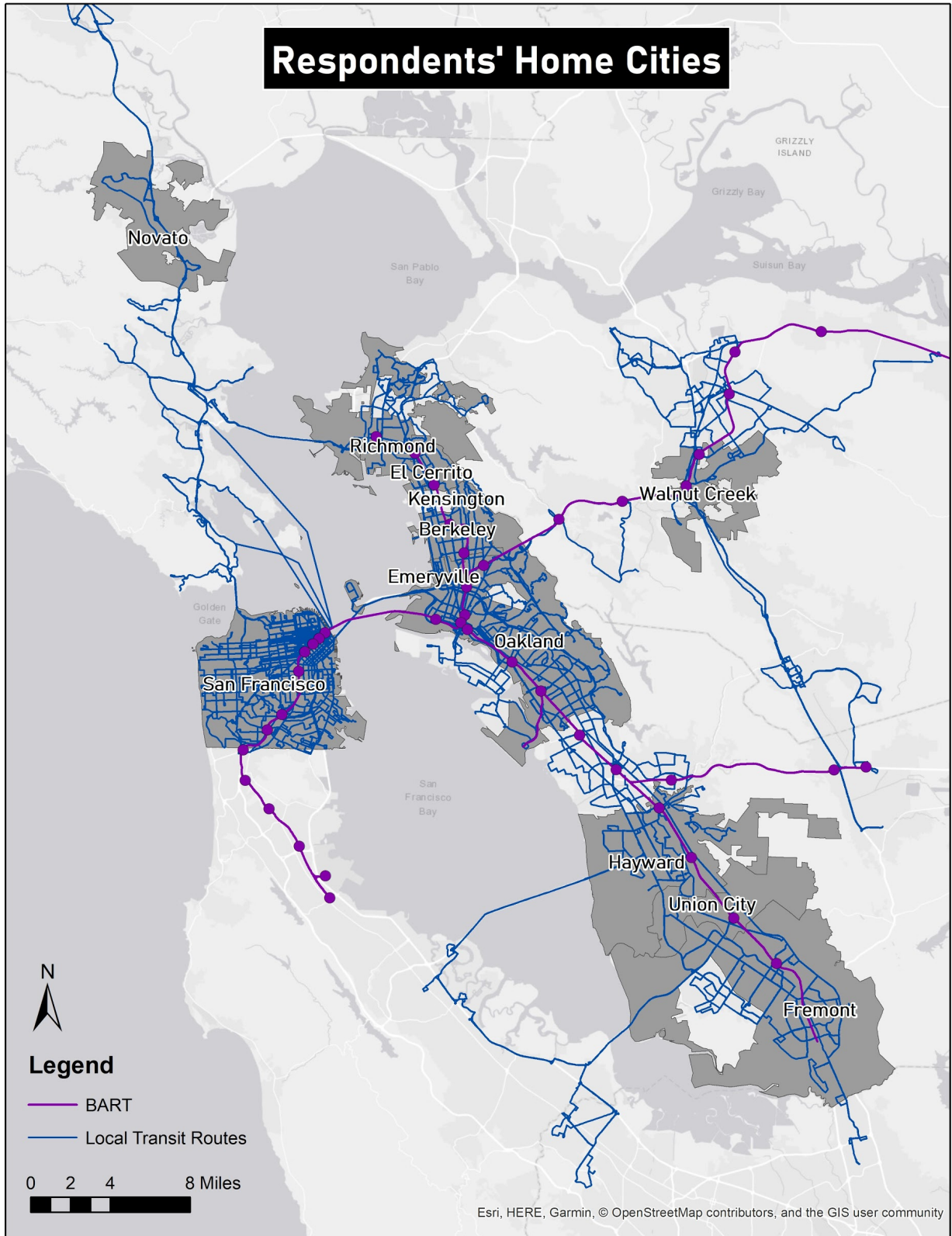


Figure 4. Respondents' home cities and routes for mentioned transit systems.

Data cleaning and analysis

I recorded full interviews for all 32 respondents in this study and, with assistance from four trained undergraduate research assistants, cleaned interview transcripts verbatim. We used Dedoose, a web application designed for doing mixed methods research, to code interviews. Dedoose was quite useful for coding collaboratively, as the app allowed my research assistants and I to work seamlessly in the same environment. It was also advantageous for identifying and visualizing trends in the data based on the occurrence and co-occurrence of codes within and between transcripts. The web-based nature of the tool was both a benefit and drawback of using Dedoose, for it meant that all doing research needed to have internet access to work in the environment. While this may be inconvenient for performing analyses in the field, it was fine for this study, which only required collecting data, not processing or analyzing data, in the field.

I followed a “flexible coding” approach for analyzing interviews, proposed by Deterding and Waters (2018). This involved developing a coding scheme that required, first, assigning each transcript attributes, or “conceptual categories that guided the research design” (Deterding and Waters 2018, 16). In this case, attributes reflected respondents’ sociodemographic characteristics, city of residence, and use of mobility aids. Then, all transcripts were coded using broad index codes, which reflected questions asked in the interview protocol. For instance, answers to the question, “Do you ever use services like Uber or Lyft?”, were assigned the index code: “Index App-Based Ridehailing.” We applied 20 first-order index codes in the first phase of coding.

In the second phase of coding, I applied analytic codes, representing finer-grained concepts used for understanding themes and identifying patterns in the data (e.g., “Affordability”), to the transcripts. I looked at instances of code co-occurrence to pull out relevant interview excerpts on subjects of interest. For example, to examine how respondents felt about the relative convenience of app-based ridehailing and taxis, I looked at excerpts coded with “Convenience” and “App-based ridehailing” and/or “Taxis.” I applied 60 first-order analytic codes, in addition to more than 50 second- and third-order codes. After fully coding all 32 interview transcripts, we ultimately generated approximately 2,000 excerpts, applying codes in nearly 4,000 instances.

Limitations

The sample of respondents in this study is not representative of the greater population of individuals with disabilities in the U.S. Notably, it boasts much greater representation of people who are blind or have low vision. According to recent American Community Survey estimates, approximately 12.7% of Americans have a disability. Of these nearly 21 million people, 51.4% have an ambulatory (mobility) disability, 28.3% have a hearing disability, and 18.5% have a vision disability (Lauer and Houtenville 2019). This is likely an outcome of this project’s recruitment strategy, provided one of the organizations that disseminated the call for research participants is an agency that serves individuals with visual impairments.

Respondents in this study reported using a mobility aid for out-of-home travel more than would be expected in a representative sample, given 57.8% of people with disabilities reported

using a mobility aid in the 2017 NHTS (Brumbaugh 2018) versus 88% of this study's sample. I suspect that self-selection bias among people with disabilities who are interested in and do travel outside of the home motivated an over-representation of people who regularly use mobility aids and transportation in this study. This is further supported by the fact that over two-thirds of respondents in this study (23) chose to complete interviews at locations that they traveled to, rather than in their homes.

4.5 Findings

Attitudes towards and use of app-based ridehailing differed based on individuals' personal characteristics and circumstances, as well as their past experiences using transportation and smartphones with a disability. The following sections explain what respondents found to be easy or difficult about using ridehailing or traveling generally, and what they considered to be the advantages and disadvantages of ridehailing specifically.

When people use ridehailing independently it can be empowering; those who feel uncomfortable using TNCs on their own may find these services daunting

A man in his seventies who is blind said that app-based ridehailing has been "a boon to my travel," by providing "other options that I didn't used to have." Others felt more independent, or otherwise liberated by the availability of app-based ridehailing services. "The advent of Uber and Lyft has changed everything. I can do so many more things now than I could five years ago," said a woman who has low vision in her sixties. She further explained that using app-based ridehailing is "as close to having my own car as I can get." When asked what sorts of trips she uses ridehailing for, she explained, "Getting home with heavy groceries used to be a real pain. And now, with Uber and Lyft, I can just get one and haul groceries home. It's great!" A woman in her fifties who is blind said, similarly, that while she used to think twice about making trips to locations that were difficult or costly to reach using transit, now she will simply "type the address into my Uber app, and know it's going to take me there."

Whether using app-based ridehailing or another mode, several respondents noted that being able to travel on one's own is empowering. A man in his fifties who is blind explained, "It's a big part of independence. Being able to just go somewhere, and not be dependent on other people." Other respondents tied the notion of independence to a more general confidence in being able to use transportation to get from place to place. A man in his thirties who became blind within the last five years explained that while having ridehailing as a fall-back service has been advantageous for getting out more, achieving greater independence has required overcoming embarrassment associated with asking passers-by or drivers for help using transportation and practicing more solo travel.

Some older respondents who became blind or lost vision later in life also wanted to be independent, but, as a result, traveled less than they would like as not to feel uncomfortable or to impose a burden on others. A woman in her nineties who has low vision explained, "You do what

you can to be independent, and if you feel frightened or insecure . . . you don't seek that out.” Though she knew about app-based ridehailing services, she felt that trying to hire a ride, find the right car, complete a trip, and navigate to a destination on her own was too daunting. So she stays in more than she used to, and chooses to “live a very quiet, some would say, ‘sedentary’ life.”

