Wellbeing, Space and Society 2 (2021) 100056

Contents lists available at ScienceDirect

Wellbeing, Space and Society

journal homepage: www.sciencedirect.com/journal/wellbeing-space-and-society

Transportation, community quality of life, and life satisfaction in metro and non-metro areas of the United States

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ARTICLE INFO

Keywords:
Livability
Quality of life
Life satisfaction
Public transportation
Rural
Walkability

ABSTRACT

This study examines the impacts of a community's transportation system on the quality of life provided to its residents. Other key livability factors are also identified, and their impacts on community quality of life are estimated. These livability indicators are categorized into four main dimensions: social, physical/climate, functional, and safety. The study also examines the impacts of community quality of life on overall life satisfaction for an individual. Data were obtained from a nationwide livability survey. Survey data were analyzed using ordered probit models. The first model estimated ease of travel as a function of community transportation characteristics and individual characteristics. The second model estimated community quality of life as a function of the quality of the livability indicators. The final model estimated life satisfaction as a function of community quality of life and other factors. Separate models were estimated for metro and non-metro areas. Transit quality, the conditions of roads, congestion, and traffic safety were all found to have significant impacts on ease of travel. Ease of travel and walkability, among other factors, were found to impact community quality of life. Results also showed the positive impact that community quality of life has on overall life satisfaction.

1. Introduction

Community quality of life and livability are synonymous terms used to describe the degree to which communities contribute to an individual's overall quality of life. While there are many factors that contribute to the livability of a community (Prasoon and Chaturvedi, 2016), transportation can be an important contributor in both large and small communities. In rural areas, public transportation provides critical lifeline services to transportation-disadvantaged individuals, connecting them to healthcare services, educational institutions, employment, and other important activities.

Community quality of life could ultimately influence individual life satisfaction. While many studies have shown how factors such as income, health, employment status, and other individual factors are related to life satisfaction (Prasoon and Chaturvedi, 2016; Erdogan et al., 2012; Palmore and Luikart, 1972; Boyce et al., 2010; Pavot and Diener, 2008), fewer have studied the relationship between community livability and life satisfaction.

This study examines the impacts of public transportation services and other characteristics of a community's transportation system on quality of life in the community. Other key livability factors are also identified, and their impacts on community quality of life are estimated. Following Leby and Hashim (2010), these livability indicators are categorized into four main dimensions: social, physical/climate, functional, and safety. Ease of travel through the community is included as one of the functional indicators.

This study also examines the impacts of community quality of life on overall life satisfaction for an individual, accounting for other factors such as health, income, employment status, age, and others. Ultimately, this study estimates the impacts of public transit quality and other transportation factors on ease of travel within a community, the impacts of ease of travel and other livability indicators on community quality of life, and the impact of community quality of life and other quality of life dimensions on individual life satisfaction. This research contributes to the literature by showing the linkages between transportation, livability, and life satisfaction in both urban and rural contexts in the United States.

Data were obtained from a nationwide livability survey conducted in

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https://doi.org/10.1016/j.wss.2021.100056
Received 21 August 2020; Received in revised form 23 August 2021; Accepted 8 September 2021
Available online 11 September 2021

the United States. Residents in both urban and rural areas responded to the survey, though efforts were made to obtain a large share of responses from smaller communities. Respondents were categorized as living in metro or non-metro areas based on their county of residence. Responses were analyzed separately to determine if relationships differ between metro and non-metro communities.

2. Literature review

As Myers (1987) described, quality of life (QOL) emerged in the 1980s as a popular term for describing cities. At the time, however, measurements were focused on comparing the QOL between places, which may not be as useful because a majority of individuals experience QOL in a single community over a long period of time. These comparisons are usually based on objective data, but QOL and livability are essentially subjective, and individuals in different communities may have different opinions and preferences regarding the components of livability. Individuals may be attracted to different places based on their preferences. For example, those who highly value transit may be more likely to live in places with a quality transit system. Based on the idea that QOL must be uniquely defined and measured for a specific community, Myers (1987) recommended a community-oriented measurement process that uses the advice of local residents in selecting and weighing QOL components and emphasizes trends over time.

A few studies have since analyzed the components of livability in individual cities or local areas. This includes research in North Carolina (Furuseth and Walcott, 1990), Alabama (Baker, 2003), Ireland (Brereton et al., 2008; Moro et al., 2008), Taiwan (Lee, 2008; Liao, 2009), Malaysia (Leby and Hashim, 2010), and rural New England (Kolodinsky et al., 2013). These and other studies have identified domains or dimensions that impact community livability and specific measurable elements within each domain.

Leby and Hashim (2010) concluded that the livability components analyzed in most studies can be organized into four dimensions: social, physical, functional, and safety. The social dimension focuses on the relationships between neighbors and community members. The physical dimension characterizes the natural environment of communities, including parks and green spaces, and environmental quality. The functional dimension describes the private and public provision of services, accessibility to activities and amenities, and employment opportunities. Lastly, the safety dimension measures the neighborhood's safety level. A summary of the livability dimensions and indicators described by previous studies is shown in Table 1. Different studies have grouped the livability components differently or have identified different indicators. For example, many studies have included housing as an indicator of livability.

