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Are multimodal travelers more satisfied with their lives? A study of accessibility and wellbeing in the Denver, Colorado metropolitan area

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ABSTRACT

In this study, we ask how the ability to use multiple transportation options affects one's subjective wellbeing (SWB), including aspects such as physical health, financial security, standard of living, and personal relationships. A clearer understanding of these associations can inform investments in multimodal infrastructure. We draw on 232 surveys from a diverse set of residents in the Denver, Colorado metropolitan area and find that having more transportation choices can improve standard of living for low- and middle-income residents. Multimodal middle-income residents are also more satisfied with their health and what they are achieving in life. Vehicle owners report higher levels of satisfaction with their standard of living, health, and achievements, compared to non-owners, unless auto is their only travel mode. Only low-income respondents had significant differences in standard of living by where they lived, with greatest satisfaction in the urban core. These results confirm the relationship between public transit and SWB, and contribute to our understanding of how the concept of motility (social and spatial mobility) shapes one's quality of life. The findings have implications for investments in transportation modes across neighborhood types and populations, so that people have a range of travel options to meet their needs and increase their satisfaction with their goals through improved daily travel.

1. Introduction

On May 26, 2015, Denver's Regional Transportation District (RTD) voted to pass sweeping bus and light-rail fare increases. At the meeting, elected board members listened to dozens of impassioned pleas from community activists, transit-reliant citizens, and advocates for poor and marginalized residents, who accused the city of catering to "choice" riders over those who depend on public transit for their daily activities. In one powerful exchange, a transit rider argued "My route is a lifeline to work, medical care and education …Your actions are dramatically affecting the Hispanic community where I live" to which a RTD board member replied "I know the Denver community is struggling with a lot of problems right now, but RTD can't be the solution to all of them" (Aqra, 2015).

Around the same time that RTD was raising fares, cutting bus service, and opening new light rail lines almost exclusively in the suburbs, Car2Go, the city's largest car share service, decided to remove their vehicles from nearly all of Denver's lowest income neighborhoods. In addition, analyses emerged in this period showing that the city's poorest neighborhoods lacked adequate bicycle infrastructure and that Denver B-Cycle, the region's popular bike share system, had located their stations disproportionately in middle- and upper-income neighborhoods, the same neighborhoods from which low-income residents were being evicted or displaced with increasing regularity.

Amidst these cuts, we discussed regularly the value that we, the authors, as middle-income households living in dense, transit-rich neighborhoods, were afforded by having multiple transportation choices. Any given day, we could bicycle or walk to the office or appointments or use our employer-subsidized, all-access transit passes to catch the bus a block from our homes and get dropped directly at our destination. And if the bus did not go to a destination, we would use a personal car or reserve a car-share. So if *we* benefitted in these multiple ways from access to multiple transportation modes, what was the impact of these cuts in service on the quality of life of lower-income, transit-dependent folks living in places that also lacked the multi-modal accessibility that we so enjoyed?

Although wellbeing is measured regularly in an increasing number of countries, we know very little about the impact of transportation accessibility on what researchers call subjective wellbeing (SWB).[1] By asking how access to a multitude of transportation options affects one's

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[1] We use the term subjective well-being (SWB) instead of personal well-being as it is based on one's own opinions of their health, security, and happiness.

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personal wellbeing, including physical and emotional health, financial security, and standard of living, this study breaks new ground in understanding how place, personal characteristics, and multimodal access to daily activities interact to shape one's satisfaction with life. We show that regardless of personal characteristics or built environment factors, transportation choice can improve certain facets of subjective well-being, particularly for lower income persons for whom owning a vehicle may be out of reach.

To test the relationships between use of multiple transportation modes[2] and SWB, we administered a unique travel and wellbeing survey to 232 residents from different economic backgrounds and neighborhood types across the Denver metropolitan area. We find that having more transportation choices can improve certain aspects of SWB. Low- and middle-income respondents who use multiple transportation alternatives for their daily activities report a higher standard of living than those relying primarily on a single transportation mode. Middle-income multimodal travelers also had higher levels of satisfaction with their physical health and what they are achieving in life. When one of the modes was a personal vehicle, respondents indicated an even higher standard of living and satisfaction with life. Nevertheless, dependency on any one mode, whether transit or automobile, tended to lower one's subjective rating of their standard of living.

These findings build on research linking transportation accessibility and SWB in three ways. First, we take into account how *who* we are, *where* we live, *how* we travel, and *where* we are able to travel interact to affect SWB (Cao, 2016; De Vos, Schwanen, Van Acker, & Witlox, 2013; Okulicz-Kozaryn, 2011). Second, we emphasize how regular use of multiple modes for all trips – and not just public transit or a personal automobile for the commute – affects SWB. And third, we break down SWB (our composite dependent variable) into seven life domain components, recognizing that our lives are complex and multi-faceted, and our physical health, for example, doesn't always vary directly with emotional health or financial security (Cummins, Eckersley, Pallant, van Vugt, & Misajon, 2003). In sum, this study furthers the research on travel and wellbeing by looking at the various wellbeing effects from a combination of modes rather than satisfaction with particular modes or trip types.

