Investigating the Relationship Between Public Transit Access and Social Isolation

Naomi Buell[1] and Richie Rivera[1]

[1]CUNY School of Professional Studies

May 11, 2025

Abstract

Social isolation is a significant public health concern, particularly among older adults and individuals with limited mobility. Prior research has established associations between transportation infrastructure and social well-being, yet the direct relationship between public transportation access and social isolation remains underexplored. This study investigates the association between transit availability and social isolation using census-tract-level data from the CDC PLACES database and the National Neighborhood Data Archive. We employed stratified Ordinary Least Squares (OLS) regression models across urban, suburban, and rural tracts, controlling for population density and age composition. Results indicate a statistically significant positive relationship between transit stop density and social isolation across all geographic contexts, with the strongest association observed in suburban areas. Additionally, the proportion of older adults was consistently and negatively associated with social isolation. These findings suggest that public transportation infrastructure may not uniformly mitigate social isolation and that its effects are conditioned by regional and demographic characteristics. This research has implications for need to integrate social connectedness goals into transportation planning and to develop targeted, place-specific interventions that account for age and urbanicity.

Keywords Social Isolation, Public Transportation, Built Environment, Regression Analysis, Public Health, Wellbeing, Census

1 Introduction

Social isolation is a critical public health issue that has been linked to higher rates of overall mortality and the development of chronic conditions such as depression, cardiovascular disease, hypertension, and cancer (F. Wang, Gao, Han, et al. 2023; U.S. Department of Health and Human Services 2024; Leigh-Hunt et al. 2017). One possible contributing factor to social isolation is limited access to public transportation, which has been identified as a significant barrier to social participation, particularly for older adults living in rural areas or those with mobility challenges (Lamanna et al. 2020). This research examines whether the availability of public transportation influences social isolation levels. Understanding this relationship can inform policies that improve transportation infrastructure to improve social connectivity and overall well-being.

2 Background

Previous research suggests that public transit can reduce barriers to social engagement. It's noted that there is a lack of direct evidence on how public transportation affects social isolation (Lamanna et al. 2020). Wang et al. analyzed mobility patterns in 50 U.S. cities, highlighting how marginalized communities face limited transit access, reducing opportunities for employment, services, and social interaction (Q. Wang et al. 2018).

Several studies link transportation infrastructure to social well-being. One study using ANOVA and OLS models found that the built environment, including transit access, influences social isolation and loneliness (Reed and Bohr 2021). A scoping review of public transit investments found that improved accessibility increased social participation, while disinvestment contributed to isolation (Anciaes and Alhassan 2024).

A case study in Saskatchewan, Canada, revealed that the loss of bus service caused increased stress and loneliness, especially for rural, Indigenous, and disabled populations (Neudorf 2021). Similarly, a Japanese study found that public transportation use was significantly associated with lower loneliness(Matsuda et al. 2019). Although this article used a very small sample size of 31, the results were found to be statistically significant. Finally, a study on the older English adults (62+) found that the use of the bus pass was positively associated with better outcomes such as a better quality of life, higher life satisfaction, fewer depressive symptoms, and more likely to engage in physical activity compared to the group who did not use the bus pass (Jackson et al. 2019).

Building on these findings, our research explores the association between public transportation access and social isolation, providing insights that can guide infrastructure improvements for better social and health outcomes.

3 Methods

3.1 Data Sources and Manipulation

We measure social isolation using census-tract-level data from the CDC PLACES database, which provides prevalence estimates of social isolation and lack of emotional support among adults (Centers for Disease Control and Prevention 2024). Transportation data comes from the National Neighborhood Data Archive (NaNDA), which includes transit stop counts per census tract (Pan et al. 2023). In order to stratify the results by rural, suburban, or urban status, we utilized the 2010 Rural-Urban Commuting Area (RUCA) Codes (Paykin et al. 2022). Lastly, we've controlled for ageby using age distributions by Census tract, retrieved from the 2020 Census (U.S. Census Bureau 2023).

These datasets are merged using census tract FIPS codes. Population density per square mile is calculated as:

$$Density = Population \div LandArea \tag{1}$$

We conducted preliminary EDA by summarizing key variables, including transit stops per 1,000 people and social isolation levels, using descriptive statistics and visualizations. We examined distributions and correlations between social isolation and transit availability, while considering confounders such as urbanity and population density.