Results from previous research have revealed many similarities between communities, but also some differences in the importance of different factors on quality of life. In Ireland, Brereton et al. (2008) found amenities such as climate and environmental and urban conditions are important when analyzing subjective well-being. Baker (2003) found that public safety was the most important factor for QOL in Alabama, followed by education. Similarly, a study in Taipei found that survey respondents were most concerned with personal safety and public services (Lee, 2008), and in Malaysia, Leby and Hashim (2010) also found that residents were most concerned with safety, while social issues were least important. Lee (2008) showed that community status, local attachments, and neighborhood satisfaction all impact community quality of life. Furuseth and Walcott (1990) found that QOL in North Carolina was largely determined by jobs, educational opportunities, clean air and water, and adequate public facilities. In a survey of residents in Virginia, Sirgy and Cornwell (2001) found that satisfaction with community-based services plays a significant role in the overall life satisfaction of community residents.

Community livability may be related to overall life satisfaction or subjective well-being. There is a wide body of research on life satisfaction. A number of studies have examined the relationships between income, finances, health, job satisfaction, and other factors with life satisfaction and have found them to be important (Prasoon and Chaturvedi 2016). Other research has studied the association between travel and life satisfaction. For example, Friman et al. (2017) found that satisfaction with daily travel directly influences emotional well-being,

Table 1
Livability dimensions and indicators identified in previous research.

Study	Furuseth and Walcott (1990)	Sirgy and Cornwell (2001)	Randall and Morton (2003)	Sun (2005)	Liao (2009)	Leby and Hashim (2010)	Ripplinger et al. (2012)
Livability Dimensions and Indicators	Physical concerns • Roads • Schools Non-physical concerns • Climate • Crime Fiscal issues • Tax rates • Welfare payments Non-fiscal issues • Pollution • Proximity to coast Basic issues • Jobs • Public health • Safety • Housing	Government services • Police • Fire/rescue • Library • Etc. Business services • Banking/savings • Insurance • Stores • Etc. Nonprofit services • Alcohol/drug abuse services • Crisis intervention • Religious services • Etc. Other • Environmental quality • Rate of change to natural landscape • Race relations • Cost of living • Crime • Ties with people • Neighborhood • Housing	Health Housing Employment Education Consumption/ finances Security Leisure Social opportunity /participation Access/mobility Environmental quality Social environment/ stability	Housing Health Employment Land use and environment Crime and safety Education Social environment and services Community participation	Medical services Domestic finances Work Education Leisure Public safety Environmental quality	Social dimension • Behavior of neighbors (nuisance) • Community life and social contact • Sense of place Physical dimension • Environmental quality • Open spaces • Maintenance of built environment Functional dimension • Availability and proximity of amenities • Accessibility • Employment opportunities Safety dimension • Number of crimes • Number of accidents • Feeling of safety	Community service • Service quality • Commercial recreation Crime • Crime level • Police satisfaction Education • Educational attainment • Educational quality Environmental quality • Odor pollution • Noise pollution • Litter • Property conditions Housing affordabilityRetail • Shopping availability • Shopping satisfaction Transit • Availability • Accessibility

and both directly and indirectly influences life satisfaction. De Vos (2019) also found that travel satisfaction affects life satisfaction, but that this was mostly an indirect effect by allowing for participation in leisure activities. Roy et al. (2018) found that areas with higher percentages of people commuting by bicycle or transit were associated with higher individual well-being scores.

The provision of transportation services is a likely contributor to community livability, and there is evidence that it influences life satisfaction. Providing transportation to those without other alternatives can have intangible qualitative benefits, such as reduced social isolation and improved quality of life. Many studies have focused on the link between mobility and quality of life for older adults, people with disabilities, and others who are transportation disadvantaged. The main finding from these studies is that providing transportation to these populations and increasing their access to activities, both needed activities as well as social activities, reduces the risk of social exclusion and improves quality of life and well-being (Banister and Bowling, 2004; Spinney et al., 2009; Stanley et al., 2011; Delbosc, 2012; Delbosc and Currie, 2011).

For example, Banister and Bowling (2004) found that engaging in a large number of social activities was an important component of what constitutes quality of life for older adults, and Spinney et al. (2009) found a significant association between transportation mobility benefits and quality of life in a study of elderly Canadians. Currie et al. (2010) showed how the provision of alternative transportation options allowed low-income carless households to have their transport needs met and avoid social exclusion. Further, based on survey data of transit users, Mattson et al. (2017) found that those who had recently missed a trip because of a lack of transportation or who reported greater difficulties in making trips reported lower overall life satisfaction after controlling for other factors such as age and health. These results show the benefits that improved mobility can have on quality of life.

Fewer studies have studied the link between community livability and life satisfaction, or the association between different aspects of transportation and livability. Okulicz-Kozaryn and Valente (2019) claimed to be the first to study the correlation between livability and subjective well-being in European cities. Their study used an objective measure of livability and a subjective measure of well-being and found a positive correlation of 0.6. Similarly, Roy et al. (2018) found that county-level demographic, socioeconomic, clinical care, and physical environment factors were associated with individual well-being scores.

3. Study framework

This study develops three models to estimate the following:

- Impacts of transportation factors on ease of travel within a community;
- Impacts of livability dimensions, including ease of travel, on community quality of life; and
- Impacts of community quality of life on overall life satisfaction.