Our findings also suggest that policies and market forces that make it more difficult for low- and middle-income households to have transportation choice, such as reduced bus service, lack of quality sidewalks, higher transit fares, unsafe biking conditions, reduced access to owned or shared vehicles, and displacement from the most transit-accessible places due to high housing costs can reduce one's quality of life. Further, communicating the wellbeing effects that multimodal travelers enjoy might encourage higher income travelers to reduce their dependency on automobiles.

2. People, place, access, and subjective well-being

SWB is the cognitive evaluation of one's life on interrelated areas such as emotion, engagement, fulfillment, satisfaction, peace, and even happiness (Diener, Diener, & Diener, 1995). Because individuals and societies have been known to rate themselves very high on some of these components and very low on others, Diener and Suh (1997) suggest that researchers should analyze SWB both as a composite whole and on its constituent dimensions. A core assumption of SWB research is that in order to obtain the best data, we need to ask people directly how they feel about their lives, according to their own standards (see Seligman, 2002).

A growing number of cities and organizations have begun collecting self-reported SWB data as opposed to relying on objective, aggregated sources alone, and they are using these data as a key metric for zeroing in on how real problems affect real people in very different ways (Graham, 2015a). These initiatives are not confined to the local level: the Gallup-Sharecare Well-Being Index has collected over 2.5 million surveys to date using questions that capture how people feel about their social, financial, community, and physical wellbeing (Sharecare, Inc, 2017).

There are a number of strengths of SWB measures. Since SWB studies focus on personal perceptions and individual opinions instead of resource levels or objective indicators, they tend to capture what is most important to individuals, what affects them most on a daily basis (Diener et al., 1995). Although reliant on self-reported data, SWB measures have been shown to have adequate levels of validity and convergence with more objective factors known to influence wellbeing and quality of life; as such, SWB studies help researchers make more confident and definitive conclusions about how specific community features, policies, or programs tend to impact life for respondents (see Diener & Suh, 1997; Suh, Diener, & Fujita, 1996). SWB measures also move us beyond economic indicators, which do not always reflect how people are doing: although economic progress has skyrocketed over the past several decades, levels of life satisfaction have remained flat and depression and distrust have increased over this same period. So although the U.S. is the richest country in the world, it ranked 23 of 145 in overall SWB in 2014 and countries as stable and well-off as South Korea, Croatia, and Singapore ranked near the bottom in most categories (Chappell, 2015). Methodologically, SWB measures can still be easily standardized across populations by asking the same question to different respondents, and conceptually, SWB studies can tease out interactions between who we are and how we feel; because SWB relies on "dispositional characteristics" and not just external life conditions, it accounts for the fact that everyone comes from different backgrounds and starting points in life and that "objectively similar life circumstances can be construed very differently" (Diener & Suh, 1997, 202).

SWB measures also have several weaknesses. First, although comprised of valid individual components, survey respondents can respond inaccurately or dishonestly, though this same shortcoming exists for certain "objective" behavioral and socioeconomic measures collected via surveys such as the U.S. Census. Second, subjective survey responses are situational and can be highly sensitive to respondents' moods or emotional states at the time of survey completion (Schwarz & Strack, 1991). Third, up to 50% of the variance in SWB has been shown to be simply attributed to stable personality traits over which we have little control (Lyubomirsky, King, & Diener, 2005), because of the genetic effects on approximately half of the variance on certain personality domains (Weiss, Bates, & Luciano, 2008). Indeed, in addition to income, marital status, and education level, researchers have found that SWB is statistically significantly dependent on age, sex, race, and ethnicity, all factors to which we are genetically predisposed (Ettema et al., 2011). Thus, SWB "also appears to be moderately heritable" (2008, 205). As such, researchers universally suggest that SWB measures be used in conjunction with objective social indicators in order to develop the most robust evaluation results possible.

With some exceptions, individuals report higher SWB if they are wealthy, religious, married, employed, educated, and healthy (Graham, 2015b). Nevertheless, residents of some of the world's poorest countries often indicate higher levels of happiness and life satisfaction than folks living in rich countries, where residents claim lower levels of job security, air quality, housing affordability, and work-life balance (OECD, 2015). Income only seems to impact SWB up to the point that one's basic needs are met and personal goals achieved (Diener & Suh, 1997). Working males show higher levels of SWB than working females; health satisfaction increases with income and education; unemployed respondents are happier than those involuntarily employed part-time; and children from better-off families nearly always indicate higher life satisfaction (Graham & Niklova, 2014; OECD, 2015; Van Praag, Frijters, & Ferrer-i-Carbonell, 2003; Niklova & Graham, 2014). Some relationships

[2] Our survey instrument asks respondents about their actual use of different transportation modes, which assumes they have access to such modes. Throughout the paper, then, we use the terms "access" and "use" interchangeably.

can be rather surprising: according to a recent Gallup poll, Black Americans living below the poverty line indicated much higher levels of happiness and optimism than the average respondent, a finding that some relate to their closer family ties and social supports that many wealthier White Americans do not maintain (Graham, 2015b).