Our analysis found that social isolation scores are normally distributed around 33.5% (Figure 1). However, explanatory variables, such as transit stop counts, are heavily skewed to the right, indicating a dataset dominated by low-density areas with few transit stops. Figure 1 shows the histograms of our key variables, highlighting their distributions.

Missing national census-level study data is significant. Transit data were unavailable for 1,006 census tracts, and in some cases whole states are missing. For example, Connecticut is completely missing. The CDC PLACES data is missing for 11 states: Arkansas, Colorado, Hawaii, Iowa, Louisiana, New York, North Dakota, Oregon, Pennsylvania, South Dakota, Virginia. We excluded these states from our analysis.

Figure 2 presents correlations between key variables and social isolation. Contrary to our expectations, census tracts with a higher share of older adults—both those aged 65+ and 85+—did not report greater social isolation. Similarly, higher population density was associated with *more* social isolation, not less, suggesting that proximity does not necessarily translate into social connection. RUCA codes, which increase with rurality, were negatively correlated with isolation, indicating that more urban areas actually reported higher feelings of isolation. Lastly, our key independent variable—transit stop access—was positively correlated with social isolation across all specifications (total stops, stops per 1,000 people, and stops per square mile). This result runs counter to our hypothesis that more transit access would reduce isolation.

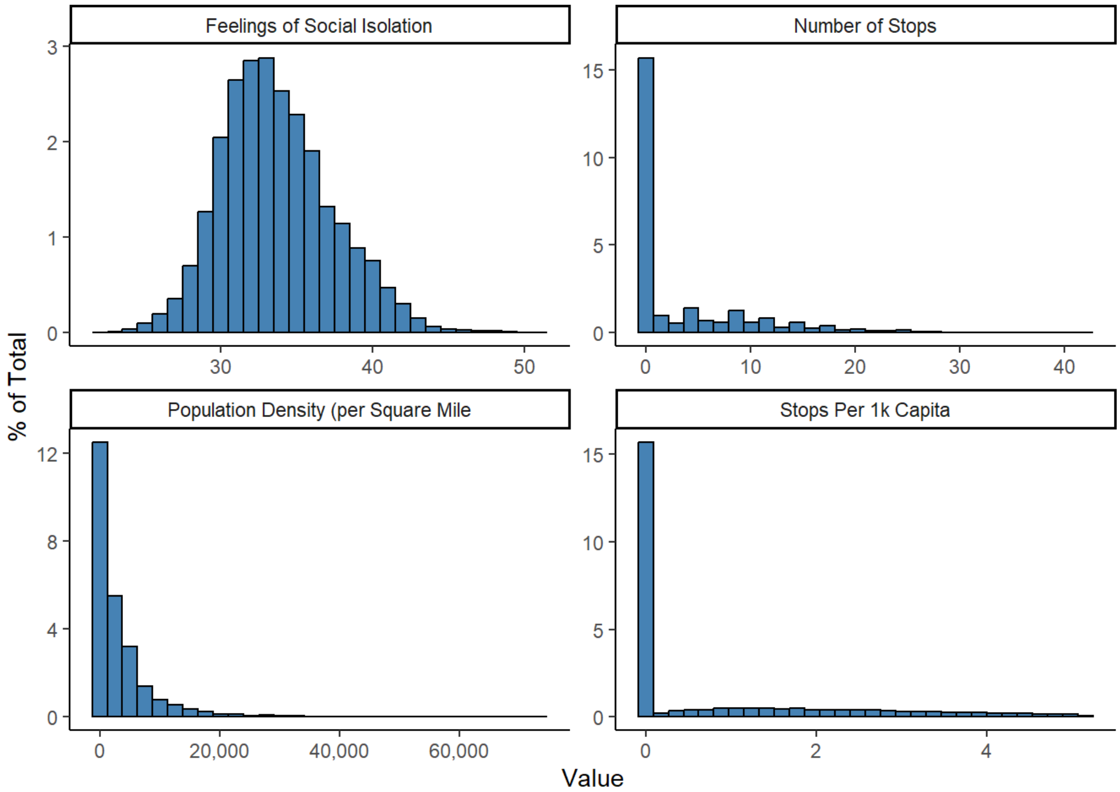

Figure 1: Distributions of the variables of interest as a percentage of the total data

