

The Transportation Security Index

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In the past 30 days, how often:

....did you have to **arrive somewhere early and wait** because of the schedule of the bus, train, or person giving you a ride?

...were you **not able to leave the house when you wanted to** because of a problem with transportation?

...did you **worry about inconveniencing** your friends, family, or neighbors because you needed help with transportation?

(Often, Sometimes, Never)

Transportation Insecurity: a condition in which one is unable to regularly move from place to place in a safe or timely manner due to an absence of resources needed for transportation (e.g. money for gas, a friend with a car, the physical health to walk) (Gould-Werth et al. 2018; Murphy et al. 2021)



Proxy measures to capture transportation insecurity:

- Mode of Transit (e.g., car, public transit)
- Travel Behavior (e.g. commute time, activity-based models)
- Neighborhood Accessibility (e.g. proximity to transit, access to destinations, walkability scores)
- 5 As of Access (affordability, availability, accessibility, accommodation, acceptability)



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Proxy measures miss:

- ✓ Car owners who are transportation insecure when they can't pay for gas
- ✓ Residents living in “accessible neighborhoods” who cannot get around
- ✓ Access to transit  transit use
- ✓ “Unmet demand” (i.e. people who skip trips and are unable to get around)
- ✓ Role of social networks in mobility
- ✓ Different measures used inconsistently makes it difficult to make comparisons and draw general conclusions
- ✓ Whether a person's transportation needs have been met

The Problem: Lacking a valid measure of transportation insecurity we cannot:

- Identify **how many** people – and **who** – experiences transportation insecurity or **where** geographically it exists (i.e. identify how many people’s transportation needs are not being met).
- Understand what is **causing** transportation insecurity (thereby helping us identify solutions to ameliorate it) (i.e. identify why people’s transportation needs are not being met)
- Understand what the **consequences** of transportation insecurity are for individual and community wellbeing.
- **Evaluate** whether our interventions and investments are effectively moving people from “transportation insecurity” to “transportation security” and assess the returns on investment of ameliorating transportation insecurity.

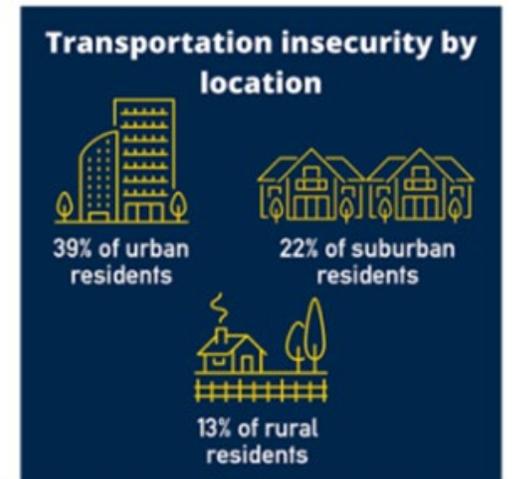
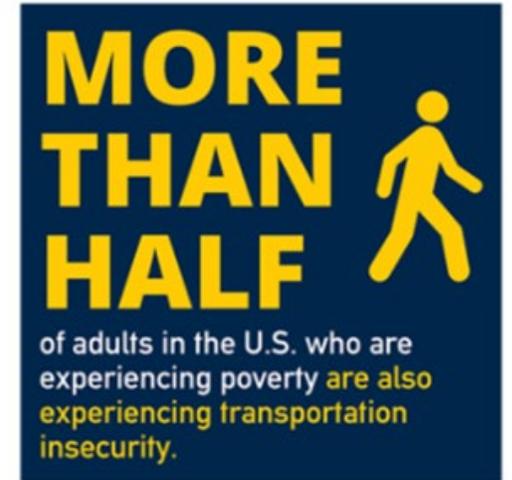


“You can’t manage what you can’t measure”

Transportation Security Index (TSI): A validated, individual-level measure explicitly designed to measure transportation insecurity as it is experienced qualitatively, regardless of geography or mode of transit (Gould-Werth et al. 2018; Murphy et al. 2021)