A number of studies have asked how access to and participation in intentional daily activities, especially as a means of pursuing one's interests and life goals, can impact SWB (Ettema, Gärling, Olsson, & Friman, 2010; Kasser & Ryan, 1996; Lyubomirsky et al., 2005). In general, those who face even minor stresses or hassles in accessing activity spaces of normal everyday life such as doctor's appointments, schools, banks, or jobs, indicate increased negative mood, low life satisfaction, and decreased quality of life (Gadermann & Zumbo, 2007; Niedzielski & Boschmann, 2014; Pychyl & Little, 1998). Conversely, Morrison (2011) and Cao (2016) find that accessibility to shops, education, and public transit can increase overall SWB. Zhang (2005) shows that increases in accessibility result in children spending more time in school and adults participating in more social activities, such as entertainment, recreation, and dining out.

In fact, convenient access to transportation of all persons can improve levels of social capital, connectedness, and feelings of belonging (Currie & Stanley, 2008; Lucas, 2006; Stanley, 2010). And the quality of the trip matters: Ettema et al. (2010) show that the efficiency and certainty with which we carry out activities can increase SWB, whereas delay or uncertainty can have a negative impact (728). The importance of trip quality, certainty, and level of service may help to explain findings that public transit users may be less satisfied with their travel (Ye & Titheridge, 2017) and experience more negative emotions during travel than those who drive or bike (Morris and Guerra, 2014). The type of built environment of the neighborhood in which a traveler lives can also affect satisfaction with different modes of travel, given that certain environments are more conducive to some modes than others (De Vos, Mokhtarian, Schwanen, Van Acker, & Witlox, 2016; St-Louis, Manaugh, van Lierop, & El-Geneidy, 2014). Transportation access and quality can thus directly or indirectly facilitate or hinder progress toward important life goals and can increase or decrease the experience of positive and negative affect, both key components of SWB (Pychyl & Little, 1998).

Much research in this area emphasizes the importance of public transit in particular in accessing daily activities. Ferrell (2015) shows that quality public transit can improve access to health care and save lower- to middle-income families money over owning a vehicle. Melis, Gelormino, Marra, Ferracin, and Costa (2015) reveal that even when controlling for powerful social factors, efficient, convenient access to public transit can reduce the risk of depression for women and elderly persons. On the contrary, low-income, transit-reliant people are known to miss critical medical appointments due to their inability or inconvenience in getting to them, and missed visits can lead to higher incidence of disease and a decline in overall health (Ahmed, Lemkau, Nealeigh, & Mann, 2001; Cronk, 2015; Guidry, Aday, Zhang, & Winn, 1997; Silver, Blustein, & Weitzman, 2012; Syed, Gerber, & Sharp, 2013; Wallace, Hughes-Cromwick, & Khasnabis, 2005). Yet, those unwillingly tied to a single mode that is also subject to external influences can lack a sense of control over their mobility (Flamm & Kaufmann, 2006).

But not all people would prefer public transit as their primary mode: Boschmann and Brady (2013) show that 90% of travel for older adults in the Denver metro region is by automobile, a particularly important finding since participation in physical activity and social interaction among this population is strongly positively correlated with cognitive SWB (Spinney, Scott, & Newbold, 2009). In the absence of quality public transit, automobile use and ownership in general have been associated with improved economic outcomes, lower exposure to neighborhood crime, life satisfaction, access to healthy food, employment, higher education, and medical treatment (Coveney & O'Dwyer, 2009; Lucas, 2006; Pendall et al., 2015). Workers who own automobiles have better access and shorter commutes to better jobs with more hours (Raphael & Rice, 2002; Lichtenwalter, Koeske, & Sales, 2006; O'Regan & Quigley, 1999; Sanchez, Shen, & Peng, 2004; Kawabata & Shen, 2007). And automobile access is particularly important for low-income commuters due to both the nature of their home-to-work journey and the work they do. As we see a rise in concentrated suburban poverty and a lack of job opportunities in the places where many lower-income people now live, this mismatch is not only bad for the commuter but also for their children's journeys to schools and afterschool activities (Hart & Lownes, 2013; White, 2015). In fact, Chetty and Hendren (2015) show that commute time is the single strongest factor in escaping poverty, an even stronger predictor than crime, school test scores, or living in a two-parent household.