Ease of travel within a community is hypothesized to depend on both individual and community characteristics. If an individual has the ability to drive and has access to a vehicle, it is expected that travel within the community will be relatively easier, as compared to someone who cannot drive or who does not have access to a vehicle. Furthermore, if an individual has mobility limitations that make it difficult to walk, travel within the community will likely be more difficult. A number of community characteristics also determine how easy it is to travel. These include the quality of the transit service, the quality of roads, congestion, traffic safety, and bicycle facilities.

Ease of travel is one of many livability factors that could impact community quality of life. To categorize factors impacting livability, this study uses the four dimensions identified by Leby and Hashim (2010). The physical dimension is expanded to include climate. The four dimensions and indicators used in this study are shown in Table 2.

The functional dimension includes the largest number of indicators, describing the community's amenities, opportunities, and accessibility. Ease of travel is included as a functional amenity because it describes how well residents are able to access amenities and activities in the community. It also relates to the physical dimension though, as it is influenced by the quality of roads and the built environment, and the safety dimension, as traffic safety is an important attribute of the transportation system. The other functional indicators are available jobs, quality healthcare, quality public schools, cultural institutions, affordable housing, overall cost of living, and shopping and entertainment options.

One livability indicator is included from the social dimension: sense of community. Sense of community is a concept in psychology and sociology that focuses on the experience of community. McMillan and Chavis (1986) defined sense of community as "a feeling that members have of belonging, a feeling that members matter to one another and to the group, and a shared faith that members' needs will be met through their commitment to be together".

The physical/climate factors are parks and recreation facilities, a clean environment, the built environment, and the weather. Built environment variables include the characteristics of the street the individual lives on and the walkability of the community. Walkability is determined by the quality of pedestrian infrastructure and whether land use patterns allow for trips to be easily made by walking. Walkability could be considered a characteristic of the transportation system, though in this study it is categorized as part of the physical environment. The crime rate is a key indicator of safety and is the only safety factor included in this study. As mentioned, though, traffic safety is also a component of the ease of travel.

Community quality of life is hypothesized to be one of the domains that determines an individual's overall quality of life, or life satisfaction. Based on findings from previous research, other factors that may influence life satisfaction include health, financial status, employment status, living arrangements, and demographic characteristics such as age, gender, and marital status. It is hypothesized that community quality of life contributes positively to life satisfaction. It is also expected that individuals in better health or with higher income will have higher life satisfaction and those who are unemployed or live alone will have lower life satisfaction scores. The expected impacts of age, gender, and marital status are uncertain.

4. Data and descriptive analysis

Data were collected through a national survey in the United States, the National Community Livability Survey, which was conducted from April to December 2017. The survey was a stratified random sample of adults aged 18 or older with a mailing address in one of the 50 states. Researchers purchased randomly selected addresses from a leading domestic address vendor. The research team obtained the physical mailing address, email (if available), sex, and estimated age. Random outreach was stratified by four U.S. regions, the nine Census Divisions, by sex, and by age.

The research team further stratified outreach by U.S. Department of Agriculture (USDA): Economic Research Service (ERS) Rural-Urban Continuum Code (RUCC) to ensure random sampling would reach an equal number of adults living in each of the nine RUCC classifications. USDA ERS classifies each county as one of nine RUCC codes based on the population and adjacency to other counties. In this study, communities with RUCC codes 1, 2, and 3 are considered metro areas and those with RUCC codes 4–9 are considered non-metro areas for comparison purposes. While 85% of the U.S. population is located in communities with RUCC codes 1, 2, and 3 (metro areas), the research team contacted roughly an equal number of adults in each of the nine RUCC classifications, meaning rural communities were over-sampled to ensure a comparable sample size of returned survey responses.

Table 2
Study framework: livability dimensions and indicators.

Dimension	Social	Physical/Climate	Functional	Safety
Livability indicator	• Sense of community	• Parks and recreation facilities • Clean environment • Street characteristics • Walkability • Weather	• Ease of travel • Available jobs • Quality healthcare • Quality public schools • Cultural institutions • Affordable housing • Overall cost of living • Shopping and entertainment options	• Low crime

Each potential respondent was contacted by postcard, email (if available, not a limiting factor), and letter with the accompanying full form. The survey form was available in Section 508 compliant online form and paper form. The online form was available in English, Spanish, Chinese, Korean, and Vietnamese. The paper form was made available in English and Spanish. Every survey participant was offered a $3.00 reward for their time (in the form of an email or SMS-messaged online gift card code). The research team contacted 25,000 adults, split into two stratified waves of outreach. The total overall response rate was 4.0%, counting only complete responses. Responses were received from all 50 states and in several languages.

The survey collected subjective information from respondents about the quality of different livability factors in their communities, the overall community quality of life, and overall life satisfaction, as well as demographic and built environment characteristics. The demographic characteristics of survey respondents suggest there could be some sampling bias. Men, younger adults, those less educated, and minorities appear to be under-represented. Men comprised 43% of respondents in metro areas and 40% in non-metro areas. Just 8% of respondents were under age 35, compared to 30% of the adult population in metro areas that belongs to this age group and 24% in non-metro areas. Only 17% of respondents in metro areas and 24% in non-metro areas did not have any education beyond high school, compared to 38% and 53% of the adult population in these areas, respectively. On the other hand, women, middle-aged adults, those higher educated, and whites are over-represented. Representation by income is close to the population distribution. Note that the biases for metro and non-metro respondents are similar, so differences in responses between these two groups are not likely due to the over- or under-representation of some groups. Table 3 shows how respondents rated the quality of transportation and livability factors in their community.