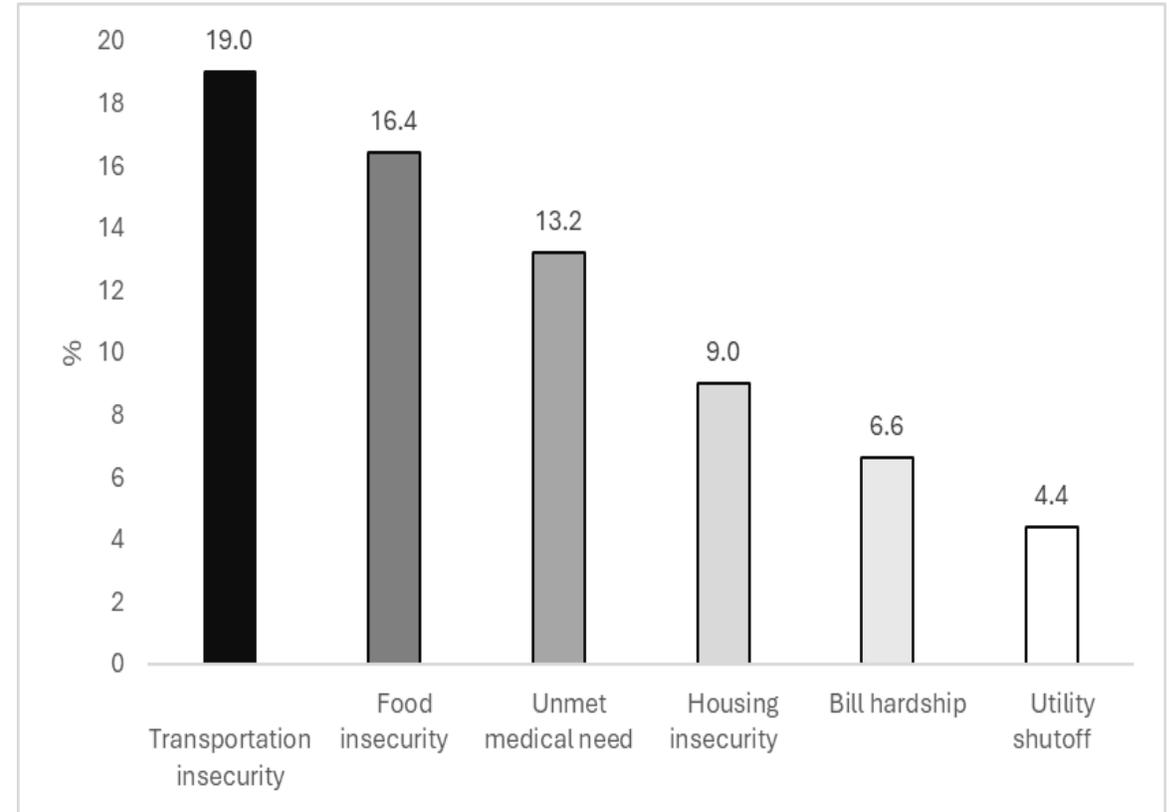
Putting the Transportation Security Index to work: Generated the first prevalence estimates of transportation insecurity in the U.S. and provided a descriptive portrait by subgroup (Murphy et al. 2022)



Putting the Transportation Security

Index to work: Conducted a study that shows that transportation insecurity is *the* most prevalent form of material hardship experienced by Americans.

It is *also just as strongly associated* with poor self-rated health and depressive symptoms as food insecurity and having unmet medical needs (Paper under review).

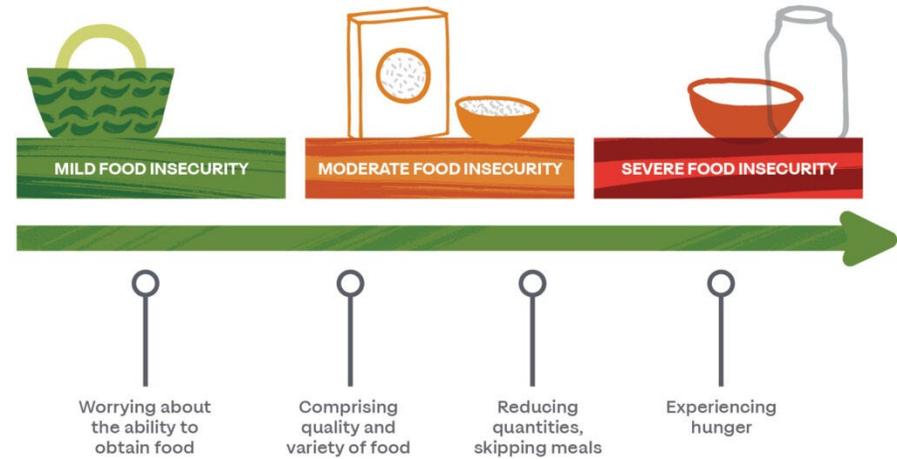


How was the TSI created?