Using an app to hail a ride can be difficult for those who have little experience using a smartphone with a disability

A man in his seventies who became blind later in life lamented that he could not use his “stupid phone” to hail a TNC ride. Another man in his seventies who has severe hearing loss and difficulty with fine motor control said that although he owns a smartphone, he has some trouble using it and can be “kind of slow to, sometimes, try new things.” A woman in her sixties who has low vision explained that even though her children, who often help her arrange transportation, want to give her a smartphone, she has been reluctant to accept their offer because she would need to seek out training in how to use it with accessibility features. “I don't want to deal with it,” she concluded.

Some respondents used GoGoGrandparent, a concierge service that riders can call from a landline or mobile phone to request rides from TNCs, and found it to be relatively easy. A man in his eighties with multiple disabilities reported that even though he feels GoGoGrandparent is a bit expensive, the call service makes using TNCs “really simple.” A woman in her nineties with low vision said that she found scheduling a ride through GoGoGrandparent to be challenging because the operator asked a lot of questions, but doable.

Several respondents who are blind or have low vision and are adept smartphone users found ridehailing apps to be accessible via screen readers and easy to use. These tech-savvy individuals were typically younger, or were older but have lived with their disability for a relatively long time. These findings are consistent with others showing that people with a longer time since disability onset are more likely to have received training in how to use assistive technologies (Kaye et al. 2008). People who are born with a disability or acquire disabilities relatively earlier in life are also more likely to have developed effective strategies for using transportation (Henly and Brucker 2019).

Because drivers are used to riders visually identifying them, finding a TNC vehicle without sight can be frustrating

While ridehailing's curb-to-curb service model circumvents the last mile problem—the challenge of providing transit services within a mile of riders' origins and destinations—as one respondent put it, the “meet and greet problem” associated with finding a TNC vehicle poses a challenge for some riders with disabilities. This respondent, a woman in her fifties who is blind and uses app-based ridehailing regularly, explained, “You ordered the vehicle. How do you find the vehicle now? How do you get that last 10 feet? It's always that 10 foot problem.” Other respondents echoed her frustrations about connecting with ridehailing drivers and finding the

vehicle that they ordered, particularly in areas that are noisy or crowded where someone might not be able to hear the car that they ordered pull up. Another respondent who is blind suspected that because drivers are not used to needing to identify themselves to riders, they will often drive away from him if he cannot connect with them prior to arrival. He described having called ridehailing drivers in the past to explain the missed connection and receiving a “snarky” comment on the other end of the line, “Well, why didn’t you find me?”

Some respondents appreciated the information provided on major app-based ridehailing platforms about the color and model of a hired car, as well as the license plate number and name of the driver, because that helps them identify the correct vehicle either personally or by asking someone nearby for help. However, a respondent in her forties who has low vision said that even with this information finding the driver is “definitely a challenge and more annoyance than I want to deal with,” which sometimes caused her to forgo a trip or take a known fixed-route service instead.

A few respondents who are blind described having more success connecting with app-based ridehailing drivers after posting pictures of them holding a white cane on their ridehailing app profiles. Some also said that they will typically call drivers before they arrive to let them know that they are blind, and will not be able to identify the car that they hired visually.

Driver discrimination against people traveling with a service animal or using a wheelchair makes some fear getting “ditched” or having their ride cancelled

A woman in her fifties who is blind and travels with a service animal described being “rejected” by app-based ridehailing drivers who “would refuse to pick me up, or would cancel the trip because they saw the dog.” She described this as a regular occurrence, but argued that evidencing driver discrimination was difficult for her and friends in similar circumstances because, “If [the driver] pulls away because he sees the dog, how do I prove that?” Having heard about friends’ experiences using ridehailing with a service animal, a woman in her forties who has low vision and is considering getting a guide dog herself said that she would worry when using ridehailing, “Am I going to be cancelled? Or will they give me a hard time?” A man in his seventies who is blind said that drivers have “. . . pulled up, and seeing a traveling companion with a dog pulled away. Not acknowledging that they didn’t want to take the dog or that they even saw us.” He sarcastically remarked that, as a result, he and his friends traveling with dogs will make a plan before a ridehailing driver arrives, “Our strategy is to tell the guide dog user to hide or to be twenty feet away.”

A woman in her fifties who uses a manual wheelchair some of the time said that she expects more “hassle” on ridehailing trips when she is using her wheelchair. She explained that the driver “has got to be willing to wait an extra minute or two” for her to disassemble the wheelchair, and if they are unwilling to wait, she explained matter-of-factly, “I might get ditched.” A woman in her forties who has low vision said that, on principle, she avoids using app-based ridehailing because, “I’m really sick of hearing about how they don’t let my friends with a

guide dog take a ride with them. Or they're not prepared for a wheelchair. Or they're not this, or they're not that!"

Wheelchair-accessible ridehailing services are presently unreliable because of low vehicle availability and long waiting times, but they could be more convenient than accessible taxis or paratransit for motorized wheelchair users

Respondents who use a motorized wheelchair and had taken a wheelchair-accessible TNC ride reported that while their trips were "fine," they likely would not use these services with regularity because there are very few vehicles available at any given time on major app-based ridehailing platforms in the Bay Area. And, when they are available, waiting times can be long—30 minutes or more, based on what respondents' described. Cancellations may result in even longer waits. A woman in her fifties who uses a motorized wheelchair stressed that, presently, app-based ridehailing "is not something I count on having access to." Hearing about long waiting times from friends deterred a man in his thirties who uses a motorized wheelchair from trying to use wheelchair-accessible services himself. However, he appreciated being able to arrange standard ridehailing trips for others, including family members or attendants.

Despite these shortcomings, a woman in her forties who uses a motorized wheelchair acknowledged that the availability of any "same-day" wheelchair-accessible ridehailing service "is an improvement over what's available," considering rides on wheelchair-accessible ADA paratransit vans must be scheduled at least a day in advance and accessible taxis are hard to come by across much of the Bay Area.

Speaking to the relative advantages of wheelchair-accessible app-based ridehailing services over accessible taxi services, one respondent said that they preferred app-based ridehailing because, "It came faster. I had more information about it coming because I had the app. . . . The payment was easy." She further expressed that the quality of the wheelchair-accessible TNC ride was comparable in terms of comfort and safety to an accessible taxi ride, and speculated that drivers' training in how to serve riders with disabilities and secure wheelchairs in the vehicles was "probably about the same" for TNC and taxi drivers. Another respondent who uses a motorized wheelchair and had taken a wheelchair-accessible ridehailing trip shared that she was concerned about whether TNC drivers are adequately trained on how to transport passengers who use wheelchairs, and said that getting into the car and properly secured was "just a bunch of bumbling and fumbling because [the driver] was very inexperienced."

Affordability, convenience and reliability, and app-based features make some feel that using ridehailing is easier and safer than taking taxis

When asked why she prefers using app-based ridehailing to taking taxis, a woman in her seventies who has low vision replied, "The price." It seems that app-based ridehailing services in the Bay Area often offer riders lower fares than taxicabs. In Los Angeles, authors have previously found that ridehailing prices are lower than taxi prices for trips with the same origin and

destination (Brown and LaValle 2020; Smart et al. 2015). In some cases, app-based ridehailing prices may even be competitive with transit fares. Several respondents who said that they used to take taxis for occasional trips have now replaced those trips, and others, with app-based ridehailing because it is cheaper.

Respondents liked that app-based ridehailing services charge a flat rate once a trip is ordered. Some respondents who are blind or have low vision worried about being “taken for a ride,” literally and figuratively, in taxis. They feared that drivers might intentionally take circuitous routes to run up the fare assessed per mile, or that they might try to cheat them by reporting a higher price than the true cost of the ride suspecting that blind or low vision passengers may not be able to read the meter. “You’re always worried [taxi drivers] are going to rip you off,” said a woman in her forties who has low vision.

Several respondents found interacting with ridehailing drivers to be more comfortable because they did not have to worry about paying them in the car, as payment occurs through the app. Other respondents who are blind or have low vision further appreciated the electronic payment feature because they liked having access to e-receipts and other records of their trip, which can be read with a screen reader.

A man in his fifties who is blind and uses ridehailing regularly suggested, also, that ridehailing drivers “are typically friendly, because there’s a rating system.” Drivers with low ratings can be removed from driving on major TNC platforms (Uber 2020), so the rating system likely incentivizes drivers to be pleasant and to provide passengers consistently with quality service. Drivers also rate riders on major TNC platforms, but respondents in this study did not mention whether or how rider rating played into their ridehailing experiences.

Having more information about their trips, including real-time updates on vehicle location and waiting times, was valuable to a number of respondents that expressed a preference for using TNCs over taking taxis. Some respondents felt safer using app-based ridehailing because they could share their trip status, which is tracked by GPS, with others in real time. Some expressed feeling frustrated in the past by long waiting times or inconsistent pickups after hiring a taxi. A man in his fifties who is blind recalled, “I took taxis, occasionally, for years. Very often, they would be extremely late or not arrive at all. There have been times when I’ve waited an hour for a taxi that never came, despite calling the dispatcher multiple times and being assured that it was on its way.” To summarize, one respondent said, of taxis, “The service you get is very poor. There’s a reason why Uber and Lyft are eating the cabs’ lunches.”