4.1. Transportation

Survey respondents were asked to rate the quality of the following aspects of transportation in their community: affordable transportation options, public transit services, bikeability, low traffic congestion, road conditions, and traffic safety. Responses were given using a 5-point Likert scale, with a higher number indicating higher quality as perceived by the respondent (1 = very poor, 2 = poor, 3 = acceptable, 4 = good, 5 = very good). In both metro and non-metro areas, the highest ratings were given for traffic safety and low congestion, and the lowest ratings were given for affordable transportation options and public transit (Table 3). Non-metro respondents, compared to their metro counterparts, gave higher ratings for traffic safety and congestion and lower ratings for bikeability, affordable transportation options, and public transit quality. These differences are all statistically significant.

Respondents were also asked the degree to which they agree with the following statement, using a 5-point Likert scale: "I can easily travel to places I need to go in my community using my current travel options." Responses are shown in Fig. 1.

Table 3
Survey respondent quality ratings for community transportation characteristics and livability factors, metro vs. non-metro respondents.

	Metro Counties (n = 404)		Non-Metro Counties (n = 562)	
Variable	Mean	St. Dev.	Mean	St. Dev.
Transportation Characteristics				
Transit quality	2.79*	1.19	2.22*	1.15
Quality of roads	3.02	1.02	2.97	1.01
Low congestion	3.21*	1.01	3.69*	1.00
Traffic safety	3.46*	0.90	3.76*	0.85
Bikeability	3.10*	1.10	2.90*	1.05
Affordable transportation options	2.98*	1.07	2.49*	1.05
Social Livability Dimension				
Sense of community	3.46*	0.94	3.64*	0.99
Physical/Climate Livability Dimension				
Parks and recreation facilities	3.67*	0.97	3.43*	1.08
Clean environment	3.67	0.87	3.79	0.91
Walkability	3.17	1.06	3.17	1.10
Weather	3.60	0.85	3.55	0.83
Functional Livability Dimension				
Available jobs	3.16*	1.02	2.66*	1.05
Quality healthcare	3.79*	1.03	3.29*	1.05
Quality public schools	3.62	0.99	3.51	1.06
Cultural institutions	3.18*	1.05	2.76*	1.07
Affordable housing	3.18	1.02	3.06	1.07
Cost of living	3.37	0.93	3.30	0.99
Shopping and entertainment options	3.32*	1.09	2.55*	1.03
Safety Livability Dimension				
Low crime	3.45*	1.02	3.68*	0.98

Note: Responses given on a 1–5 scale (1 = very poor, 2 = poor, 3 = acceptable, 4 = good, 5 = very good).
*Differences statistically significant at 5% level.

4.2. Other community livability factors

The survey also asked respondents to rate the quality of a number of other livability factors in their community, on a similar 1–5 Likert scale. Overall, respondents gave the highest ratings for clean environment and low crime and lowest ratings for shopping and entertainment options and available jobs. Responses differ between metro and non-metro respondents (Table 3). Those from non-metro areas gave higher ratings for low crime and sense of community and lower ratings for parks and recreations facilities, quality healthcare, cultural institutions, shopping and entertainment options, and available jobs.

Regarding built environment, respondents were asked to describe the type of street they live on, given the following six options: 1) urban core street (downtown, high-rise/mid-rise housing units), 2) urban center street (near downtown, multi-level housing units), 3) general urban street (single to multi-level buildings, townhomes/row houses/apartments/etc.), 4) suburban street (mostly single-family houses or apartment buildings), 5) rural street (small city/towns, typically single-family houses or small apartment buildings), and 6) open country/natural area (few houses, open-country mostly). Overall, the largest shares of respondents lived on a rural street (35%), suburban street (28%), or open country (26%).

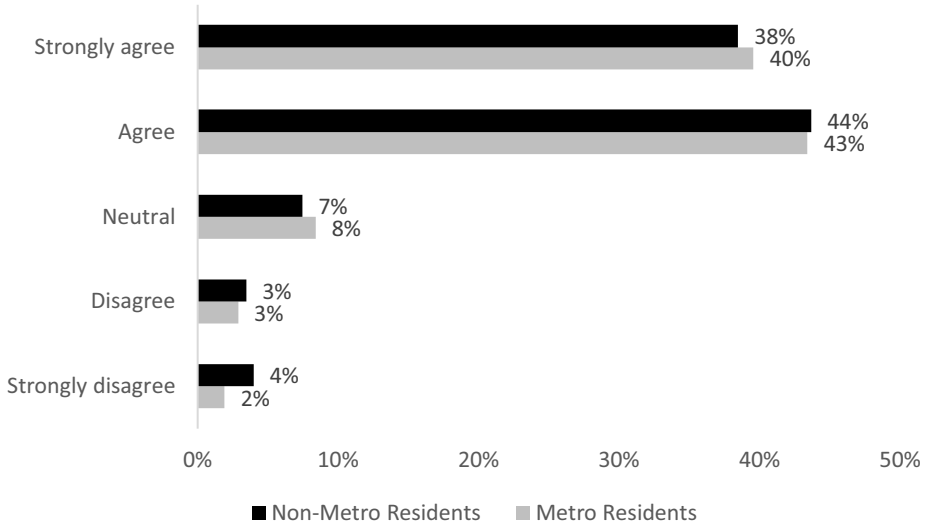

Fig. 1. Degree to which respondents agree with the statement "I can easily travel to places I need to go in my community using my current travel options.".