Inspiration: The Food Security Index which directly captures the experience of food insecurity by measuring *symptoms* (vs inputs):

“In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?”

“The food that we bought just didn't last, and we didn't have money to get more.” Was that often, sometimes, or never true for your household in the last 12 months?



Creating the Transportation Security Index

Phase I: Identifying the *symptoms* of transportation insecurity

- Drew on ethnographic data and 187 interviews conducted in urban, suburban, and rural areas across 3 states to identify the symptoms of transportation insecurity



3 Manifestations of Symptoms of Transportation Insecurity

- **Material:** Physically observable and relate to whether people can get around in a safe or timely manner (e.g. time-consuming travel, being stuck at home, unsafe travel, rescheduling appointments)
- **Relational:** Social strains stemming from using social networks for travel or from the inability to see people because of transportation problems (e.g. worry about inconveniencing ride givers, social isolation)
- **Emotional:** Stress and worry related to problems with transportation (e.g. worrying about transportation, feeling left out, embarrassment)



Creating the Transportation Security Index

Phase II: Brainstorming Items

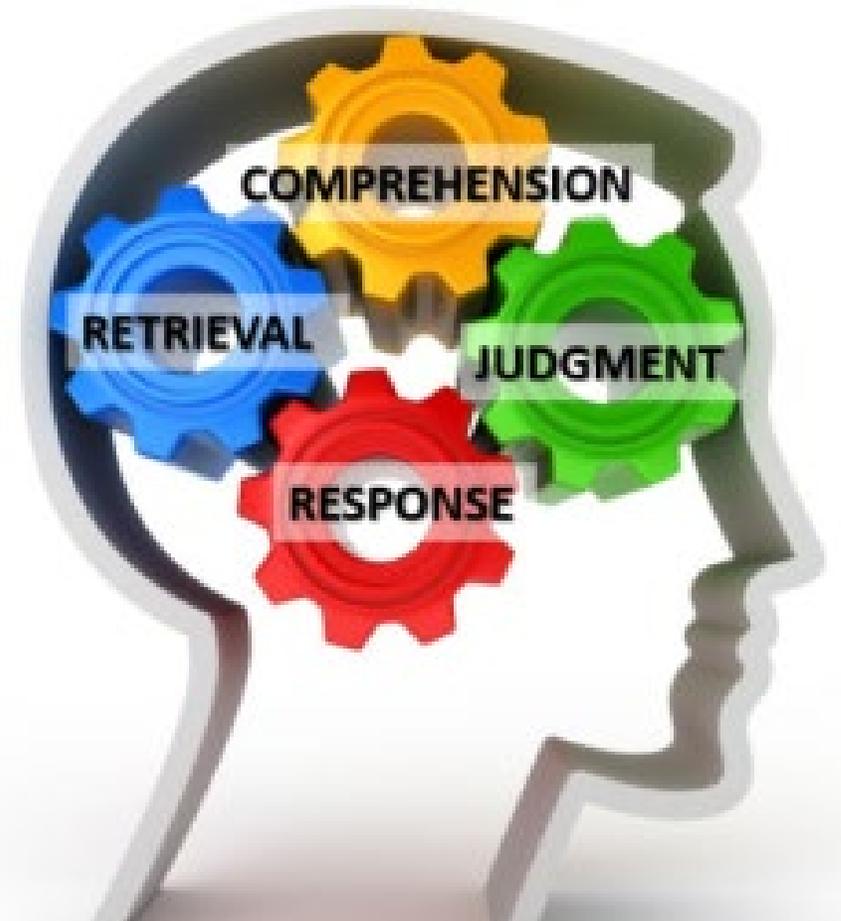
- Drew on our qualitative data to develop 23 candidate items that captured the material, relational, and emotional manifestations of transportation insecurity
- We intentionally left out outcomes of interest (i.e. work/employment, doctor/health) so researchers can use the TSI in a causal inference framework to look at the consequences of insecurity on these outcomes