4.6 Discussion and policy implications

Findings from this research indicate that some people with disabilities use ridehailing because they find it to be more affordable than taxis, they perceive TNCs to be reliable and convenient, and they feel comfortable and secure using ridehailing’s unique technological features, like GPS tracking, electronic payment, and the driver rating system. When travelers decide whether to use a transportation service they will, of course, consider how the service meets their needs. They will consider whether it is affordable within their budget, and reliable and

convenient given their schedule. They will also consider whether making a trip using that service seems easy or difficult, based on previous personal experiences and hearing about other people's experiences using said service. Factors like price, as well as elements of service quality like reliability, convenience, and comfort, are known to influence transit ridership (Taylor and Fink 2003). Brown and LaValle (2020) found that perceptions of affordability, reliability, and accountability explained observed differences in service quality between app-based ridehailing services and taxis in Los Angeles. They found TNCs to be cheaper, more reliable in terms of waiting times and trip cancellations, and better at responding to customer issues than taxis.

It follows that people might use TNCs or closely comparable services more if they were more affordable. Respondents in this study who lived in San Francisco and used the subsidized SF Paratransit taxi service shared experiences that support this conclusion. Through this program, eligible riders are given a SF Paratransit Debit Card that works in all licensed taxis in the city. For every 6 dollars a rider contributes to their debit card account, the SFMTA loads a 30-dollar value onto their debit card up to a maximum purchase allotment. SF Paratransit taxi riders can hail rides in the same manners as all other taxi riders in the city: on the street, by calling taxi companies on the phone, or using the Flywheel e-hail app. Flywheel allows eligible riders to use a SF Paratransit Debit Card instead of a credit card to sign up, hail rides, and pay electronically.

Several respondents who used the SF Paratransit taxi service preferred taking taxis to using app-based ridehailing services. They thought that the taxi drivers were more skilled, and found them to be more knowledgeable and experienced than app-based ridehailing drivers, which, they said, was reflected in their driving and navigation. These respondents also felt that taxi drivers tended to have more experience working with riders with disabilities. A man in his seventies who is blind and takes taxis in San Francisco often said that although taxi service in the last five years has become "less reliable" because taxis are "harder to get," he feels "more confident in being found and getting to where I want to go" using taxis versus app-based ridehailing.

Some respondents mentioned that they liked the ability to hire a favorite driver with taxis. Though choosing the driver is not an option when e-hailing Flywheel taxis, one respondent said that, occasionally, the same drivers will recognize her profile and take her ride request, which she likes. Uber, the biggest app-based ridehailing platform in the U.S., has recently started allowing users to schedule rides with "favorite drivers."

Other respondents in this study reported having used one or several taxi voucher programs offered to people with disabilities and seniors in some Bay Area cities, including Berkeley and Oakland. A man in his eighties said that his attempts to use the scrips had been unsuccessful because, "Sometimes, [the taxis] didn't show up. Sometimes, they were late. There are so few taxis around anymore . . ." A woman in her fifties who is blind explained that the taxi scrips for the City of Berkeley's program are inaccessible to her because they are all the same size, though they denote different dollar values. They are difficult for her to differentiate independently, which makes it a hassle to pay with them. She added, "Getting [the scrips] was a pain in the neck."

Though ADA paratransit service is not closely comparable to app-based ridehailing services or taxis, provided riders must apply and be eligible to use paratransit and must schedule rides at least a day in advance, many respondents said that for demand-responsive trips, paratransit services were the most affordable option. As one respondent, a woman in her fifties put it, for the price, “you know, you can’t beat it.” A woman in her sixties who has low vision said that “the price is right” on paratransit, but went on to note, “Since the advent of Uber and Lyft, I have not used paratransit very much at all. It’s not reliable. It takes too much time.” Other respondents perceived paratransit to be much less reliable and convenient than app-based ridehailing services or taxis.

Given affordability concerns, several respondents suggested that more people with disabilities might use and benefit from app-based ridehailing services if they were subsidized. One man argued that a subsidized paratransit–TNC partnership program, like the SF Paratransit taxi service, would make app-based ridehailing “immediately more accessible to a lot more people.” Another respondent said that finding a way to subsidize app-based ridehailing for low-income people and people with disabilities “. . . would be great. I think it would help a lot of people get out and about.” A woman who works in transportation planning and uses a motorized wheelchair said that she increasingly recommends subsidized TNC programs as strategies for public agencies to provide improved accessible transportation for people with disabilities. While she used to recommend subsidized taxi programs, she said that she could not anymore because there are so few accessible taxis still in operation.

My findings suggest, unfortunately, that paratransit–TNC partnership programs and new regulations for wheelchair-accessible TNC services will do little to benefit a substantial and growing segment of people with disabilities in the United States: older adults who acquire disabilities later in life. It is predicted that more than 1 in 5 people in the U.S. will be “older Americans”—those age 65 and over—by 2030 (“Older Americans” 2016). Disability rates increase with age, but have been falling among cohorts of elderly people due to advances in nutrition and health care, and better education and higher incomes (Rosenbloom 2003). Nevertheless, a substantial portion of older adults will acquire disabilities as they age, and the number of Americans aging from midlife to later decades with disabilities is growing (Iezzoni 2014; Rosenbloom 2003). Older adults with disabilities experience additional barriers to ridehailing use arising from a lack of training and experience using a smartphone to hail a TNC ride, as well as from hesitations about being able to complete a ridehailing trip independently. Policies to facilitate ridehailing use among older adults with disabilities must address these barriers, for example, by offering targeted training programs to this population covering how to access and use available ridehailing services. Until this is done, it is unlikely that accessible transportation policies aimed at improving on-demand transportation services for people with disabilities will serve the disabled community, in its entirety, effectively.

4.7 Conclusion

How and why people with disabilities use app-based ridehailing depends on past experiences using transportation and smartphones with a disability. People who are older and those who acquired disabilities recently had a hard time using ridehailing because they encountered difficulties hailing a TNC ride, and worried about finding the vehicle and getting to their destination independently. People who are younger, more tech-savvy, less physically limited, and/or more experienced disabled travelers were inclined to try to use TNCs even when they worried about facing challenges along their journey. Such challenges included potential cancellations by discriminatory drivers who might not want to accommodate a wheelchair or a service animal, and trouble connecting with their driver and finding the vehicle.

Respondents acknowledged the inherent value of being able to conveniently travel on demand to any desired destination independently. Using ridehailing allowed some people to travel in this way, which felt empowering. Others who did not feel confident about hailing a ride or completing a TNC trip unassisted found the prospect of using ridehailing to be daunting. People who use motorized wheelchairs liked the idea of using wheelchair-accessible ridehailing services for their potential convenience, but those who had tried the services experienced long waiting times and had mixed experiences with drivers.

Some people used app-based ridehailing because they perceived it to be more convenient and reliable than taxis. They also found ridehailing to be more affordable than taking taxis, but acknowledged that it is usually more expensive than taking transit or paratransit. Several respondents noted that more people with disabilities would use ridehailing if it were a more affordable option. This suggests that subsidizing ridehailing may encourage greater use of these services among some people with disabilities; however, this approach, as well as new policies aimed at improving wheelchair-accessible ridehailing services, do not address barriers to ridehailing use among older adults with disabilities who face additional challenges using technology and transportation.

More research is needed to understand people with disabilities' travel behavior and attitudes towards transportation, particularly as ridehailing and other private services grow. Understanding the barriers that keep people with disabilities from using transportation services at a similar rate and with comparable ease to other people with and without disabilities is key to identifying and addressing problem areas. If providing quality accessible transportation services that facilitate more travel among people with disabilities is the goal, then planners and policymakers need to know how and why people with disabilities use transportation.

Chapter 5. Understanding the role of transportation-related social interaction in travel behavior and health

This study explains the role of transportation-related social interaction in the travel behavior of people with disabilities. It builds on the results of previous chapters, which highlight barriers and facilitators to ridehailing among people with disabilities, by explaining how feelings about transportation-related social interaction may influence individuals' travel behavior (including their use of particular modes, like ridehailing) as well as their health.

5.1 Chapter summary and contribution

People with disabilities experience particular transportation challenges that arise from socializing while in transit. Completing or anticipating transportation-related social tasks, like asking drivers, fellow passengers, family/friends/caregivers, or passers-by for help, can impact one's health by influencing feelings of self-efficacy, stress, and perceived social isolation. These feelings may, in turn, affect travel behavior, which also has implications for health. Drawing on 32 in-depth interviews conducted with adults with disabilities living in the San Francisco Bay Area, this study sheds light on the role of transportation-related social interaction in travel behavior and health among adults with disabilities. Findings from this study indicate that people with disabilities may change their travel behavior in response to these feelings. Individuals with low transportation self-efficacy or who have experienced stressful interactions may limit travel. This might pose a health risk by contributing to feelings of perceived isolation. Difficulties completing transportation-related social tasks and related health consequences may be especially pronounced among individuals who acquired disabilities relatively recently and/or in old age. Individuals with high transportation self-efficacy or who feel socially connected while traveling may travel more. This might promote health.

The social tasks associated with using transportation deserve more attention in literature on travel behavior and transportation planning, as they pose barriers to using transportation for some adults with disabilities and can affect travelers' health. Offering travel training to people with acquired disabilities, and training drivers and educating riders about how to appropriately and effectively interact with passengers who require special assistance might improve transportation for, and associated health outcomes among, people with disabilities.

5.2 Review of literature on disability, transportation, social exclusion, and health

People with disabilities travel less than people without disabilities, and older adults with disabilities travel even less than their younger counterparts (Brumbaugh 2018). When traveling, people with disabilities make trips for different purposes than people without disabilities. Henly and Brucker (2019) found that having a disability is associated with lower odds of taking a trip for

social and recreational reasons, even when controlling for other factors correlated with disability status. Many individuals with disabilities express a desire to travel more than they do, particularly to make trips for leisure, recreation, or to socialize (Mattson et al. 2010). Lack of access to transportation hinders people with disabilities' social lives and participation in their communities (Bascom and Christensen 2017).