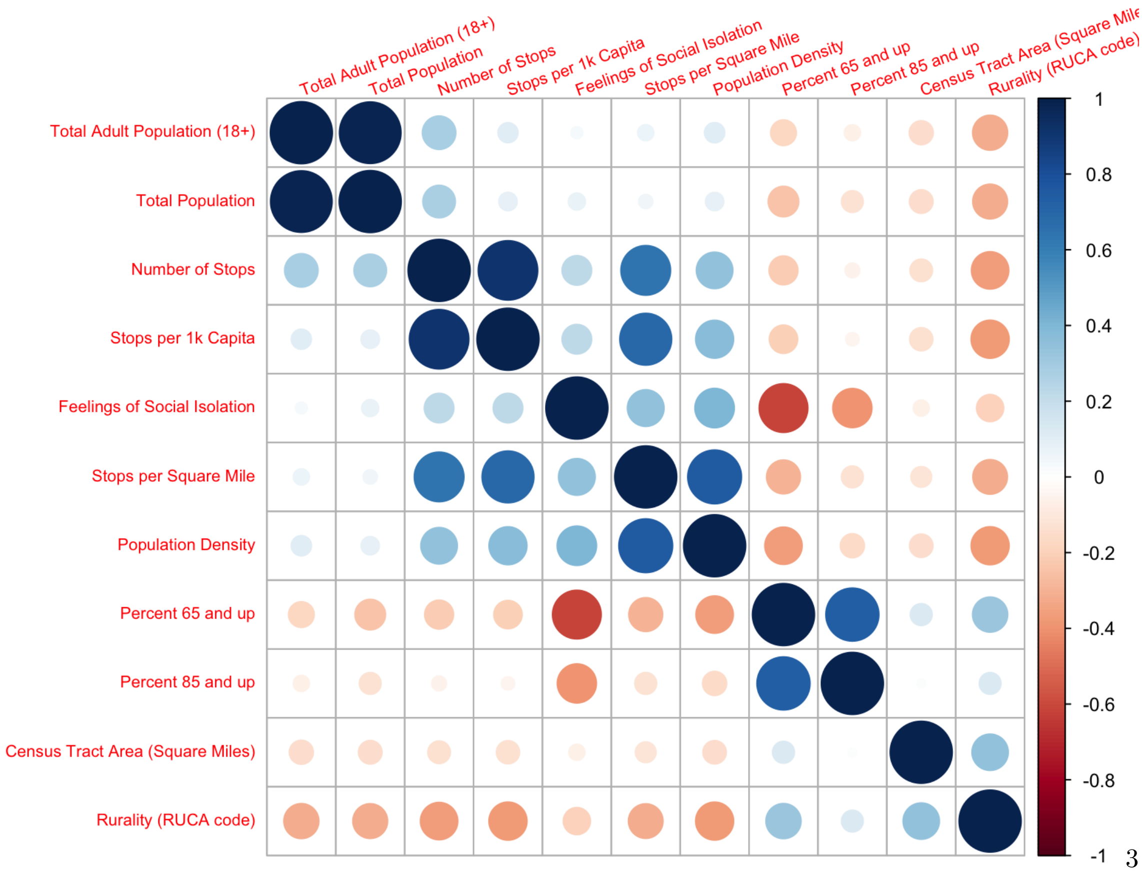

Figure 3 presents a box plot illustrating social isolation levels across urban, suburban, and rural areas. As the plot shows, urban areas have a slightly larger median social isolation level compared to suburban and rural areas. The median isolation is around 34% for urban areas, while it's around 33% for suburban and rural areas. Additionally, urban areas exhibit a wider inter-quartile range (IQR), indicating greater variability in social isolation levels within these areas. All three groups have outliers, which are shown as dots. The range of outliers is similar across all three groups.