Creating the Transportation Security Index

Phase III: Cognitive Interviews

- Conducted 52 cognitive interviews in urban, suburban, and rural areas
- Coded response for question comprehension, recall, and judgment
- Result:
 - Burdensome items were refined
 - Items generating false positives were dropped
 - Reference to the cost of transportation in each item was dropped
 - New items were developed



Creating the Transportation Security Index

Phase IV: Identifying & Validating the Transportation Security Index

- Identified a preliminary 16-item index by fielding an original survey and conducting exploratory factor analysis
- Validated the 16-item index on a nationally representative sample by fielding an original survey and conducting confirmatory factor analysis.
- Each of the 16-items tap into the symptoms of transportation insecurity and draws on a 30-day reference period. Response options for all items are “Never, Sometimes, Often”
- Items are scored 0=never; 1=sometimes; or 2=often; thus, possible cumulative scores ranged from 0 to 32

Articles

Developing a New Measure of Transportation Insecurity: An Exploratory Factor Analysis

Alix Gould-Werth¹, Jamie Griffin², Alexandra K. Murphy²

Tags: poverty, transportation insecurity, factor analysis

Survey Practice

Vol. 11, Issue 2, 2018

Scholarship recognizes that problems with transportation have important consequences for individual well-being and life chances. Yet no single measure exists that captures the multiple manifestations of transportation insecurity, a condition in which one is unable to regularly move from place to place in a safe and timely manner because one lacks the resources necessary for transportation. Using an original survey of 511 respondents from GfK's KnowledgePanel®, we use exploratory factor analysis to estimate an initial factor structure, a step toward developing a new measure of transportation insecurity: the Transportation Security Index. Our results suggest that a two-factor solution best fits the data, and item content suggests that the factors represent the material and relational manifestations of transportation insecurity, respectively.

ARTICLES

Validating the Sixteen-Item Transportation Security Index in a Nationally Representative Sample: A Confirmatory Factor Analysis

Alexandra K. Murphy¹, Alix Gould-Werth², Jamie Griffin¹

¹ University of Michigan, ² Washington Center for Equitable Growth

Keywords: transportation equity, material hardship, accessibility, poverty, transportation insecurity, validation, replication