A myriad of barriers keep people with disabilities from traveling and using transportation at a comparable rate to the rest of the population (Bezyak et al. 2017; NCD 2015). In the U.S., people use personal vehicles for most trips, but people with disabilities use them for a smaller share of trips than people without disabilities, and people with disabilities travel as passengers, rather than as drivers, for a greater share of trips in personal vehicles than those without disabilities (Brumbaugh 2018). Economic barriers keep many people with disabilities from being able to purchase their own cars, particularly if they require a modified vehicle (NCD 2015). Furthermore, disability keeps some people from driving altogether, and may limit others' driving by contributing to self-regulation or cessation, particularly among older adults (Chihuri et al. 2016).

A lack of adequate transportation and low trip-making puts people with disabilities and older adults at greater risk of experiencing social exclusion, or "circumstances where individuals or groups of people are unable to participate in activities or to access goods, services and opportunities that are available to others as a fundamental part of belonging to society" (Mackett and Thoreau 2015, 3). Mackett and Thoreau (2015) identified various direct and indirect ways in which transportation-related social exclusion impacts health. Active transportation, or participation in walking and cycling, promotes physical activity and good health. People with mobility impairments may be less able to engage in active transportation (Sundar et al. 2016). Furthermore, transportation provides access to essential goods and services, like healthy food and medical care, as well as to recreation and exercise facilities. Transportation also enables opportunities for interaction with family, friends, and others, which can enhance well-being and mental health. Greater transportation access and use thereby promotes physical and psychological health via numerous mechanisms. Inadequate transportation access and/or low transportation use and resulting social exclusion, thus, poses a health risk to people with disabilities.

Satisfaction with daily travel and activity participation, age, and disability status interact to influence psychological well-being, which is related to physical and mental health (Freedman et al. 2017). People with disabilities with greater access to transportation have a higher sense of well-being (Blais and El-Geneidy 2014). Older adults who feel that their transportation needs are not adequately met report lower well-being (Cvitkovich and Wister 2001). Limited mobility resulting from barriers to accessing and using transportation and/or driving cessation can contribute to feelings of perceived isolation and depression among people with disabilities and older adults (Chihuri et al. 2016; Choi and DiNitto 2016). Members of these groups are more likely than others to report feeling socially isolated, which is associated with ill health and increased risk of death (Repke and Ipsen 2020).

Stanley et al. (2011) modeled relationships between mobility, social exclusion, and subjective well-being to investigate covariance between these transportation and health variables among samples from two Australian urban areas. Drawing from travel surveys conducted to study populations “likely to face transport difficulties” (e.g., older adults), the authors measured the risk of social exclusion and subjective well-being for approximately 680 individuals. Social exclusion was determined along five dimensions, including household income, employment status, political activity, participation in social and/or cultural events, and level of social support. The authors constructed their model hypothesizing that: (1) a person’s risk of social exclusion is reduced if they have high social capital, are relatively mobile, extroverted, and high income; and (2) subjective well-being is improved if a person has a low risk of being social excluded and has high levels of spatial knowledge, positive relations with others, a strong sense of community, and demonstrates self-acceptance. Relying on a simultaneous equation system to isolate effects of social exclusion risk and well-being variables, the authors found a positive association between mobility, exhibited in trip-making and activity-participation behaviors, and reduced risk of social exclusion, which, in turn, was shown to be significantly associated with personal well-being. These findings suggest that transportation policies which improve people’s ability to travel and participate in activities might also reduce their risk of social exclusion and promote well-being and health.

The transportation difficulties that people with disabilities experience are complex, arising from riders’ physical interactions with transportation systems, as well as their social interactions with people encountered en route (Bezyak et al. 2017; Mackett and Thoreau 2015). It is often necessary for people with disabilities to ask others for help using transportation, including drivers, fellow passengers, family/friends/caregivers, or passers-by. This can be as simple as asking for directions, to as involved as help entering or exiting a vehicle or properly securing a wheelchair or scooter. These interactions can make using transportation easier or more difficult. Transportation self-efficacy—one’s belief that they can successfully get where they want to go, or otherwise complete transportation tasks—is linked to the social problem-solving involved with making a trip. Transportation self-efficacy and transportation-related stress impact mental health, and influence travel and activity participation among adults with disabilities (Crudden et al. 2016; Sundar et al. 2016).

Providing better access to transportation for people with disabilities requires considering both physical transportation improvements and opportunities for progress in “the softer side of travel—the ‘human element’” (BTS 2003, 2). Yet, compared to infrastructural obstacles, barriers to using transportation associated with interpersonal interaction receive far less attention in academic literature and professional reports offering guidance on how to improve transportation for people with disabilities.

In this study, I draw from in-depth interviews conducted with adults with disabilities living in the San Francisco Bay Area to explain how social interaction associated with using transportation makes traveling easier or more difficult for some people with disabilities, and how people’s feelings about socializing in transit influence determinants of health, including self-

efficacy, stress, and perceived social isolation or connectedness, as well as travel behavior. This research highlights some potential health consequences of transportation-related social interaction, as well as resulting travel behavior changes. Findings have policy and practice implications in transportation and public health.

5.3 Methods & Data cleaning and analysis

Interview data used in this study was the same as that used in Chapter 4. See Section 4.4 and subsections for a comprehensive description of sampling, recruitment, and interviewing strategies; respondent characteristics (Table 2); a general discussion of methods for data cleaning and analysis; and limitations.

In order to examine how respondents spoke about the transportation and health outcomes discussed in this paper, including self-efficacy, stress, and social isolation and connectedness, I analyzed the occurrence and co-occurrence of codes representing feelings or perceptions, like “Fear” and “Independence,” and those related to actions, objects/services, or phenomena, like “Social interactions,” “Taxi,” and “Time of day.” For example, to examine excerpts in which respondents expressed feeling stress or a lack of stress, I looked at all excerpts coded with “Stress.” To examine how respondents experienced stress, or a lack thereof, during social interactions when using different transportation modes or services, I could, for example, compare excerpts in which “Stress” co-occurred with “Social interactions,” as well as codes like “Bus” or “App-based ridehailing.”

5.4 Findings and discussion

More so than other themes, self-efficacy, stress, and social isolation and connectedness were consistently discussed and stood out as key linking concepts in interviews, connecting reactions to interpersonal interactions, health, and travel behavior. Findings of this study, detailed following, indicate that feelings about socializing in transit sometimes caused respondents to change their travel behavior. In some cases, this meant limiting travel. As limiting travel may contribute to feelings of perceived isolation, findings suggest that inherent feelings about transportation-related social interaction and travel behavior changes resulting from these feelings may both contribute to negative health outcomes among adults with disabilities. This may be especially problematic for people with relatively recently acquired disabilities and/or older adults with disabilities, as such individuals may lack the experience needed to develop effective coping strategies for completing transportation-related social tasks.

Self-efficacy hinged on confidence asking for help

Most respondents at least occasionally required assistance using transportation and/or navigating to their destination. This meant needing to ask for help, a social task which was entangled with notions of independence and self-efficacy. For respondents with more experience

and confidence traveling solo with a disability, asking for help was one of many transportation tasks that simply needed to be done to complete a trip. “It’s a big part of independence. Being able to just go somewhere, and not be dependent on other people,” explained a man in his fifties who is blind. Other respondents expressed that being able to get from place to place successfully and independently felt empowering, contributing to a stronger sense of transportation self-efficacy. However, completing a trip independently did not necessarily mean completing a trip unassisted. Rather, several respondents linked feelings of self-efficacy to autonomy in when and whether to ask for, or to accept help from others.

“Asking for help is one of the bigger things you have to get over,” said a man in his thirties, describing how his travel behaviors have changed in the last five years since becoming blind. He said that overcoming his initial hesitations has made traveling easier and opened up new opportunities. “It’s been a lot better, just being able to get out and get around and do more things.” Similarly, a woman in her seventies who has low vision said that she’s “gotten a lot better at knowing the bus routes that I do take a lot” and using transit to get where she needs to go because she’s “. . . gotten way better in the last year or two at asking for help.” She explained, “I really had a hard time asking for help before. I would just be going crazy and never asked anybody to help me.” Now, she’s found that, “Most people are really helpful!” As another respondent, a woman in her sixties who is blind, put it, “I would say that probably the most helpful thing in transportation is other people’s assistance.”

For other respondents who were typically older, asking for assistance or otherwise relying on others could be intimidating, contributing to low transportation self-efficacy and, in some cases, reluctance to make a trip. When asked, “Do you ever feel like you can’t do what you want to do because it’s difficult to get somewhere?”, a man in his seventies who is blind answered,

“No, I do pretty much what I want to do if I really want to do it. The factor for me is being willing to engage socially, publicly at the level that is necessary to do some things that more prevents me from doing things, rather than a transportation issue.”

A self-reported “intrepid” traveler earlier in life, he followed with a chuckle, “I got lazy and complacent as an aging person.” He felt greater worry than he used to about successfully navigating unfamiliar environments, potentially due in part to normal physical and cognitive declines that accompany aging, but also because sometimes he did not feel up to the social demands of the task.