4.3. Community quality of life and life satisfaction

To assess the overall subjective quality of life in the community, respondents were asked the following question: "How satisfied are you with the quality of life in your community?" Respondents answered using a 5-point Likert scale, as shown in Fig. 2. If the responses are coded on a 1–5 scale (1 = very dissatisfied and 5 = very satisfied), the average response is 4.0 for metro respondents and 3.8 for non-metro respondents, with the difference being statistically significant at the 1% level.

To determine overall quality of life, or life satisfaction, survey participants were asked the following question: "All things considered, how satisfied are you with your life as a whole these days?" Respondents answered using a 0–10 scale, with a higher number indicating greater satisfaction (Fig. 3). This question has been used in previous research as a measure of life satisfaction (Kahneman and Krueger 2006). The difference in average response between metro and non-metro respondents is not statistically significant.

4.4. Individual characteristics

Ability to drive, access to a vehicle, and mobility impairments likely impact an individual's ability to travel. Health, income, employment status, age, and living arrangement may influence life satisfaction. Characteristics of respondents are described in Table 4. Ability to drive was not assessed, but respondents were asked if they have a driver's license. Difficulty walking was determined if respondents reported having serious difficulty walking or climbing stairs.

5. Model specification

The study developed three ordered probit models. Ordered probit models were used because the dependent variables were measured using an ordinal scale, as shown in Figs. 1–3. The first model estimated ease of travel as a function of community transportation characteristics and individual characteristics. The second model estimated community quality of life as a function of the quality of the livability indicators. The final model estimated life satisfaction as a function of community quality of life and other factors.

Ease of travel is the degree to which respondents agree that it is easy to travel within their community, as shown in Fig. 1. It was measured with a 1–5 scale. Ease of travel is expected to be related to the quality of transportation characteristics in the community and characteristics of the individual that may hinder or encourage travel. Therefore, ease of

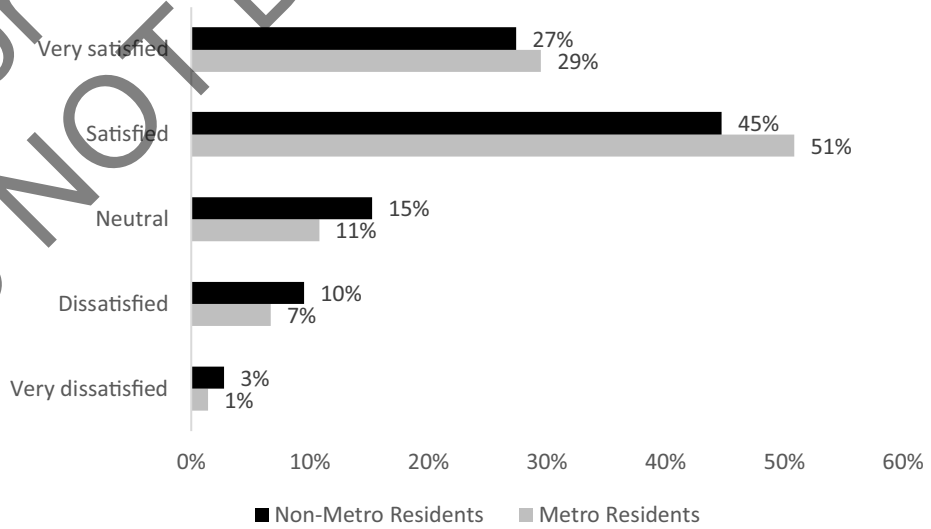

Fig. 2. Degree to which respondents are satisfied with the quality of life in their community.

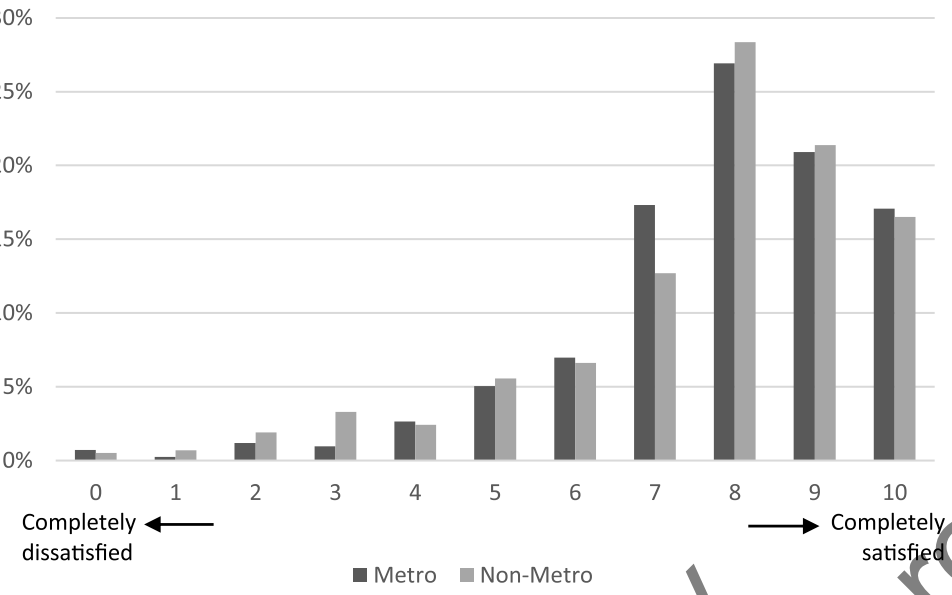

Fig. 3. Degree to which respondents are satisfied with their life as a whole these days.