Although this literature has drawn critical attention to the impact of transportation access on SWB, a large share focuses on differences in commuting behavior rather than travel to a confluence of daily activities such as school and afterschool activities, recreation and exercise, grocery stores and healthy food outlets, and medical appointments and pharmacy visits (Abou-Zeid & Ben-Akiva, 2011; De Vos et al., 2013; Ettema et al., 2011; Olsson, Garling, Ettema, Friman, & Fuji, 2013). This is in spite of the fact that work travel accounts for only about 1 in 6 daily trips, and even on public transit, the commute only accounts for 1 in 3 trips (AASHTO, 2013). However, since the work trip occurs regularly and is considered “unloved” by so many, it may have a different impact than other trips (Morris & Guerra, 2015). Nevertheless, this “white-collar work lens” can therefore undervalue experiences of those that do not or cannot work – including older adults, people with disabilities, students, and young people (Jaffe, 2015). Indeed, the number of “all purpose” riders who take transit to work, dining, shopping, appointments, or entertainment, is a powerful signal that a transit system is functioning at its peak (Bliss, 2016).

In addition, most studies focus on how either access to convenient, high-quality public transit *or* owning an automobile can improve quality of life, particularly for low-income folks, children, and older adults (see Pendall, Blumenberg, & Dawkins, 2016). Yet we know that many daily travelers, especially urban dwellers, rely on multiple transportation modes to get to different destinations: in a single day, we might take transit to work, drive to the cinema, ride our bike to the park, and walk to the local market. Indeed, the concept of “motility” introduced by Flamm and Kaufmann (2006) captures the notion that the mode one selects is based on both access to the mode and the destination, personal capabilities, and a decision based on values, habits, and strategies that are not necessarily utility-maximizing. Their research shows that the composition of one's “mode portfolio” can contribute to both social and spatial mobility; therefore, we choose to focus on how access to multiple modes contribute to SWB instead of focusing on the tradeoff costs of selecting one mode over another.

A final oversight is that most studies in this area focus on the experiences of a subset of residents such as low-income workers, middle-income commuters, or young people traveling to school, even as we know that not everyone in a sample experiences the same accessibility due to residential or job location, health conditions, age, sex, quality of transit, or perceptions (Niedzielski & Boschmann, 2014). Spatial characteristics of the transportation journey can also factor into decisions since the built environment directly and indirectly influences the range of modes available and whether or not people will choose to use them (De Vos et al., 2016; Flamm & Kaufmann, 2006).

Given these gaps, we survey a heterogeneous group of citizens from the Denver metro area to understand how access to multiple transportation modes affects aspects of SWB and SWB overall. We account for how personal characteristics such as income and race and neighborhood characteristics might play an intervening role in the transportation-wellbeing relationship. In this regard, we use what Niedzielski and Boschmann (2014) call a place-based accessibility approach – one that looks at how people, place, and travel behavior interact to impact SWB and its constituent components. In the end, our paper sheds light on how the coordination of public health, social services, and public infrastructure might benefit our least well off; this “upstream” approach

to SWB moves beyond symptoms to focus on the drivers of, and barriers to, SWB (Manchanda, 2014).

3. Methodology and data

Our research team conducted 232 surveys from April to December 2015 in a variety of locations around the Denver metro area. The sample same size was sufficient to allow for tests across different demographics in each of our three location types. We chose Denver because it is representative of other revitalizing mid-sized cities in the U.S. and abroad with global city aspirations such as Frankfurt (Beaverstock, Hoyler, Pain, & Taylor, 2006), Vancouver (Hutton, 2004; Kear, 2007), and Portland (Hagerman, 2007), where gentrification from rapid population growth and the expansion of urban public transit and other amenities are displacing low-income persons and persons of color from the most accessible locations in the city (Bereitschaft, 2014). Like other cities, individuals and families are being forced to move to less dense suburban areas outside the core where there are fewer transportation choices and jobs and amenities are further away. Although Denver has often been called one of the U.S.'s "best places to live," inequality is increasing markedly as thousands move to the region.

Each survey had 38 closed-ended questions that began with questions about the respondent's SWB, personal characteristics (i.e., demographic and socioeconomic data), and residential location (that we matched to neighborhood built form characteristics). We intentionally asked about travel behavior (i.e., the various transportation modes and preferences of respondents, including how they traveled to twelve frequent destinations such as a job, grocery store, library, park, medical care, church, social services, and school) after the respondent scored their SWB characteristics. By asking first about SWB, before raising the issue of travel, we reduced the possibility that their recent experiences with a particular trip influenced their responses to the SWB questions.

Table 1 provides details on our survey respondents. Because we were particularly interested in the experience of those at least partially dependent on public transit and other modes, 84% of our respondents were low- or middle-income (see Table 1). Eighty percent (80%) of our participants were persons of color. Nearly all surveys were gathered in person at community events and festivals, housing developments, libraries, and public meetings. The time- and resource-intensive nature of this data collection effort limited the size of our sample, but it allowed us to target participants who lived in our different neighborhood types. Participants completed their surveys independently and anonymously but were permitted to ask the project team members for assistance. We collected identifying information under separate cover for purposes of an incentive raffle.