A woman in her nineties who has low vision also said that she shies away from making trips to destinations that she does not know very well, because “to go into a new situation and not know where things are” is daunting, as is asking people for help. “A lot of people will ask anybody for anything,” she explained. “I’m not one of those people.” She went on to say that she wouldn’t take trips that she felt she couldn’t complete easily by herself.

Some respondents said that they felt more dependent on family and friends for rides with age, particularly those who used to drive themselves. While they worried that asking for rides

imposed a burden, they didn't feel confident in being able to complete trips otherwise. One woman in her seventies who has low vision lamented, "I just don't find that there's a lot of empathy for people who are older in terms of transportation." She runs a low-vision support group, and said of the members, "They go through a lot of turmoil, I think, when it comes to giving up their car, because it means: how am I going to be . . . self-sufficient?" For this woman, and several other respondents who used to drive, transportation self-efficacy was strongly linked to the ability to drive, and without it, this sense was diminished.

Respondents with lower transportation self-efficacy tended to be older adults with recently acquired disabilities who had less experience and/or training using transportation with a disability. They felt less secure traveling, and some feared imposing a burden on friends or family when they did ask for transportation-related assistance. Several limited their travel as a result. Sundar et al. (2016) suggested that self-efficacy and participation have a "complex reciprocal relationship in which self-efficacy influences participation but participation experience also influences self-efficacy" (3). This was the case among respondents in this study—those who were more comfortable asking for help and had developed higher self-efficacy were more likely to report using transportation and to talk optimistically about travel; those who were not comfortable asking for help, demonstrating low self-efficacy, did it less and used transportation less, which reinforced negative feelings about their future travel prospects.

Stress lingered from past negative interactions, and arose from fear of future interaction

Taking transit was stressful for some respondents who had experienced unpleasant interactions with drivers or other passengers in the past. Stress arose from fear of conflict with others, and from concerns about safety and comfort. A woman in her fifties who uses a motorized wheelchair explained,

"I really don't take buses. They're pretty rough rides for me. They swing around . . . I can't always depend on the bus driver to properly tie my chair down. But I get harassed by passengers, and I get too much attention. I've actually had things thrown at me, or really obnoxious conversations."

Another woman in her fifties who is blind said that she used to take buses, but doesn't anymore because "other passengers on buses were a problem." She travels with a service animal and said that she often received unwanted attention or comments from fellow passengers at bus stops and on board. Now she hails an Uber or Lyft, walks, or asks for rides from family for trips that she used to take using the local bus. Of using ridehailing instead of transit, she said, "It's faster, it's easier. Sometimes it might take me a little longer to get there than it would have taken me on transit, but I don't have to stress."

A woman in her forties who has low vision and a condition that makes it difficult to stand for long periods of time said that she has a lot of trouble navigating interactions with other passengers who may not immediately recognize her as “disabled.” She explained,

“For people who have non-visible disabilities . . . especially for me, when I get on BART, I need to sit down. I would never ask people for their seat, but when I’m sitting there in disabled seats that are the only ones available, people give me a really hard time and yell at me for it.”

She said that fear of judgment and, potentially, conflict with other passengers causes her to take public transportation less and, instead, use private services more. “Depending on my mood, I might definitely be, like, ‘I don’t feel like dealing with this. I’m going to go on Uber.’”

Other respondents experienced stress using transportation because they felt unsafe. A woman in her fifties who uses a motorized wheelchair worried about her physical safety in crowded train cars, remembering of a recent trip,

“The BART train was crowded . . . and we were packed in. I had backpacks in my face and people kicking and shoving . . . I try not to ride when it’s gonna be crowded. I’m short and people grab my chair. They hold on and try to balance themselves. Or they bump into me, or kick my feet . . .”

A woman in her seventies who has low vision and frequently uses transit in San Francisco explained that she avoids traveling at rush hour,

“Because, particularly younger people . . . will tend to be more entitled and shove and push and act like you’re invisible . . . I do have osteoporosis, and I am worried I’m gonna get knocked down and fall.”

Other respondents feared getting “crushed” or “pushed” when taking transit at peak times. A man in his seventies who is blind said that he was “intimidated” by the prospect of navigating busy transit stations when there are a lot of people and a lot of noise. “It’s just too difficult,” he said.

Other respondents indicated feeling more or less safe and/or stressed while traveling as a result of combined personal and environmental factors. For instance, female respondents and older respondents tended to express more concerns about traveling safely, especially at night. Some female respondents worried about traveling after dark on transit and felt particularly vulnerable to harassment or other criminal activity when waiting for vehicles to arrive at transit stops or stations, or at the curb for a ridehailing vehicle. A woman in her seventies who has difficulty walking worried, “I can’t move fast. I’m a sitting duck for getting mugged.” A couple of respondents who were blind or have low vision and acquired their visual impairment later in life described feeling as though they needed to be more aware of potential safety threats while

using transportation, and generally “on guard.” One woman in her seventies who has low vision worried,

“I’ve certainly heard stories from enough people using [white] canes that sometimes you just have to be more careful. But how are you going to be more careful? You don’t have sight, and you can’t judge people’s body language or facial expression.”

It is well documented that women and people with disabilities, and especially women with disabilities, are more likely to be victims of violence in transit environments than others (Iudici et al. 2017). Findings from this study support Iudici et al.’s (2017) claim that vulnerability of people, particularly women, with disabilities, “. . . should not be understood only as an effect of violence but also as a ‘cause’ of disability itself.” In this study, stress arising from respondents’ feelings of vulnerability and insecurity influenced their behavior, in some cases resulting in limiting use of certain modes, like public transit, or travel at particular times of the day. Experiencing stress, and/or limiting travel as a means to avoid stress—a strategy known as “avoidance coping” (Crudden et al. 2017)—are likely to contribute to poorer health.

Social isolation resulted from traveling less; some who traveled more felt more connected

Several respondents felt socially isolated as a result of mobility impairment. Some, who had limited their travel more over time with progression of age and disability, described becoming more disconnected from social networks that they used to rely on. A woman in her seventies who has low vision and difficulty walking said, of the neighborhood she’s lived in for 50 years,

“We used to have block parties every year. And I guess there still are [block parties], but they’ve moved up to the cross street . . . and because of my difficulty walking, I never go.”

Another woman in her nineties who has low vision explained, “I make less and less out-of-the-home trips as I get older and less ambulatory . . . I live a very quiet, some would say ‘sedentary’ life.” Older adults are more likely than others to report feeling socially isolated (Repke and Ipsen 2020), so it is unsurprising that several respondents in this study linked feelings of perceived isolation to processes of aging.

Other respondents felt relatively more isolated because their dependence on public transportation resulted in greater time spent traveling for non-discretionary trips, which people with access to more convenient transportation, like a personal vehicle that they can drive, might devote instead to discretionary social or recreational trip-making. A woman in her seventies who has low vision and had recently given up driving explained,

“Well, I drove everywhere, right? And so, in the last year, I’ve had to take a lot more Lyft and public transportation. I take the shuttle, or I walk. But, in general, there was so much freedom . . . there was a lot of freedom for me to travel everywhere . . .”

Since then, she said, she has isolated herself more because it feels increasingly difficult to travel and participate in activities like she used to. “My disability has been eating into my social life. And I know, I try to do my best to have a social life because that’s when depression starts—if you don’t have a social life.”

Some respondents derived a lot of pleasure from the social element of using transportation, which made them feel more connected to others. A man in his forties who is blind and a long-time transit rider explained, “I like the community aspect of it . . . I like being on transit because I kind of get to hear what’s-going-on-in-the-city type of thing.” He and others also liked the camaraderie of traveling among regular riders. A woman in her sixties who has low vision compared her travel patterns in different seasons,

“When there’s a summer . . . I love to go walk and then check in [with neighbors] and take public transportation. I talk to more people. In the wintertime I feel more alone because I see nobody, talk to nobody because [a private shuttle] just takes me to the doctor, to the store, to the pharmacy. They pick me up, take me back over to my house, and that’s it.”

Other respondents found that the more intimate setting of a private car made it easier to have fulfilling conversations. Speaking to perceived advantages of ridehailing, a man in his thirties who is blind said, “I like the more social aspect of it with the shared rides. I like meeting people and talking to people in the cars.” Others found it stimulating to exchange stories with taxi and ridehailing drivers. A few respondents used community transportation services staffed by volunteer drivers. A woman in her eighties who has limited mobility looked forward to her trips with these drivers, for, she explained, “They bring a lot of kindness with them.” She recalled a recent trip to the hair salon in which a driver offered to buy her some spices from a nearby market before picking her up from the appointment. “They add quality. It’s more than just the ride.”

The relationship between isolation and transportation perhaps hinges more on the presence or absence of the opportunity to socially interact than it does on transportation, per se. This aligns with other literature concerning the effects of transportation use on social outcomes, like social capital (Boniface et al. 2015; Currie and Stanley 2008) and social exclusion (Mackett and Thoreau 2015). Respondents who used transportation less felt isolated. In contrast, people who used transportation and, hence, engaged in transportation-related social interactions, felt more socially connected.

Experiences differed based on time spent living with a disability

Respondents who acquired their disabilities recently and/or in old age reported different experiences using transportation than others who have lived with their disabilities for a long time.