Table 4
Individual characteristics of respondents.

	Metro Counties		Non-Metro Counties	
	Mean	St. Dev.	Mean	St. Dev.
Driver's license (0 = no, 1 = yes)	0.96	0.19	0.96	0.20
Number of vehicles in household	1.87	0.86	2.00	0.83
Difficulty walking (0 = no, 1 = yes)	0.11	0.32	0.20	0.40
Health (1 = poor, 2 = fair, 3 = good)	2.69	0.52	2.64	0.56
Household income (1–8 scale[1])	4.84	2.03	4.36	1.98
Unemployed (0 = no, 1=yes)	0.02	0.14	0.02	0.12
Retired (0 = no, 1 = yes)	0.36	0.48	0.41	0.49
Living alone (0 = no, 1 = yes)	0.28	0.45	0.25	0.43

[1] 1=<$15,000; 2=$15,000-$24,999; 3=$25,000-$34,999; 4=$35,000-$49,999; 5=$50,000-$74,999; 6=$75,000-$99,999; 7=$100,000-$249,999; 8=$250,000 or more.

travel was estimated as a function of the perceived quality of community transportation characteristics, as shown in Table 3, the ability to drive, access to a vehicle, and whether the individual has a mobility impairment. Quality of transit service, quality of roads, congestion, traffic safety, and bikeability were measured on a 1–5 scale, with a higher number indicating higher perceived quality. The affordable transportation options variable was not included in the model because it is highly correlated with quality of transit service. Whether the individual had a driver's license was used as a proxy for ability to drive. Access to a vehicle was measured as the number of vehicles available in the household. Mobility impairment was measured using a dummy variable to indicate if the respondent had serious difficulty walking or climbing stairs.

Community quality of life was the dependent variable in the second model, and it measures the degree to which respondents are satisfied with the quality of life in their community, as shown in Fig. 2. It was estimated as a function of each of the livability factors listed in Table 2, as well as street type. The affordable housing variable was dropped from the model because it is highly correlated with cost of living. The dependent variable and all explanatory variables except street characteristics were measured on a 1–5 scale, with a higher number indicating improved perceived quality. Street type was measured using dummy variables to indicate the type of street the respondent lives on. The open country was used as the base, and urban core street and urban center street were combined because of the low number of respondents living on these types of streets.

Life satisfaction, measured with a 0–10 scale as shown in Fig. 3, was the dependent variable in the final model. As discussed in section 3, it was estimated as a function of community quality of life and individual characteristics, which included health, income, employment status, age, gender, and living arrangement. As noted, health was measured with a 1–3 scale and income with a 1–8 scale. Dummy variables were used to indicate if the individual was unemployed and looking for work or if they were retired. Because the impact of age on life satisfaction might not be linear, it was measured using dummy variables for different age groups (age 18–34 was the reference). Regarding living arrangements, a dummy variable was used to indicate if the individual was living alone.

For each of the three models, two separate models were run. One used data from respondents living in metro counties and the other with data from those living in non-metro counties. The models were tested for multicollinearity by examining correlation coefficients and variance inflation factors (VIF). As noted, two variables were dropped due to potential multicollinearity (absolute value of correlation coefficients greater than 0.6 or VIF greater than 5). Independent variables are assumed to be exogenous. For variables that could potentially be endogenous, results of likelihood ratio tests to determine if the error term is correlated with the error term for a model of the explanatory variable failed to reject the null hypothesis that they are exogenous. The models were estimated using PROC QLIM in SAS 9.4.

6. Results

Transit quality and the conditions of roads were found to have significant impacts on ease of travel in both the metro and non-metro models (Table 5). Respondents who rated the quality of these attributes higher were more likely to believe that it is easy to travel within their community. Low congestion was also significant in the metro model and traffic safety was significant in the non-metro model. It is not surprising that congestion is found to be significantly related to ease of travel in metro areas but not non-metro areas. Results in both the metro and non-metro models also show that ease of travel is greater for those with a driver's license, that ease of travel increases as the number of vehicles in the household increases, and that travel is significantly more difficult for those who have difficulty walking.

Ease of travel was found to be one of many factors associated with community quality of life (Table 6). Sense of community was found to have a significantly positive impact on community quality of life in both the metro and non-metro models. Those respondents who rated their

Table 5
Ordered probit results for ease of travel.

Variable	Metro ($n = 385$) Estimated Parameter	p value	Non-Metro ($n = 529$) Estimated Parameter	p value
Intercept	−1.14	0.0179**	−1.06	0.0074***
Transit quality	0.17	0.0038***	0.19	< 0.0001***
Quality of roads	0.15	0.0306**	0.16	0.0031***
Low congestion	0.22	0.002***	−0.01	0.9266
Traffic safety	0.09	0.2863	0.33	< 0.0001***
Bikeability	0.07	0.2747	0.00	0.9305
Driver's license	0.95	0.0112**	0.50	0.0741*
Number of vehicles	0.21	0.0049***	0.26	0.0001***
Difficulty walking	−0.37	0.0473**	−0.43	0.0009***
Goodness of fit				
McFadden's LRI	0.10		0.10	
Estrella	0.21		0.21	

*$p < 10\%$, **$p < 5\%$, ***$p < 1\%$.