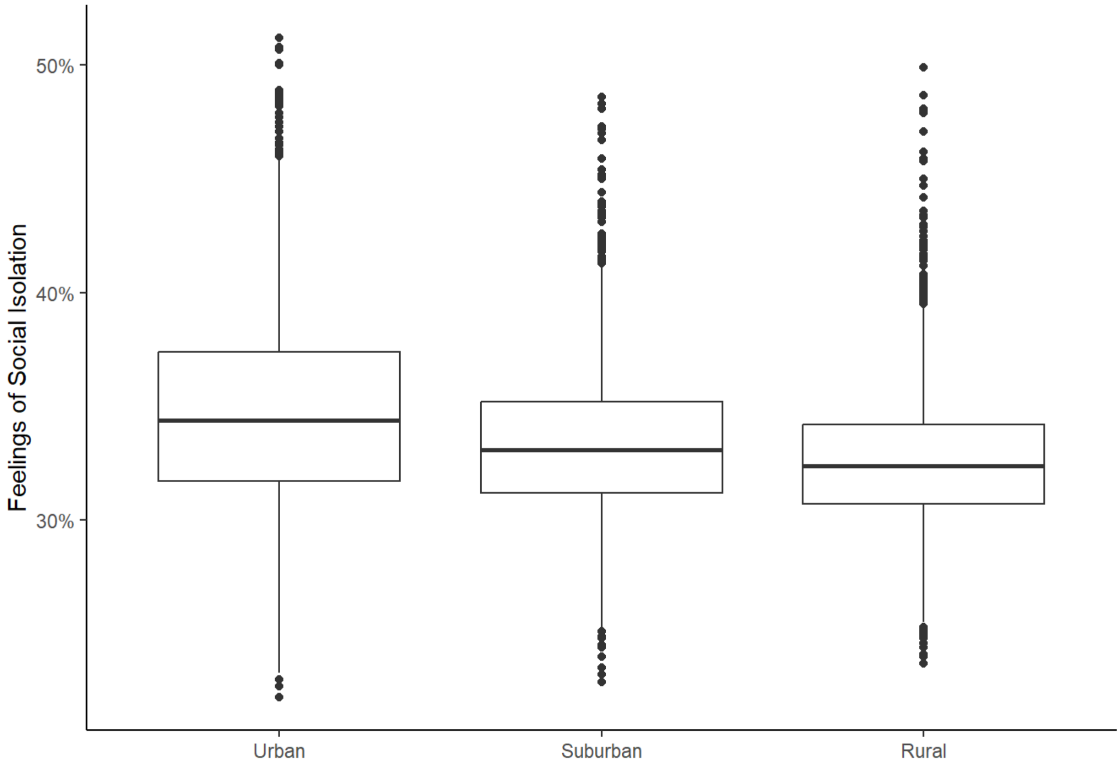

Figure 3: Box plot of social isolation by rurality

3.2 Linear Model

To investigate whether the relationship between access to public transportation and social isolation varies across different levels of urbanity, we conducted stratified Ordinary Least Squares (OLS) linear regression analyses. We divided our dataset into three subgroups based on the 2010 Rural-Urban Commuting Area (RUCA) codes: urban, suburban, and rural census tracts. For each of these subgroups, we ran a separate OLS linear regression model with social isolation (percentage of adults reporting feelings of social isolation) as the dependent variable and the number of transit stops per 1,000 people and population density per square mile as independent variables.

The general form of the linear regression model for each stratum can be represented as:

$$\begin{aligned}\text{Social Isolation}_i = \beta_0 + &\\ &\beta_1(\text{Transit Stops per 1,000 People})_i + \\ &\beta_2(\text{Population Density})_i + \\ &\beta_3(\text{Percent of Population 65+})_i + \epsilon_i\end{aligned}$$

where, for each stratum (urban, suburban, rural):

- Social Isolation$_i$ is the percentage of socially isolated adults in census tract i within that specific stratum.

- Transit Stops per 1,000 People$_i$ is the number of transit stops per 1,000 residents in census tract i within that stratum.
- Population Density$_i$ is the population per square mile in census tract i within that stratum.
- Percent of Population 65+ is the percentage of the total population who are 65 years old or older.
- β_0 is the intercept for that specific stratum.
- β_1, β_2, and β_3 are the coefficients for transit access, population density, and the proportion of the population 65+, respectively, within that stratum.
- ϵ_i is the error term for census tract i within that stratum.

By running separate regression models for urban, suburban, and rural areas, we aimed to assess whether the effect of public transportation access on social isolation differed significantly across these distinct geographic contexts. This approach allows us to understand the nuanced relationship between these variables in different types of communities, rather than assuming a uniform effect across all levels of rurality.

4 Results of Stratified Linear Regression Models

Table 1 presents the coefficient estimates and corresponding p-values from our stratified Ordinary Least Squares (OLS) linear regression models, examining the relationship between social isolation and our predictor variables (transit stops per capita, percentage of the population aged 65 and over, and population density per square mile) within urban, suburban, and rural census tracts. It is important to note that these coefficients are scaled and centered within each stratum. This means that the coefficients reflect the effect of a one standard deviation change in the predictor variable on the change in standard deviations of the outcome variable within that specific urbanity category (urban, suburban, or rural). As such, these coefficients show the relative importance of each predictor within each stratum, but cannot be directly compared across strata.