Omitted responses on some categories were likely due to: the ordering of our survey questions and design and length of the survey instrument; the fact that some survey locations were age-restricted (such as senior centers, food pantries, and public housing) so respondents may have been reluctant to provide their real age; and that many of our respondents were either very low-income or physically disabled residents in-and-out of employment so they were unsure how best to respond to the employment question. We accounted for missing data in different ways. For example, of the 37 participants who left the income field blank, we were able to place 34 of them in an income category based on their responses to other questions.

For the SWB questions, we chose the Personal Wellbeing Index from the International Wellbeing Group (IWbG) which consists of seven subjective questions representing the core domains of life that contribute to overall SWB (International Wellbeing Group, 2013). We use this index because multi-item scales are more reliable than single questions about satisfaction, and because the index can help tease out which aspects of wellbeing are most-affected by access to transportation. Using a five-point Likert scale, the survey asked participants seven questions about how satisfied they felt about their standard of living, physical health, personal relationships, attachment to their community, personal safety, future security, and what they are achieving in life. We entered data from the paper surveys into an electronic database and coded and analyzed the data in Microsoft Excel, Access, and SPSS.

Table 1
Study sample demographics.

Variable	N	%
Income		
Low income (< $20,000)	128	55%
Middle Income ($20,000–$59,999)	67	29%
High income ($60,000 or more)	37	16%
N/AV (removed from sample)	3	
Race and Ethnicity		
African American	92	40%
Asian/Pacific Islander	4	2%
Hispanic	54	23%
Two or more races	18	8%
Native American	8	3%
Other or blank	7	3%
White non-Hispanic	55	24%
Born outside US	24	10%
Gender		
Female	144	62%
Male	79	34%
N/AV	9	4%
Age		
18–29	20	9%
30–55	65	28%
56–74	50	22%
75 +	4	2%
N/AV	93	40%
Employment		
Employed in 1 or more jobs	93	40%
Not employed	16	7%
N/AV	123	53%
Transportation		
No vehicle	85	30%
Cannot drive	51	21%
Uses transit	192	77%
Bikes to destinations	70	29%
Walks to destinations	182	76%
Housing		
Rent: apartment, dorms, military, public	122	53%
Shelter or transitional housing	19	8%
Own	68	29%
N/AV	23	10%

For the travel behavior variables, we grouped respondents into one of three categories: those who rely predominantly upon one single mode (modal-dependent), those who used at least two modes regularly (semi-multimodal), and those who used three or more modes regularly (multi-modal). The travel behavior categories are a composite score of several fields derived from the survey that asked whether the respondent could drive, if they took transit to work or to any of 12 listed destinations, how many vehicles they own, and whether they ever walk or bike to destinations. We combined the results from these questions using if-then statements to construct the three levels of multimodal travel listed above.

If the only mode someone recorded was auto or transit, their travel behavior received a score of "1". If someone recorded two modes, such as transit and walking, and traveled to more than half their destinations using transit, including work, we scored them a "2" for travel behavior. To be considered multi-modal, i.e. to receive a "3", respondents had to travel regularly using at least three modes, be able to drive, and take public transit to either three or more destinations, or regularly to work. To clarify the difference between categories 2 and 3, those placed in the semi-multimodal category relied heavily on a single mode with occasional/sporadic use of a second mode, whereas those deemed truly multi-modal had multiple options for any and all given trips.

In order to account for intervening personal characteristics such as demographics and socioeconomic status, we coded individual responses to questions about age, sex, ethnicity, and work status and constructed three ordinal variables related primarily to annual median income: low (less than $20,000), middle ($20,000 to $59,000), and high ($60,000 or more).

Finally, for the place-related variables, we used data derived from the 2009 American Community Survey 5-year estimates and the 2009 TIGER/line shape files from the US Census for block groups compiled by the Center for Neighborhood Technology[3] to sort all respondents into one of three neighborhood types based on each respondent's home intersection address: suburban neighborhood, urban neighborhood, and urban core. The three types ranged from low, to moderate, to high density and accessibility to transportation options and destinations. By sorting into neighborhood types prevalent in mid- to large-sized cities around the globe, our findings become relevant outside the Denver context. We also sorted each block group by whether it is socio-economically disadvantaged or not (SED). A block group was considered SED if it performed worse than the city of Denver on eight variables: median income, poverty rate, median home value, percentage of housing ownership, average high school graduates, college graduates, employment in executive and management professions, and employment rate. Of our sample, 83 participants (36%) lived in SED block groups: of these, 58 of these were in the urban core, 21 were in suburban areas, and 4 were in urban neighborhoods. Table 2 shows how respondents fell into different categories and Fig. 1 shows the respondent locations in relation to the urban form of their neighborhoods.

We used the Kruskal-Wallis one-way ANOVA test, a nonparametric test for small samples that are not normally distributed, to understand whether and to what extent the ability to use multiple transportation modes impacts overall SWB or its constituent variables. To account for associations between other variables we used *t*-tests, chi-square, and other standard tests for bivariate correlations.