Table 6
Ordered probit results for community quality of life.

Variable	Metro ($n = 370$) Estimated Parameter	p value	Non-Metro ($n = 520$) Estimated Parameter	p value
Intercept	−2.75	< 0.0001***	−1.65	< 0.0001***
Social Dimension				
Sense of community	0.30	0.0004***	0.33	< 0.0001***
Physical/Climate Dimension				
Parks and recreation facilities	−0.10	0.2788	−0.01	0.8038
Clean environment	0.13	0.1993	0.08	0.2606
Street type (Base: Open country)				
Urban core/ center street	−1.13	0.0020***	−0.96	0.0094***
General urban street	−0.64	0.0226**	−0.59	0.0330**
Suburban street	−0.76	0.0012***	−0.31	0.0438**
Rural street	−0.15	0.5341	−0.38	0.0011***
Walkability	0.06	0.4233	0.11	0.0267**
Weather	0.27	0.0026***	0.09	0.1757
Function Dimension				
Ease of travel	0.19	0.0140**	0.10	0.0693*
Available jobs	0.13	0.1190	0.08	0.1826
Quality healthcare	0.20	0.0103**	0.12	0.0325**
Quality public schools	0.21	0.0071***	0.12	0.0424**
Cultural institutions	0.02	0.7689	0.10	0.0823*
Cost of living	0.12	0.1495	0.03	0.5935
Shopping and entertainment options	0.25	0.0023***	0.11	0.0996*
Safety Dimension				
Low crime	0.08	0.3824	0.10	0.1273
Goodness of fit				
McFadden's LRI	0.27		0.19	
Estrella	0.53		0.42	

*$p < 10\%$, **$p < 5\%$, ***$p < 1\%$.

community as having a better sense of community gave higher ratings for overall community quality of life.

Among the physical/climate variables, the quality of parks and recreation facilities and clean environment did not have a significant impact. Regarding street type, those who lived in the open country gave the highest community quality-of-life ratings in both models. Walkability was found to have a significant positive impact on community quality of life in the non-metro model, and weather was found to have a significant positive impact in the metro model.

Many of the variables within the functional dimension had statistically significant results. Ease of travel, quality healthcare, quality public schools, and shopping and entertainment options were significant in both models. Cultural institutions was significant in the non-metro model. As respondents rated the quality of these factors more highly, they were more likely to rate overall community quality of life more highly.

Of all the livability indicators, sense of community was found to have the largest impact in terms of magnitude. This is true for both the metro and non-metro models. Street type was also found to have an important impact. The next most important factors in terms of the magnitudes of the effects are shopping and entertainment options and weather in the metro model, and quality healthcare, quality public schools, and ease of travel in both models.

Results from the final model show the positive association that community quality of life has with overall life satisfaction (Table 7). In both the metro and non-metro models, respondents who rated their community quality of life as higher were significantly more likely to rate their overall life satisfaction as higher. An individual's health was also found to have a significant impact on their life satisfaction, as those who rated their health better gave higher life satisfaction ratings. Among the other variables, those who were unemployed and looking for work gave lower life satisfaction ratings in the metro model, men had lower life satisfaction than women in the metro model, and those living alone had lower life satisfaction in the metro model, everything else equal. Although employment status was found to be important in the metro model, the impact of household income was not statistically significant in either model. Lastly, age was found to have some association with life satisfaction. Results show that, everything else equal, life satisfaction was highest for those aged 75 to 84.

Two goodness-of-fit measures analogous to the R^2 in the linear regression model are reported in Tables 6–8. The community quality of life model has the overall best fit. Results show that while many of the explanatory variables are statistically significant, much of the variation in the dependent variables is unexplained by the models.

The magnitude of the results can be illustrated through the estimation of marginal effects, which measure the expected change in the dependent variable as a function of a change in an explanatory variable,

Table 7
Ordered probit results for life satisfaction.

Variable	Metro ($n = 388$) Estimated Parameter	p value	Non-Metro ($n = 532$) Estimated Parameter	p value
Intercept	−0.17	0.7326	−0.61	0.1026
Community quality of life	0.41	< 0.0001***	0.43	< 0.0001***
Health	0.66	< 0.0001***	0.70	< 0.0001***
Household income	0.01	0.839	0.04	0.1416
Unemployed	−1.24	0.0013**	−0.21	0.6021
Retired	0.09	0.5573	0.14	0.3199
Age (Base: Age 18 to 34)				
Age 35 to 44	0.31	0.189	−0.02	0.9376
Age 45 to 54	0.22	0.29	−0.03	0.8824
Age 55 to 64	0.34	0.1034	0.21	0.2393
Age 65 to 74	0.48	0.0442**	0.28	0.1976
Age 75 to 84	1.10	0.0002***	0.43	0.0738*
Age 85 or older	0.57	0.1456	0.17	0.5794
Male	−0.31	0.0046***	−0.08	0.405
Living alone	−0.35	0.0075***	−0.07	0.5482
Goodness of fit				
McFadden's LRI	0.11		0.09	
Estrella	0.34		0.31	

*$p < 10\%$, **$p < 5\%$, ***$p < 1\%$.