Resilience, or an ability to “bounce back” when faced with stressors or adversity, has been associated with psychological health and social and physical functioning in individuals with disabilities (Battalio et al. 2017). Battalio et al. (2017) found that sociocultural factors, like sex, may influence how men and women with physical disabilities develop and demonstrate resilience. In their study, men reported slightly higher levels of resilience than women. In this study, respondents did not report notable differences in their belief that they could deal with challenging social interactions in transit or otherwise complete transportation tasks based on their gender.

Drawing from interviews with people with multiple sclerosis as well as their care partners and community stakeholders, Silverman et al. (2017) found that people who have lived longer with a disability may have developed greater resilience because they have had more time to adapt to their circumstances and forge supportive social connections among other facilitators of resilience. On the other hand, longer time spent living with a disability and coping with associated challenges, including barriers to using transportation, caused a “burn out” effect in some individuals resulting in lower resilience over time (Silverman et al. 2017). Using data from a longitudinal survey, Silverman et al. (2015) found that higher resilience predicted a decrease in depressive symptoms and an increase in social functioning in people aging with a disability.

In this study, older adults with recently acquired disabilities worried about their ability to complete transportation tasks in the future. Those with degenerative conditions, or who were worried about their health worsening with age, were particularly concerned that they would not be able to get around without reliable help from family or close friends—help that they were reluctant to ask for sometimes, as discussed previously. One woman in her seventies who has low vision said, contemplating her next five years,

“I have progressive vision loss . . . eventually I expect to be totally blind. If I were 30, I wouldn't be worrying about being five years older, but between 72 and 77 . . . [I worry about] what's going on with my whole body and my ability to get around in general. I worry that my life will be more limited than I want it to be.”

When asked whether anything made her feel optimistic looking ahead, she said,

“Maybe I'll become good friends with someone who can drive . . . And I'm also getting a guide dog probably next year. I'm excited about the possibility that I will get more help in navigating the world than currently I have. And partly why I don't have it now is because I'm still struggling with asking for help. And so I just go out there and I do things by myself, but it's really, really, really hard.”

In contrast, a man in his seventies who became blind in the last decade reported that after “a lot of good training” provided by local social service agencies on orientation and mobility and using transportation he has become very comfortable getting around even though he had to stop driving.

Of interacting with people in transit, he said, “It's really gratifying how willing absolute, total strangers are to assist!”

Receiving training on how to use transportation with a disability seemed important for developing self-efficacy and resilience in respondents with acquired conditions, particularly if they were acquired relatively recently. This training, as well as exposure to others with the same disability, seemed to help these respondents overcome their hesitations confronting transportation challenges, including experienced or anticipated difficulties asking for help or otherwise interacting with people while in transit. Though they may have received travel training in the past, respondents who had lived with their disabilities for a long time seemed to rely more on experience to develop coping strategies for getting needed assistance using transportation and traveling adeptly.

5.5 Conclusions and policy implications

People with disabilities may require special assistance completing transportation tasks and need to socialize in transit more than others to get help. Findings from this study suggest that transportation-related social interaction influences feelings of self-efficacy, stress, and perceived social isolation and connectedness among adults with disabilities. These feelings inherently impact health. For instance, respondents with lower transportation self-efficacy, who were uncomfortable asking for help using transportation, found the idea of performing the social tasks necessary to get to their destination to be anxiety-inducing, which is harmful to psychological well-being. These respondents, and others who experienced stress as a result of socializing in transit, sometimes limited their travel as a result. Reducing travel and participation in activities may also pose harm by putting people at greater risk of experiencing feelings of missing out or exclusion, loneliness, and social isolation.

In this study, respondents who felt socially isolated were those who used transportation rarely or less than they would like to, and engaged in few transportation-related social interactions. They tended to be older adults with recently acquired disabilities who were less experienced using transportation with a disability. To make up for a lack of experience, people who had acquired their disabilities recently and/or in old age relied more external sources, like social service providers and other people with their same disability, to learn travel skills and build transportation self-efficacy and resilience. It is thereby particularly important that travel training be available to the growing population of older adults with disabilities in the U.S. As one respondent who is in her seventies and has low vision noted,

“Not only do I have a mobility problem, I have a hearing impairment as well as a visual impairment. And that is what seniors deal with that other populations of people with disabilities do not. If you're young, you don't have three or four impairments at the same time.”

While this is not always true of young people with disabilities, aging is likely to contribute to people becoming more disabled (Lin et al. 2012). Accordingly, travel training and other resources tailored for people with relatively common age-related disabilities, like vision, hearing, and mobility impairments, should be offered by public health, transportation, and social service professionals to older adults at opportune times—for instance, when they turn 65 and become eligible for Medicare—regardless of their current disability status. Such programs might allow older adults to be more prepared and resilient in the event they acquire one or more disabilities in the future, and could possibly mitigate some of the negative effects of having a disability on travel behavior and health that were observed in this study, like feeling stressed in transit and limiting travel. Future research on the implementation and outcomes of interventions like these, and other issues pertaining to the travel behavior and health of older adults with acquired disabilities is needed to facilitate transportation use and promote health among this population.

As the intent of this research was not to quantify the incidence of shared experiences among respondents or any larger population of people with disabilities, but instead to gain an in-depth understanding of respondents' experiences, it is not known whether the views expressed capture those of adults with disabilities more generally. Study findings are revealing nevertheless. Respondents who reported more negative feelings about socializing in transit tended to travel less. Those who felt that they could not reach their destination independently or felt stressed using transportation limited their travel entirely or conditionally to services and/or times of day that felt more comfortable. Feeling bad and traveling less can both contribute to worsened health. In contrast, respondents who spoke more positively about transportation-related social interaction traveled more. For these people, transportation provided a welcome social outlet—they felt more connected. Feeling socially connected and traveling more likely improved their health.

It is clear that transportation-related social interaction influences travel behavior and health. And, yet, the social tasks associated with using transportation are often ignored in literature on transportation planning. Instead, more attention is given to how people interact with tangible, physical elements of transportation systems (i.e., infrastructure), which are easier to manipulate. Findings from this study suggest that investing in the “human element” of transportation systems—the interactions between transportation workers and passengers—is worth doing to realize health co-benefits of making transit more accessible to people with disabilities and everyone.

Transportation providers need to be prepared to provide quality services to all passengers. Results of this study indicate that facilitating more positive interactions between drivers and riders with disabilities could make transportation more accessible to these riders. This might be accomplished by training drivers on aging and disability awareness, which has been shown to promote knowledge of people with disabilities' and older adults' needs, and improve drivers' attitudes towards, and acceptance of, travelers with disabilities (Lindsay 2020; Reynolds 2010). Such training may be particularly effective when mandated and enforced, and when designed to include riders with disabilities who can provide personal insight on the importance of accessible transportation (NCD 2015). Results of this study indicate that training programs for drivers and

riders with recently acquired disabilities would benefit from including individuals who have lived with disabilities for a long time in their development and implementation. These individuals can explain driver behaviors that have made using transportation easier or more difficult for them in the past, and shed light on how to cope with transportation challenges from experience traveling with a disability.



Figure 5. “Bay Area Rides Together” campaign poster that includes icons depicting people using wheelchairs (BART 2017).

Transportation providers could also improve the accessibility of their services to people with disabilities by making a deliberate effort to foster a safer and generally more inclusive environment. When asked about whether he was particularly optimistic about anything in the transportation realm, a respondent in his fifties who is blind and hard of hearing said that he hoped travelers would develop more “mindfulness and awareness” of others. He described past experiences in which riders had pushed him while hurrying to catch a train, or had otherwise been inconsiderate. By highlighting and celebrating diversity among riders, transportation providers might make travelers think twice about the needs and experiences of their fellow passengers. This might encourage riders to act more considerately.

In 2017, Bay Area Rapid Transit (BART) launched their “Bay Area Rides Together” campaign (BART 2017). They placed 280 posters inside trains reminding riders that, “On this train, everyone is welcome,” acknowledging riders’ diversity and affirming their commitment to welcoming and serving everyone. This included passengers with disabilities, who were represented in some poster images (Figure 5). Public outreach campaigns that promote disability awareness may contribute to improving public attitudes towards people with disabilities (Fisher and Purcal 2017). Combined awareness and information campaigns could educate passengers about how to appropriately and effectively interact with fellow riders who may require special assistance, which might further improve transportation experiences, encourage travel, and enhance health among people with disabilities.

Chapter 6. Planning for disability accessibility in the era of ridehailing and beyond

Ridehailing presents new opportunities for travelers with and without disabilities. This dissertation contributes to understanding how and why having a disability influences whether people can take advantage of these opportunities, and sheds light on some of the equity implications of these services. Findings describe and provide an explanation for the travel behavior of people with disabilities in the era of ridehailing. This information can inform policy and planning strategies aimed at providing adequate, equitable service to all travelers, including those with disabilities.

In theory, ridehailing services might be particularly attractive to individuals with disabilities, who have historically relied more on alternative modes to the private vehicle to get around, including public transportation and shared services like taxis. However, results of this research and evidence from other studies that used national survey data (Brumbaugh 2018; Schaller 20108) indicate that people with disabilities use ridehailing less than the rest of the population. Even when controlling for other factors that correlate with disability status and may influence ridehailing use, like age, income, and home metropolitan area size, having a disability predicts lower app-based ridehailing use.