<https://doi.org/10.2915/SP-2021-0011>

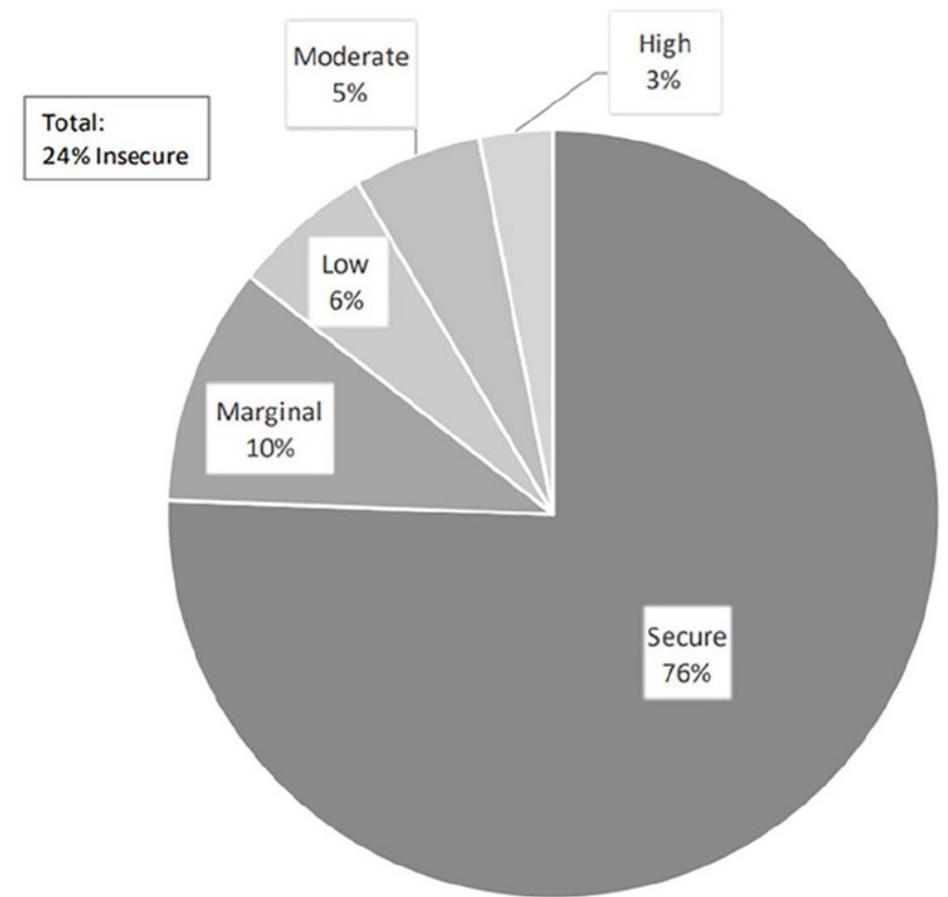
Survey Practice

Vol. 14, Issue 1, 2021

Scholars, policymakers, and planners lack a single, valid measure of transportation insecurity. This has hindered the development of evidence on the relationship between transportation insecurity and poverty. To address this, in previous work, we developed a preliminary Transportation Security Index (TSI): a 16-item measure that captures the experience of transportation insecurity at the individual level, regardless of geography or mode of transit. In this paper, drawing on an original survey of a nationally representative sample (n=1,999) from GfK's KnowledgePanel®, we use confirmatory factor analysis to replicate and validate the 16-item TSI. Our results show that a slightly modified TSI16 is an effective tool that can be used to uncover transportation insecurity across different samples. They also suggest that, counter to the results of our previous study, transportation insecurity is a unidimensional condition that is experienced both materially and relationally. Together, these findings represent a significant advancement in the study and measurement of transportation insecurity.

Creating the Transportation Security Index: Phase V: Identifying Categories of Insecurity

1. **No insecurity/Transportation Secure** (0-2): People who can regularly get from place to place in a safe or timely manner
2. **Marginal insecurity** (3-5): People who are inconvenienced by transportation and experience transportation-related worry but can regularly access essential destinations
3. **Low Insecurity** (6-10): People who experience constrained travel that impacts daily life
4. **Moderate Insecurity** (11-16): People who experience even greater constrained travel and affirm items that measure negative feelings about their transportation situation
5. **High Insecurity** (17+): People who experience extremely constrained travel behavior with some reporting not being able to go places at all or being severely limited in the places they can go



McDonald-Lopez, Karina et al. 2023. "A Driver in Health Outcomes: Developing Discrete Categories of Transportation Insecurity." *American Journal of Epidemiology*, 192(11): 1854-1863.

Challenge: 16-items is too long for many surveys where questionnaire real estate is constrained

Creating the Transportation Security Index:

Phase VI: Identifying and Validating Abbreviated Indices

Validated 6-Item Abbreviated TSI (TSI-6)

In the past 30 days, how often did you have to reschedule an appointment because of a problem with transportation?

In the past 30 days, how often did you skip going somewhere because of a problem with transportation?

In the past 30 days, how often were you **not** able to leave the house when you wanted to because of a problem with transportation?

In the past 30 days, how often did you feel bad because you did not have the transportation you needed?

In the past 30 days, how often did you worry about inconveniencing your friends, family, or neighbors because you needed help with transportation?

In the past 30 days, how often did problems with transportation affect your relationships with others?

Validated 3-Item Abbreviated TSI (TSI-3)

In the past 30 days, how often did you skip going somewhere because of a problem with transportation?

In the past 30 days, how often were you **not** able to leave the house when you wanted to because of a problem with transportation?

In the past 30 days, how often did problems with transportation affect your relationships with others?

Time vs Category Tradeoffs

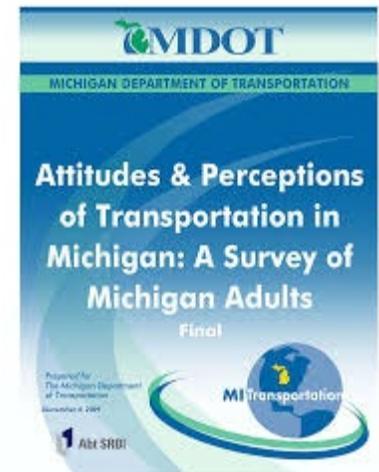
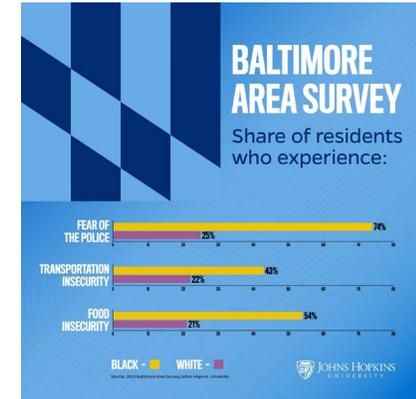
- Whereas the TSI-6 identifies 3 categories of insecurity, the TSI-3 only identifies 2 (secure/insecure)
- Whereas, on average, the TSI-6 takes 51.1 seconds to complete, the TSI-3 takes 28.5

Use Case #1: DOCUMENTATION & TRACKING OVER TIME.