4. Findings

Across income groups, multimodal respondents do indeed indicate a higher standard of living and a stronger connection to their communities than those with worse access. For the middle-income group, multimodal travel is also associated with higher SWB scores on physical health and a satisfaction with what one is achieving in life. For high-income respondents, multimodal travel has no impact on overall SWB or any of its constituent variables. And for all respondents, owning a vehicle is also positively associated with higher levels of overall SWB, standard of living, health, and achievements. See Table 3 below for more details.)

To also understand whether personal characteristics were driving SWB, we tested income, race, ethnicity, gender, age, education levels, and employment against the seven separate measures of SWB as well as the combined score. Only income was significantly associated with the combined score of SWB and with standard of living, health, achieving in life, and relationships (See Table 4). The lack of association with age and employment may have been due to the missing data in these categories. In other words, the richer the respondent, the higher they scored their overall and disaggregated SWB, regardless of travel behavior or where they live.

To analyze the impact of place, i.e., neighborhood characteristics, on SWB, we used our composite measure of neighborhood type and the SED binary categorization of block groups. For all participants, not controlling for income, there was a significant difference among the three neighborhood types for how satisfied they were with feeling part of their community: those in the urban core rated their satisfaction highest (4.04), followed by the residents in suburban areas (3.8). In addition, participants in SED block groups were surprisingly more attached to their community than those in better-off block groups. The results by income and urban form may be due to the income mix of our sample and the oversampling of low and middle-income residents; in the high-income group, for example, only five participants lived in an urban neighborhood and only seven lived in an urban core neighborhood. One explanation for the low number of high-income residents in urban core and urban neighborhoods is that one of our primary survey locations was located in one of Denver's suburban-style upper income neighborhoods. See Table 5 for details.

Once we took income into account, the only association between place and SWB was for low-income participants, where residents of urban core neighborhoods were more satisfied with their standard of living than others. Nevertheless, the direction of scores shows all income groups were more satisfied with their standard of living and in feeling part of their community if they lived in an urban core or urban neighborhood.

Table 2
Distribution of sample by urban form and income.

	Urban Form		
	1-Suburban	2-Urban Neighborhood	3-Urban Core
Sample distribution by urban form			
Low Income	60	12	56
Middle Income	43	10	14
High Income	25	5	7
Socioeconomically disadvantaged			
Not SED	107	23	19
SED	21	4	58
Total Sample	**129**	**27**	**77**

5. Discussion

Our analysis indicates a number of interesting findings that confirm our hypotheses and reveal some unexpected relationships.

5.1. Access to and use of multiple modes increases standard of living

Although income affects standard of living, health, achieving, relationships, and overall SWB, low- and middle-income households tend to feel even more satisfied with their standard of living if they use multiple modes, which might be due to a sense of freedom, control and flexibility in their daily travel. This is particularly the case when the low- or middle-income respondent lives in an urban core neighborhood with a denser urban form that allows them to choose to use multiple modes of transportation.

5.2. Place affects multimodal travel

Multimodal respondents in our study were more likely to live in places with more urban characteristics. Households were best able to be multimodal in such places because their neighborhoods were more walkable and transit-friendly with greater densities and more access to jobs and amenities.

5.3. Owning a vehicle has a major impact on SWB

For all respondents at all income levels living in all types of neighborhoods, vehicle ownership was associated with higher levels of overall SWB, standard of living, health, and achievements. But dependency on auto travel *alone* was not significantly associated with SWB.

[3] These data were downloaded from the Center for Neighborhood Technology's H + T Index website at the block group level for the Denver region, http://htaindex.cnt.org/download/.