What is it about having a disability that makes ridehailing less accessible or attractive to people with disabilities than other services, especially taxis, which provide very similar offerings to TNCs and which people with disabilities have historically used, and do presently use more than people without disabilities? Results from interviews conducted with San Francisco Bay Area residents as part of this dissertation suggest that it depends in large part on individuals' past experiences using transportation and smartphones. These experiences, in turn, are influenced by how long an individual has lived with a disability, the nature of their disability, whether they've participated in travel training, and whether they mobility aids during travel like wheelchairs, white canes, or service animals.

The best evidence suggests that people with disabilities are less likely to travel than people without disabilities and are at greater risk of experiencing social exclusion than others. Could ridehailing promote more travel, and potentially, better health among this group? Results described in Chapter 5 are encouraging, though there were differences among interviewees. Some individuals with disabilities felt less stressed traveling on lower-capacity modes, and said that the more intimate setting of a private car facilitated conversation with drivers and other passengers, which made them feel more socially connected. Some people who felt that using ridehailing allowed them to travel independently had higher transportation self-efficacy. Thus, it seems that comfort using ridehailing made some individuals feel better in travel, and allowed them to travel more. Others were stressed by the idea of using ridehailing, or asking for help planning or executing their trip. For them, having ridehailing as an option did not promote health or encourage more travel.

6.1 Ridehailing policy and partnerships

Results of this research can inform whether existing policy strategies for regulating ridehailing services for disability accessibility are likely to accomplish stated goals. Thus far, these strategies have included regulating an industry with influence over TNCs, and assessing a tax or fee on TNCs to raise money for accessible service provision (Barnett 2019). Some TNC legislation has included provisions to collect data on accessible ride requests so that policymakers might ensure TNCs are meeting the requirements of applicable state and local non-discrimination regulations (Moran et al. 2017). In some instances, public transit agencies have also partnered with TNCs to provide ADA paratransit or other accessible service to people with disabilities.

My findings suggest that making TNCs accessible to people with disabilities will require more than increasing the number of wheelchair-accessible vehicles available on ridehailing platforms. This is because the difficulties that many individuals with disabilities face using ridehailing stem from challenges hiring a vehicle using a smartphone, connecting with the driver, and successfully completing a trip, rather than from vehicle inaccessibility (Chapter 4). It is more likely that user-side policies and programs that make using ridehailing easier and more affordable for people with disabilities, like travel training and subsidies, will encourage ridehailing use and overall greater travel among this group. Ultimately, a combination of supply- and user-side policy interventions would be best suited to improve the accessibility of ridehailing, and the transportation system more generally, to travelers with disabilities.

Policies aiming to regulate TNCs for disability accessibility by regulating the supply and performance of wheelchair-accessible TNC services might encourage greater use of ridehailing, but only for a small percentage of people with disabilities. The majority of adults who reported having a disability in the 2017 NHTS did not use a medical device for traveling; in fact, only about 4 percent reported using devices that would likely require traveling in a wheelchair-accessible vehicle, including motorized wheelchairs or scooters.

Interviewees from the San Francisco Bay Area who used motorized wheelchairs reported that wheelchair-accessible ridehailing services, at present, are quite unreliable because there are few wheelchair-accessible vehicles available on major TNC platforms, even in cities where TNCs market these services, and wait times can be (Chapter 4). However, respondents saw potential in accessible TNCs to offer more convenient service than ADA paratransit, which must be reserved in advance. Respondents also reported that accessible taxis are rarely available in adequate supply outside of dense urban cores. They hoped that wheelchair-accessible TNC services might make on-demand, accessible rides more available and more affordable in other locations.

If customers generally choose ridehailing for its relatively high convenience, reliability, and affordability compared to other modes, as results from this study and others (e.g., Brown and LaValle 2020) suggest, then wheelchair-accessible TNC services should offer wait times that are comparable to standard TNC services. This would not only likely increase the attractiveness of accessible TNC services to riders with disabilities, but would make ridehailing service provision more equitable. Training accessible vehicle drivers in how to safely secure riders' devices and otherwise provide appropriate assistance is also recommended for promoting use of accessible

TNC services. In this study, some interviewees did not feel comfortable using accessible ridehailing services because they lacked confidence that drivers knew how to transport them safely (Chapter 4). To ensure that their drivers receive adequate training, TNCs could work with entities that develop training programs for paratransit operators.

Little research has been done on the implementation of accessible TNC policies, such as those intended to offset the cost of providing improved wheelchair-accessible services like California's "TNC Access for All Act." More data and research is needed to identify how and why such policies succeed or fail. Negotiating data sharing agreements with TNCs can be difficult (Grossman and Lewis 2019), but customer and ride information is needed to monitor the performance and quality of accessible TNC services where they operate, as well as to quantify the demand for these services generally. Lessons from accessible taxi programs would suggest that policies that encourage wheelchair-accessible TNC services ought to not only incentivize companies to provide vehicles and train drivers, but should also provide incentives to drivers to drive accessible vehicles and accept accessible trips (NCD 2015).

Partnering with for-hire vehicle companies, including taxis and TNCs, to provide ADA paratransit services could benefit transit agencies and riders. 2017 NHTS data show that people with disabilities still use a combination of taxi and TNC services for a greater share of travel than people without disabilities (Chapter 3). Respondents in this study who used the SF Paratransit taxi program preferred taking advantage of this subsidized taxi service rather than using app-based ridehailing when they could. Many people with disabilities find ridehailing services to be reliable and convenient, and they appreciate technological features offered by TNCs, like electronic payment. If these desirable features are extended to those eligible to use paratransit partnership services, as they are in the SF Paratransit taxi program, then it seems quite likely that people will use these services.

Some people with disabilities may be even more inclined to take advantage of subsidized taxi or TNC services that allow them to choose their driver. One SF Paratransit taxi user was pleased that she had become familiar with some of the city's taxi drivers through the program (Chapter 4). She and some other respondents enjoyed talking to taxi and ridehailing drivers because the interaction made them feel more socially connected (Chapter 5). Uber allows riders in select markets to schedule rides with chosen "favorite drivers." It seems feasible and advantageous for TNCs to make this feature more widely available to riders.

6.2 Broader issues and implications for accessible transportation planning

People with disabilities are less likely to use ridehailing than people without disabilities, even when controlling for other factors like location within an urban area, age, and income (Chapter 3). To plan an equitable transportation system that is accessible to people with disabilities, policymakers and planners require greater understanding of how and why having a disability may affect travel behavior, generally, and ridehailing use specifically. In the following

sections, I summarize findings from this research that point to areas of special concern for accessible transportation planning—including planning for older adults with disabilities and for people with disabilities in the wake of the COVID-19 pandemic—and make recommendations for addressing these issues.

Planning for older adults with disabilities

My interviews shed light on why some individuals with disabilities have difficulty using ridehailing, revealing barriers that likely influence travel among people with disabilities. Older adults with disabilities, and people who acquired their disabilities more recently, encountered challenges hailing a ride using an app, and they worried about being able to find a vehicle and reach their desired destination independently (Chapter 4). As the American population is aging, older adults with acquired disabilities represent a large and growing group that requires attention from policymakers and planners (Iezzoni 2014).

Older people with disabilities and people who have lived with their disabilities for less time are more likely to limit their travel because of their disability (Chapter 4; Henly and Brucker 2019). Furthermore, past negative experiences using transportation or feeling anxious about asking others for help with travel adversely affects health among some older people with disabilities, and keeps these individuals from traveling (Chapter 5). Older adults and people with disabilities are already more prone to feelings of social isolation (see Repke and Ipsen 2020). Older adults with disabilities are more likely to perceive using ridehailing as daunting, and in some cases limit their travel as a result. This suggests that the expanding population of older Americans with disabilities is at high risk of experiencing transportation-related social exclusion and associated health consequences, potentially placing additional demands on healthcare systems. How can policymakers and planners, then, encourage greater use of transportation services and travel among older adults with disabilities? This research shows that part of the issue is a lack of awareness of one’s transportation options. It is well-established in behavioral science that people are creatures of habit generally and when it comes to using transportation, but also that there are “touch points” to intervene to change people’s habits and behaviors (“Behavioral Insights” 2018). For older adults with acquired disabilities, touch points may arise when individuals are faced with anticipated transportation decisions or are exploring new options—for instance, anticipating a driver’s license expiration date, at the time of applying for a reduced-fare transit pass, or when applying to use paratransit. Planners could intervene at such times by offering targeted trainings to older adults and people with disabilities on how to use smartphones to hail TNC rides or otherwise assist with transportation (e.g., by using mapping, trip-planning, or real-time vehicle tracking apps), as well as how to use particular services to get from place to place.

People with disabilities who had lived with their disabilities for longer, or had more experience using technology and transportation, reported they were more likely to use ridehailing and other alternative modes, and to have positive experiences doing so. They had learned through training and personal experience how to travel effectively, which in some cases contributed to a

heightened sense of self-efficacy and, in turn, encouraged them to travel more. It follows that offering transportation training and tools to older adults with disabilities and people with recently-acquired disabilities might facilitate greater transportation use among some people with disabilities, and minimize risks associated with social isolation and exclusion. Developing and implementing such interventions will require collaboration between transportation providers, social service providers, and private companies such as TNCs.

Accessible transportation in the wake of the COVID-19 pandemic

Opportunities to travel and interact have drastically changed for everyone since the early months of 2020 in response to the COVID-19 pandemic. Governments and transportation oversight agencies continue to grapple with how to provide essential services, including public transportation, in the face of unprecedented budget crises and great uncertainty. Though \$25 billion was appropriated to transit agencies to cover expenses related to the pandemic response as part of the Coronavirus Aid, Relief, and Economic Security (CARES) Act, passed on March 27, 2020, this amount is unlikely to offset significant losses from farebox revenue, as well as other major sources of transportation funding, including sales taxes, payroll taxes, and parking fees and fines (Badger 2020).