Stakeholders can include the TSI on original surveys to identify insecurity in a sample of interest. If included on re-occurring surveys, states, cities, and MPOs can document the prevalence of transportation insecurity in their region, track it over time, and compare their rates of insecurity with that of others. By doing so they can assess their progress in terms of reducing transportation insecurity across the population and calculate what kinds of returns on investments states and regions get as a result.

Examples:

- The TSI was used in the 2024 Minnesota Department of Transportation's Omnibus Survey (26% of Minnesotans experience transportation insecurity) and they plan to use it in future surveys to track changes over time
- The TSI has been included on the Detroit Metropolitan Communities Area Survey and the Baltimore Area Survey to document city-level prevalence
- Snohomish County Transportation Coalition is planning to include the TSI on their Regional Mobility Survey for Priority Populations
- The state of Michigan has plans to use the TSI on their state-wide household travel survey and their Attitudes and Perceptions survey



Use Case #2: EVALUATION. Evaluate transportation interventions and investments to determine whether they are achieving the goal of moving people from “transportation insecurity” to “transportation security” (conversely, evaluate how transportation disinvestment impacts transportation insecurity).

Examples:

- The U.S. Department of Transportation’s Mobility, Access, and Transportation Insecurity Demonstration Program
- Washington DC’s free public transit fare pilot program
- South Bend’s Commuter’s Trust Program which provides participants ride hailing vouchers and bus passes and assesses whether such interventions increase people’s ability to show up to work and get to work on time
- Feonix Mobility Rising’s Mobility Wallet Program
- Los Angeles’ Universal Basic Mobility Wallet Pilot
- New York State’s clean energy project in six different “transportation deserts” in the state
- Urban Institute and Open Research’s respective studies of the impact of a Universal Basic Income Program
- Transit agencies have inquired about using the TSI in their ridership surveys



COMMUTERS TRUST



Use case #3: ANALYZE THE CAUSES & CONSEQUENCES OF TRANSPORTATION INSECURITY.

The TSI can be used to examine the causes of transportation insecurity (which can help identify potential solutions to ameliorate it). It can also be used to analyze how transportation insecurity is linked with outcomes of interest related to individual wellbeing (educational attainment, health, employment, financial insecurity, food insecurity, etc...) and assess how addressing transportation insecurity can help ameliorate these outcomes. Such analyses could be scaled up to the community-level to assess how ameliorating individual insecurity impacts community outcomes of interest (tax revenue, employment, costs of public services).

Examples:

- Researchers at the Yale School of Medicine have registered a Randomized Control Trial that will use the TSI to evaluate medication adherence among HIV patients who use drugs
- Researchers at the Stanford University School of Medicine are using the TSI to look at whether transportation insecurity predicts colonoscopy completion &
- Researchers at UC Davis are using the TSI to evaluate how transportation insecurity impacts dialysis treatment outcomes.



Contingency Management and Pre-Exposure Prophylaxis Adherence Support Services (CoMPASS): A hybrid type 1 effectiveness-implementation study to promote HIV risk reduction among people who inject drugs

Minhee L. Sung^{a, b, p, 1}, Adam Viera^{c, d, 1}, Denise Esserman^{e, f}, Guangyu Tong^{e, f}, Daniel Davidson^g, Sherry Aiudi^f, Genie L. Bailey^{g, h}, Ashley L. Buchananⁱ, Marianne Buchelli^j, Mark Jenkins^k, Betsey John^l, Jennifer Kolakowski^m, Albana Lameⁿ, Sean M. Murphy^o, Elizabeth Porter^p, Laura Simone^f, Manuel Paris^q, Carla J. Rash^r, E. Jennifer Edelman^{b, c, d, p}

Show more



EnROUTE: Evaluating the Role of Transportation on Hemodialysis Access and Health Disparities