Table 1: Scaled and Centered Coefficient Estimates from Stratified Linear Regression Models

Predictor	**Urban**	**Suburban**	**Rural**
(Intercept)	34**	33**	32**
Stops per Capita	0.296**	0.320**	0.193**
Age: Proportion 65+	-2.146**	-1.608**	-1.503**
Population Density (per Square Mile)	0.938**	0.326**	0.066*

** $p < 0.001$, * $p < 0.1$

The results of our stratified regression models, using scaled and centered coefficients, indicate that the relationship between social isolation and the predictor variables varies across urban, suburban, and rural areas.

Transit Stops and Social Isolation: The number of transit stops per capita is positively associated with social isolation in all three settings. However, the magnitude of this association, relative to the variability within each setting, is smallest in rural areas (0.193) and largest in suburban areas (0.320), with urban areas (0.296) falling in between. All of these associations are highly statistically significant ($p < 0.001$).

Percentage of Adults 65 and Over and Social Isolation: The percentage of adults aged 65 and over is negatively associated with social isolation in all three settings. The strongest negative association, relative to the variability within each setting, is observed in urban areas (-2.146), followed by suburban areas (-1.608) and rural areas (-1.503). All of these associations are highly statistically significant ($p < 0.001$).

Population Density and Social Isolation: Population density is positively associated with social isolation in urban (0.938, $p < 0.001$) and suburban areas (0.326, $p < 0.001$). The association between population density and social isolation in rural areas is positive, but only marginally significant (0.066, $p = 0.0704$). The effect of population density, relative to the variability within each setting, is strongest in urban areas.

4.1 Unscaled and Uncentered Coefficients

Table 2 presents the unscaled and uncentered coefficients. These coefficients allow for direct comparisons across urban, suburban, and rural areas, as they represent the raw change in the social isolation percentage associated with a one-unit change in the predictor variable.

Table 2: Unscaled and Uncentered Coefficient Estimates from Stratified Linear Regression Models

Predictor	**Urban**	**Suburban**	**Rural**
(Intercept)	34.4	33.3	32.6
Stops per Capita	0.200	0.574	0.525
Age: Proportion 65+	-0.288	-0.283	-0.266
Population Density (per Square Mile)	0.000156	0.000273	0.000153

The unscaled coefficients show that a one unit increase in `Stops per Capita` is associated with a larger increase in social isolation in suburban (0.574) and rural areas (0.525) compared to urban areas (0.200).

5 Discussion and Limitations

Several data limitations may affect our findings. We use loneliness as a proxy for social isolation, although loneliness is a subjective feeling, while social isolation is an objective measure of physical proximity to and social interaction with others (Masi et al. 2011). This could explain why we saw our proxy measure of social isolation increase even in more densely populated areas. We also observed a significant amount of missingness in our data sources. Notably, missingness in rurality and age-related variables limits our ability to fully account for context and demographic confounders. The high proportion of missing values, especially for older adults, is a key limitation, given that social isolation disproportionately affects this group. The transit stop count represents a lower bound, as data is voluntarily submitted by just 270 agencies, when there are 6,800 agencies supported by the Federal Transit Administration (FTA) (American Public Transportation Association 2024). Future analyses could consider imputation or inclusion of alternative demographic datasets to fill these gaps. Lastly, CDC PLACES data as of 2022 and NaNDA transit data as of January 2023 create a potential temporal mismatch. For each of our sources, we used the most recent data available.

Our analysis suggests that census tracts with greater access to public transportation, measured by the number of transit stops per capita, tend to report slightly *higher* rates of feelings of social isolation among adults. This is counter to our hypothesis that tracts with more transit would have less social isolation. This may be due to a key conceptual distinction: loneliness and social isolation are related but not interchangeable. While access to transit may reduce physical barriers to social engagement, it does not guarantee meaningful social interaction. In fact, areas with high transit density may be crowded or impersonal, potentially intensifying feelings of disconnection.

Another important consideration is that isolation may stem more from mental health and social factors than from geographic accessibility alone. High-density urban environments, though rich in infrastructure, can foster anonymity, limiting the sense of community. Furthermore, the presence of more transit stops may reflect other underlying neighborhood characteristics such as poverty or disinvestment—factors we were not able to directly measure in this study.