Preliminary findings from follow-up interviews that I conducted in late March and early April 2020, with Bay Area residents with disabilities who participated in interviews during the fall of 2019, suggest that the pandemic is underscoring many transportation issues that people with disabilities have always faced. People with disabilities rely on close contact with other people, often drivers, to get needed assistance with transportation tasks. This “assistance” may range from simply driving a vehicle, to helping a rider enter or exit a car or van or securing a mobility aid, like a motorized wheelchair.

In the wake of the pandemic, providing this assistance has become more complicated. Public health officials continue to urge people to keep a safe distance (typically 6 feet) from one another. These guidelines, and others, have revealed vulnerabilities in systems of assistance that people with disabilities rely on. For instance, riding in a standard vehicle with another person necessarily requires being within approximately 6 feet of that person. This has made some people with disabilities question whether it is safe to use ridehailing and transit. As one respondent in his seventies who is blind put it,

“I think that all the problems that everyone are having are probably magnified somewhat with disability, because, I mean, if I really had to go someplace right now, and I didn't want to use Lyft or Uber, and I'm a little nervous about the bus and BART—I'm stuck. Now, even to the extent that if I didn't feel well and thought I needed to go to the doctor, Boy, I'd have to take my chances and probably go with a ride[hailing] service and hope that I'd get one! And it would be tricky because . . . if I were ill, I'm getting in somebody's car and I'm ill . . . and they might be ill! I think the disability piece makes that harder. For

instance, a lot of my friends are not going to hop on their bike, or they don't have a car. And if they're not using public transit . . . there aren't that many alternatives.”

When asked about how her travel behavior has changed since the coronavirus outbreak, another respondent in her forties who uses a motorized wheelchair explained that she has a “hesitation” to use transit that she does not normally have because of concerns about the pandemic and response strategies. She clarified,

“One of the things about the way that transit is responding [to the pandemic] is the move to rear-door boarding, to help people stay distanced and separate. And, the fact is, for somebody like me [using a motorized wheelchair] on a bus or for anybody using paratransit, you can't be distanced from the driver; it's just not an option.”

These issues compound other problems accessing and using transportation that all people without reliable access to a private vehicle are presently facing, including service changes and cuts. Transit services have been reduced seemingly everywhere, and public and shared services, including ridehailing options, have been altered to reduce contact between people in vehicles. Uber and Lyft have suspended their more affordable, shared ride options UberPool and Lyft Line. Many paratransit operators have limited their services to only provide riders with “essential” trips (e.g., those to grocery stores or medical appointments), and have made changes to reduce crowding in vehicles. Paratransit services are only required to operate where transit services do, so where transit is cut, paratransit may be too. Reduced access to transit and paratransit services is worrying in itself, but particularly so as taxis and ridehailing services have also become less available as drivers weigh their own safety concerns and face severely reduced revenue resulting from low demand for rides (Conger 2020).

In order to ensure that people with disabilities are able to access essential goods and services during and after this time of crisis, transportation regulators and providers should consider how to offer safe, affordable, and convenient service to those who need it most. This will likely require exploring new and innovative partnerships with on-demand providers, as well as with any equipped vehicle fleets that could contribute accessible vehicles. Providers are faced with the difficult task of continuing to offer high-capacity, frequent service (to allow for appropriate distancing in vehicles), for far fewer riders paying a fare. Any way to minimize costs while continuing to provide adequate service is worth exploring. Partnering with TNC platforms to supplement or replace transit services such that they could make on-demand or pre-scheduled trips rather than following fixed schedules or routes could be one approach to potentially reduce transit supply without compromising service for those who need it (Reid 2020). Measures to offer more demand-responsive service need to be combined with the implementation of new safety protocols that minimize risks of virus transmission to drivers and passengers, such as requirements that all on board must wear masks or other personal protective equipment. Most

transit operators and TNCs have implemented such guidelines (Goldbaum 2020). Transit agencies and TNCs should consider providing masks to all drivers and passengers who do not have one.

This pandemic highlights the extent to which people with disabilities depend on accessible services as well as human assistance to travel. Since people can no longer interact safely in ways that they are used to, policymakers and planners looking ahead ought to consider solutions that allow people with disabilities to use transportation more easily and independently. Technological interventions, like installation of automatic docking systems that might allow wheelchair users to safely secure their wheelchairs without assistance or accessible wayfinding infrastructure, could improve transportation accessibility for some people with disabilities. Opportunities for up-to-date travel training should be expanded for people with disabilities, particularly as transportation options and technologies change. Driver training and education campaigns for passengers, as discussed in Section 5.5, could also contribute to making transportation more accessible to people with disabilities.

6.3 Future research directions

While this research has made contributions to understanding the travel behavior of people with disabilities in contemporary contexts, there is much more to learn about the mobility needs of people with disabilities. Policymakers and planners need an accurate understanding of demand among people with disabilities for transportation services, as well as barriers and facilitators to using these services, if they are going to provide adequate, accessible, non-discriminatory transportation. This understanding should come from quantitative and qualitative data on travel behavior and experiences, as well as from asking about trips not taken. There is likely high latent demand for more travel and social participation among people with disabilities. Meeting this population's unfulfilled travel needs will be key to allowing individuals with disabilities to access more opportunities for economic and social participation.

People with disabilities are not a homogenous group. Age, primary disability type, length of time living with a disability, and other factors play a role in explaining the travel behavior and experiences of people with disabilities. Greater attention ought to be given in future studies not only to understanding how having a disability represents an axis of inequality (Shandra 2018), but how aspects of people's disabilities, as well as other personal characteristics, including age, race, class, and gender, etc., interact with disability status and affect travel behavior.

Greater knowledge of the travel behavior of people with disabilities can help evaluate whether proposed or pilot accessible transportation policies and programs might be successful at meeting stated goals. But research focusing on the implementation of such policies would provide far greater insight into their efficacy. Presently, this is lacking. So too is research on the accessible transportation policymaking process, which could show how stakeholders contribute to defining and setting the accessible transportation policy agenda, and what effect this has on service provision.

6.4 Conclusion

Despite gains made since passage of the ADA, barriers to accessing transportation continue to keep people with disabilities in the United States from traveling at a comparable rate and with the same ease as people without disabilities (NCD 2015). The advent and rapid growth of app-based ridehailing services has done little to close the gap. People with disabilities use ridehailing less than the rest of the population, which may be because some individuals have difficulty using new technology and transportation services independently. Greater knowledge of barriers and facilitators to using ridehailing and other services, old and new, is needed to craft policies and plans that will make transportation more accessible to people with disabilities, and promote travel and health among this growing population now and in the future.

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Appendix A. Interview Protocol

1. Introduction

Hello, my name is [NAME]. I am contacting you per our previous arrangement to ask you some questions about your day-to-day travel experiences, and attitudes towards transportation.

Before we begin the interview I would like to confirm that you have reviewed the consent form that I sent previously. Do you have any questions? If you're comfortable with it, I will record our conversation for the purpose of accuracy. The recording will not be shared with anyone outside of our trained research team, and will be stored securely. Furthermore, I will destroy the recording once I am able to transcribe it. Sensitive personal identifying information described during the interview, including your name, will be kept confidential barring your agreement of release. Is this okay with you? I expect this interview will take between 35 and 60 minutes of your time. Know if you are uncomfortable with a question or continuing at any time, you may stop the conversation or ask to move on to another question. I really appreciate your participation.

2. Preliminary Information

A. Demographics: Disability status, gender identity, age, city of residence, employment status, income category [?]

B. Please tell me a little bit about yourself. How long have you lived/worked in the Bay Area?

C. Can you tell me a little bit about the neighborhood where you live?

3. A Typical Day

A. I'd like to get a sense of your daily routine. Would you mind walking me through what you did yesterday?

a. Inquire/note what activities the interviewee engaged in, and how they traveled between activities.

B. Would you say that you usually get around in the ways that you just described?

a. Inquire more about each travel mode. Probe where respondent expressed feeling of relief/ease or frustration/difficulty.

C. Do you ever feel like you can't do what you want to do because it's difficult to get somewhere?

a. Inquire here about why – Scheduling? Relying on others? Relying on timetables/particular services? Etc.

4. Transportation and Wrap-Up Questions

A. What kinds of challenges do you think people with disabilities face when traveling in the day-to-day? In the Bay Area, or otherwise?

- B. Have you ever used a subsidized fare, voucher, or other service provided to people with disabilities to reduce the cost of transportation?
- C. Have you ever used paratransit? How about other demand-responsive services?
- D. Do you take taxis? How often? Do your friends take taxis?
 - a. Inquire why/why not? About the experience.
- E. Do you ever use services like Uber or Lyft? How often? Do your friends use these services?
 - a. Inquire why/why not? About the experience.
- F. How has the way you travel around routinely changed in the past 5 years?

Thank you for your time. If you know of anyone that you think might be interested in participating in an interview for this study, please feel free to pass along my contact information to them (which we've been using to schedule this interview, and which can be found in the initial recruitment materials you received). If I have any follow-up questions or concerns about the information you have provided during this interview, may I contact you for clarification? Thank you, again.