“

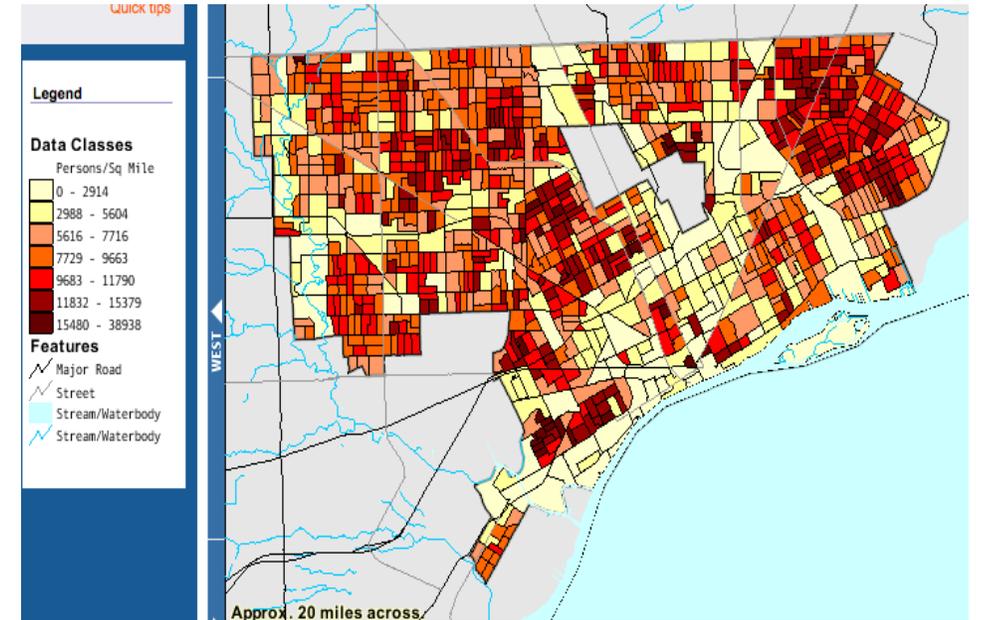
Our hope is this data will help guide us on how to screen for patients who are transportation insecure and help us develop the best strategies to better support them.”

— Na'amah Razon



Use Case #4: IDENTIFY GEOGRAPHIC “HOTSPOTS: OF INSECURITY. States, cities and MPOs could use survey data that includes the TSI to identify geographic “hotspots” of transportation insecurity. Such data could be used to decide how (and where) to more effectively allocate resources, including mobility interventions (e.g. new transit routes and stops, transit vouchers) and the location of social services.

- No one has used the TSI in this way to date. The biggest challenge to this use is collecting data with sufficient sample sizes at fine enough spatial scales.



Case Study: Deploying the TSI in Detroit

Transportation Insecurity in the Motor City

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Figure 1. Prevalence of Transportation Insecurity in Detroit