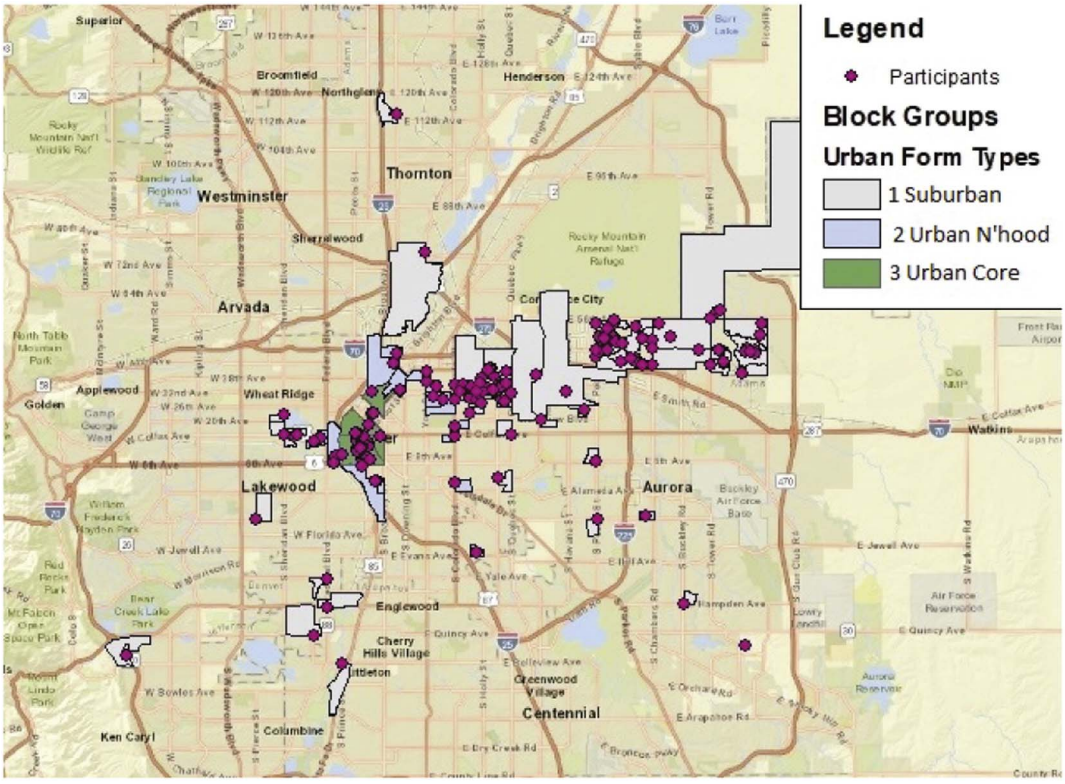

Fig. 1. Participant distribution across urban form types.

5.4. Income shapes SWB on its own and in relation to neighborhood form and travel behavior

The richer people are, the higher they score on SWB overall and on nearly all its constituent variables. Income and place characteristics also interact: low-income people indicate a higher standard of living when they live in a dense urban core neighborhood, which could relate to proximity to destinations and jobs, the availability of frequent public transit, and the ability to walk to some destinations. Indeed, as one urban core resident commented "I take transit to work, walk 1-2 miles to local stores, drive 1-2 times/month to Costco, drive or take transit to family & friends, and [I'm] close enough to walk to central library." Low- and middle-income people have constrained choices in how they must travel, and their travel behavior varies less with urban form. High-income people, who ostensibly have the ability to more freely choose their modes of travel since they have fewer economic constraints, are more likely to become multimodal when they are in a denser environment. This last finding may be affected by the small sample size of high-income people who live in urban neighborhoods.

These findings deepen our understanding of the ways spatial patterns, socioeconomic status, and personal characteristics together relate to travel behavior and indicate a clear pattern between travel behavior and life satisfaction (see St-Louis et al., 2014).

6. Conclusion

In this study, we asked how access to and reliance on a multitude of transportation options might affect one's SWB, including their physical and emotional health, financial security, and standard of living. We hypothesized that regardless of personal characteristics or built environment factors, multimodal travel can improve certain facets of subjective wellbeing. Both the statistical and descriptive results indicate that personal characteristics, particularly income, impact SWB, and that place by itself does not directly affect SWB, except for potentially making one feel more a part of one's community. Indirectly, neighborhood characteristics seem to allow one to more easily use more transportation modes, which we know can increase standard of living. Although our sample sizes are relatively small and statistical tests insignificant across some categories, the findings confirm what other recent studies have found on the influence of travel behavior, urban form, and socioeconomic status on SWB.

Future qualitative research should begin to confirm the reasons why being a multimodal traveler has such a major impact on standard of living. Such research should also explore the possible influences of attitudes and personality, which we did not consider in this study. Follow-up research could also help to identify the specific physical designs that improve access to multiple transportation modes for different types of people in different types of places, whether more urban or suburban. A larger sample size, particularly with greater numbers of moderate and high-income households in urban neighborhoods, may also shape the results of subsequent studies.

Providing better transit, coordinating with other modes, and ensuring low- and middle-income households can live in areas with a range of transportation modes is something the many regions continue to struggle with. Reducing transit service, increasing fares, and allowing displacement from urban cores to occur misses the opportunity to not only reduce residents' vehicle emissions and guarantee them safe and affordable access to work and other destinations, but also the opportunity to help improve quality of life and wellbeing. Planners in Denver and other regions should think hard about how best to service lower-income households through transit improvements, car share programs, bicycle access, and other shared mobility strategies, particularly in less dense areas. As the number of households living at or below the poverty level grows every day in the country's outer-edge urban neighborhoods and suburbs, finding innovative, equity-oriented solutions to these vexing problems presents a critical challenge for the nation's planners and policymakers.

Table 3
Effects of travel behaviors on SWB.