Table 8
Estimated average marginal effects.

Variable	Lowest Rating		Highest Rating	
	Metro	Non-Metro	Metro	Non-Metro
Ease of Travel Model				
Transit quality	−0.009	−0.014	0.059	0.064
Quality of roads	−0.007	−0.012	0.049	0.055
Low congestion	−0.011		0.073	
Traffic safety		−0.025		0.113
Driver's license	−0.046	−0.036	0.320	0.168
Number of vehicles	−0.010	−0.019	0.072	0.087
Difficulty walking	0.018	0.032	−0.126	−0.145
Community Quality of Life Model				
Sense of community	−0.008	−0.013	0.073	0.083
Urban core/center street	0.031	0.041	−0.269	−0.240
General urban street	0.018	0.025	−0.152	−0.146
Suburban street	0.021	0.013	−0.180	−0.078
Rural street		0.016		−0.095
Walkability		−0.005		0.029
Weather	−0.007		0.064	
Ease of travel	−0.005	−0.004	0.044	0.024
Quality healthcare	−0.005	−0.005	0.047	0.031
Quality public schools	−0.006	−0.005	0.050	0.029
Cultural institutions		−0.004		0.025
Shopping and entertainment options	−0.007	−0.005	0.059	0.027

everything else held constant. Table 8 shows the estimated marginal effects for the ease of travel and community quality of life models for the extreme ends of the dependent variables. For example, a one-unit increase in perceived transit quality increases the probability of an individual strongly agreeing that it is easy to travel by about 6%, and having a driver's license increases the probability by 32% in metro areas. Perceived sense of community has the greatest impact on the probability of an individual being very satisfied with community quality of life, in both metro and non-metro communities. Estimated marginal effects for the life satisfaction model show that a one-unit increase in the perceived community quality of life increases the probability of an individual reporting a 10 on the life satisfaction scale by 9% in both metro and non-metro areas.

7. Discussion and conclusion

Results ultimately show the relationships between transportation and quality of life. If residents have more positive perceptions about the quality of transit service, road conditions, congestion (in metro areas), and traffic safety (in non-metro areas), they are more likely to believe that it is easy to travel within their community, which positively impacts their perception of community quality of life. This ultimately impacts overall life satisfaction as results show the positive relationship between community quality of life and life satisfaction, or subjective well-being. These relationships were found to exist in both metro and non-metro communities.

It is noteworthy that the positive relationship between quality of transit service and ease of travel was found to be significant in not just the metro model but also the non-metro model. Even though use of transit is much lower in rural areas and smaller communities, results suggest the quality of public transit is still an important determinant of ease of travel and community livability in these areas.

The findings are consistent with those from previous studies that have shown the positive impacts of transportation, public transit services, and improved mobility on quality of life (Mattson et al., 2017; Banister and Bowling, 2004; Delbosc and Currie, 2011; Spinney et al., 2009; Stanley et al., 2011). Delbosc (2012) argued that transportation influences life satisfaction indirectly by facilitating access to important activities and directly through physical mobility and externalities. Many of the previous studies have focused specifically on older adults and people with disabilities. This research, however, is not limited to these transportation-disadvantaged populations, but is based on survey data from the general public. Results, therefore, show the positive impact not just for older adults or people with disabilities but for the general public. Results also show that the impact of public transit is just as significant in non-metro areas as in metro areas.

Walkability and characteristics of the street were also found to impact community quality of life. In the non-metro model, those who rated the walkability of the community more highly were more likely to rate community quality of life more highly. This result supports efforts to improve livability through improvements in walkability. As shown in previous literature, walkability can improve community livability by encouraging physical activity (Fenton, 2005), improving the attractiveness of a neighborhood, and encouraging social interaction and activity (Appleyard, 1980; Litman, 2003). Interestingly, respondents who lived in a more urban environment tended to rate community quality of life lower than those who lived on small-town streets or rural areas.

Many other livability indicators were found to be important, as expected. The magnitude of the impact that sense of community has on livability is an interesting finding that somewhat differs from previous research focused on physical, functional, and safety characteristics. The sense of belonging to a place or community is very important. The finding is consistent with Francis et al. (2012), who found a strong sense of community to be associated with improved wellbeing. Additional research could explore how sense of community is developed and strategies that communities can employ to improve sense of community. The built environment could play an important role in developing such sense of community (Francis et al., 2012).

Lastly, community quality of life is shown to be an important contributor to overall life satisfaction, along with health status and employment status. Results from this study support efforts to improve community livability and subjective well-being through improvements in public transit services, traffic safety, and walkability.

There are some limitations to the study. As noted, the survey had a low response rate, and some populations were under- or over-represented. Younger adults, the less educated, and minorities were under-represented. Further research would need to determine if these relationships hold among those population groups. This study linked subjective perceptions of livability factors to subjective quality of life, and perceptions can differ. Perceptions of some factors, such as the weather, for example, can vary widely. Additional research also employing objective measures could be used. There are some additional data limitations. For example, the model used driver's license as a proxy for ability to drive, but some may drive without a license, and others may have a license but do not feel comfortable driving. The study also does not capture the extent to which an individual may be able to rely on family members or friends for a ride, or the availability of other transportation options. Because of interrelated variables and the potential for common unobserved characteristics, future research could explore the use of a systems approach.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

This research was funded by the U.S. Department of Transportation through the University Transportation Centers program.

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