Finally, it's important to distinguish between transit availability and usage. Simply having access to public transit does not mean individuals are using it or that it facilitates social connection in meaningful ways.

Conclusions

These findings suggest that transit infrastructure alone cannot be the sole fix for social isolation. City planners, practitioners, and policymakers must consider the broader social context in which people experience isolation, as improving transit access may be necessary but not sufficient, to foster social inclusion and well-being. Future research could explore transit usage patterns (as opposed to access), as well as incorporate variables measuring mental health, income level, and true social isolation–not just a proxy. Expanding this research will help policymakers better understand and design holistic interventions within the complex systems in which infrastructure, environment, and public health interplay.

References

American Public Transportation Association (Mar. 2024). *2023 Public Transportation Fact Book*. Fact Book. American Public Transportation Association.

Anciaes, P and J A K Alhassan (2024). "Economic and social impacts of public transport investments: A scoping literature review". In: *Advances in Transport Policy and Planning*. Ed. by J S Mindell and S J Watkins. Vol. 13. Academic Press, pp. 227–254. DOI: 10.1016/bs.atpp.2023.12.002.

Centers for Disease Control and Prevention (July 15, 2024). *PLACES: Local data for better health, census tract data (2023 release)*. URL: https://data.cdc.gov/500-Cities-Places/PLACES-Local-Data-for-Better-Health-Census-Tract-D/em5e-5hvn/about_data.

Jackson, S E et al. (2019). "Social isolation and physical activity mediate associations between free bus travel and wellbeing among older adults in England". In: *Journal of Transport & Health* 13, pp. 274–284. DOI: 10.1016/J.JTH.2019.03.006.

Lamanna, M et al. (2020). "The Association between Public Transportation and Social Isolation in Older Adults: A Scoping Review of the Literature". In: *Canadian Journal on Aging* 39.3, pp. 393–405. DOI: 10.1017/S0714980819000345.

Leigh-Hunt, N et al. (2017). "An overview of systematic reviews on the public health consequences of social isolation and loneliness". In: *Public Health* 152, pp. 157–171. DOI: 10.1016/j.puhe.2017.07.035.

Masi, C M et al. (2011). "A meta-analysis of interventions to reduce loneliness". In: *Personality and Social Psychology Review* 15, pp. 219–266.

Matsuda, N et al. (2019). "Association Between Public Transportation Use and Loneliness Among Urban Elderly People Who Stop Driving". In: *Gerontology and Geriatric Medicine* 5. DOI: 10.1177/2333721419851293.

Neudorf, C (2021). ""It feels like somebody cut my legs off": Austerity, transportation and the 'web of dispossession' in Saskatchewan, Canada". In: *Social Science & Medicine* 282, p. 114147.

Pan, Longrong et al. (2023). *National Neighborhood Data Archive (NaNDA): Public Transit Stops by Census Tract and ZIP Code Tabulation Area, United States, 2016-2018 and 2024*. DOI: 10.3886/ICPSR38605.V2. URL: https://www.icpsr.umich.edu/web/ICPSR/studies/38605/versions/V2.

Paykin, Susan et al. (Mar. 15, 2022). *spaykin/rural-urban-classification: Rural, Suburban, Urban Classification for Small Area Analysis*. Zenodo. DOI: 10.5281/ZENODO.6359701. URL: https://zenodo.org/record/6359701.

Reed, S and J Bohr (2021). "The Influence of Local Built Environments on Social Wellbeing: a Community's Experience with Social Isolation, Social Loneliness, and Social Belonging". In: *International Journal of Community Well-Being* 4, pp. 393–413. DOI: 10.1007/s42413-020-00091-6.

U.S. Census Bureau (2023). *2020 Census Demographic and Housing Characteristics File (DHC)*. Washington, DC.

U.S. Department of Health and Human Services (2024). *Social Cohesion*. Accessed October 25, 2024. URL: https://health.gov/healthypeople/priority-areas/social-determinants-health/literature-summaries/social-cohesion.

Wang, F, Y Gao, Z Han, et al. (2023). "A systematic review and meta-analysis of 90 cohort studies of social isolation, loneliness and mortality". In: *Nature Human Behaviour* 7.8, pp. 1307–1319. DOI: 10.1038/s41562-023-01617-6.

Wang, Q et al. (2018). "Urban mobility and neighborhood isolation in America's 50 largest cities". In: *Proceedings of the National Academy of Sciences* 115.30, pp. 7735–7740. DOI: 10.1073/pnas.1802537115.