Travel Behavior and Income	Standard of Living	Health	Achieving in Life	Relationships	Feeling Safe	Feeling Part of Community	Future Security	Sum Wellbeing	Average Wellbeing
Total Sample (*N* = 232)									
Mode-dependent (*N* = 97)	3.53	3.61	3.76	3.85	4.00	3.84	3.57	26.03	3.73
Semi modal (*N* = 88)	3.65	3.74	3.74	3.77	3.88	3.75	3.57	25.92	3.73
Multimodal (*N* = 49)	4.06	4.02	4.08	4.04	3.96	3.98	3.80	27.70	3.98
Significance	***0.091****					***0.041****			
Low Income (*N* = 128)									
Mode-dependent (*N* = 56)	3.38	3.38	3.61	3.64	3.91	3.79	3.50	25.13	3.59
Semi modal (N = 49)	3.57	3.69	3.67	3.76	3.94	3.73	3.49	25.78	3.70
Multimodal (N = 23)	3.96	3.70	3.91	3.96	3.96	4.00	3.70	27.17	3.87
Significance	***0.066****								
Middle-Income (*N* = 68)									
Mode-dependent (*N* = 26)	3.46	3.85	3.85	4.04	4.12	3.96	3.50	26.62	3.82
Semi modal (N = 26)	3.50	3.58	3.71	3.62	3.85	3.76	3.62	2.19	3.67
Multimodal (*N* = 16)	4.13	4.47	4.29	4.13	4.12	3.94	3.94	28.29	4.14
Significance	***0.068****	***0.033****	***0.071****						
High Income (*N* = 37)									
Mode-dependent	4.14	4.07	4.15	4.29	4.14	3.86	3.93	28.29	4.08
Semi modal	4.23	4.23	4.08	4.15	3.69	3.77	3.77	27.92	4.00
Multimodal	4.20	4.00	4.10	4.10	3.70	4.00	3.80	27.90	3.98
Significance									
Vehicle ownership									
0 vehicles (*N* = 85)	3.45	3.60	3.79	3.70	4.02	3.93	3.58	25.92	3.72
1 or more (*N* = 144)	3.86	3.85	3.94	3.94	3.92	3.81	3.67	26.79	3.86
Significance	***0.010****	***0.057****	***0.010****					**0.081***	**0.048****

Significance: *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.10$.

Table 4
Associations between income and SWB.

Household income	Standard of Living	Health	Achieving in Life	Relationships	Feeling Safe	Feeling part of Community	Future Security	Sum Wellbeing
Low (N = 128)	3.55	3.55	3.69	3.74	3.93	3.80	3.53	25.74
Middle (N = 68)	3.63	3.90	3.91	3.90	4.01	3.88	3.65	26.49
High (N = 37)	4.19	4.11	4.11	4.19	3.86	3.86	3.84	28.05
Significance	***0.003*****	***0.001*****	***0.025*****	***0.029*****	–	–	–	***0.016*****
Sample Avg.	**3.68**	**3.74**	**3.82**	**3.86**	**3.94**	**3.84**	**3.62**	**26.34**

Significance: *** = $p < 0.01$, ** = $p < 0.05$.

Table 5
Effects of place on SWB.

Urban Form and Income	Standard of Living	Health	Achieving in Life	Relationships	Feeling Safe	Feeling Part of Community	Future Security	Sum Wellbeing	Average Wellbeing
Urban Form									
Suburban (*N* = 129)	3.60	3.78	3.83	3.83	3.93	3.80	3.63	26.22	3.7736
Urban Neighborhood (*N* = 27)	3.56	3.89	3.89	4.00	3.89	3.48	3.54	26.11	3.7407
Urban Core (*N* = 76)	3.87	3.64	3.79	3.87	4.00	4.04	3.64	26.69	3.8338
Significance						***0.026*****			
Urban Form by Income									
Low Income (N = 128)									
Suburban (*N* = 60)	3.45	3.72	3.68	3.70	3.87	3.68	3.52	26.62	3.66
Urban Neighborhood (N = 12)	3.00	3.42	3.67	3.75	4.00	3.58	3.33	24.75	3.52
Urban Core (N = 56)	3.79	3.41	3.69	3.79	3.98	3.98	3.59	26.09	3.74
Significance	***0 = 0.046*****								
Middle Income									
Suburban (*N* = 43)	3.49	3.77	3.85	3.88	4.00	3.85	3.58	25.98	3.77
Urban Neighborhood (*N* = 10)	4.00	4.30	4.10	4.10	4.10	3.60	4.00	27.80	4.02
Urban Core (N = 14)	3.85	4.07	4.00	3.86	4.07	4.21	3.71	27.50	3.97
Significance									
High Income									
Suburban (*N* = 25)	4.12	3.96	4.13	4.04	3.96	3.96	3.96	27.96	4.02
Urban Neighborhood (N = 5)	4.00	4.20	4.00	4.40	3.20	3.00	3.20	26.00	3.72
Urban Core (N = 7)	4.57	4.57	4.14	4.57	4.00	4.14	3.86	29.86	4.27
Significance									
Block Group Socioeconomics									
Non-SED Block Group (*N* = 151)	3.65	3.83	3.81	3.82	3.93	3.75	3.61	26.22	
SED Block Group (*N* = 83)	3.75	3.59	3.84	3.93	3.98	4.00	3.62	26.57	
Significance						***0.043*****			

Significance: ** = $p < 0.05$.

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