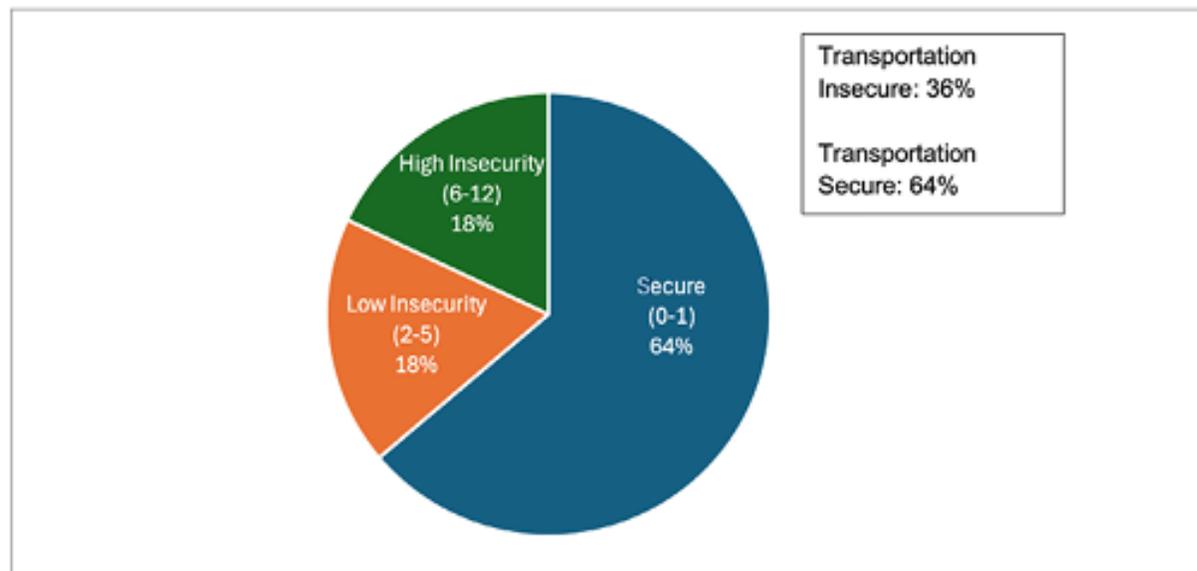
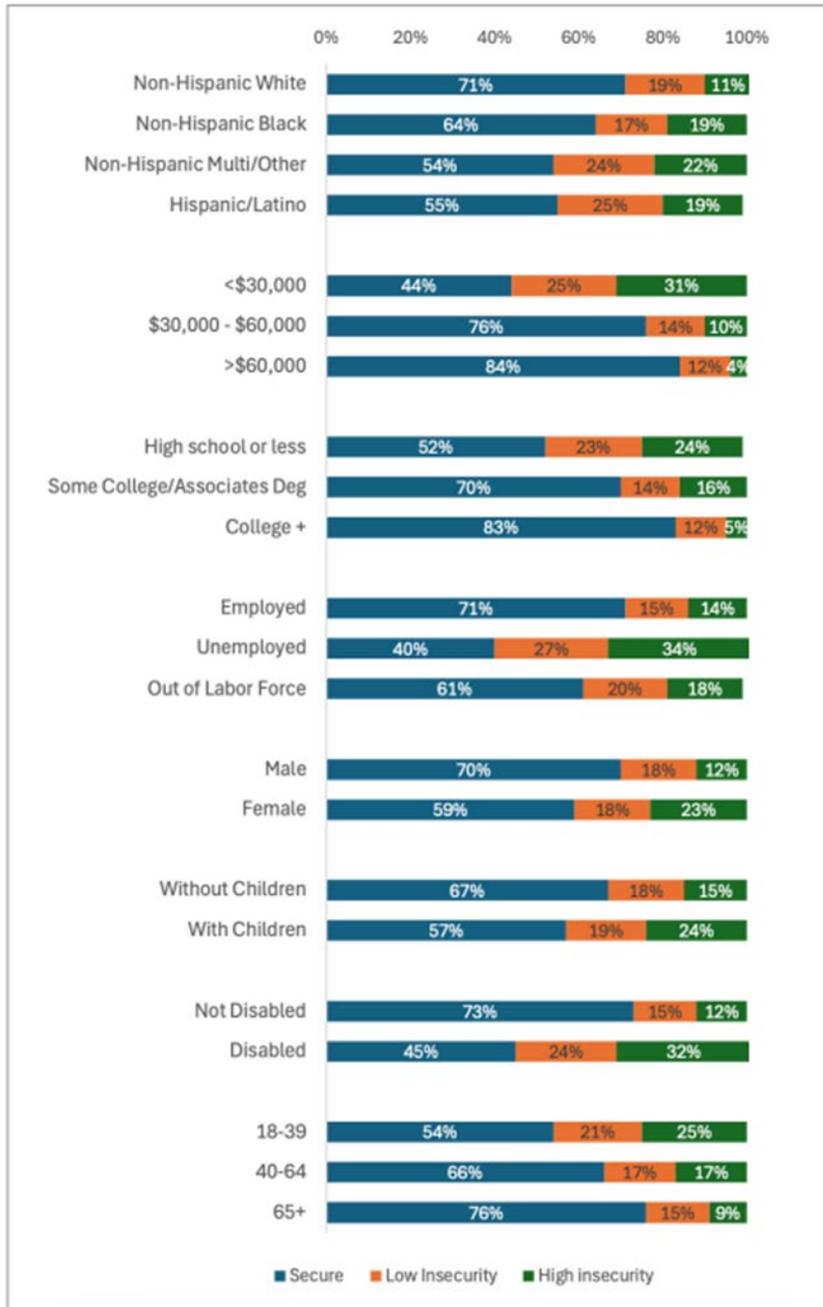
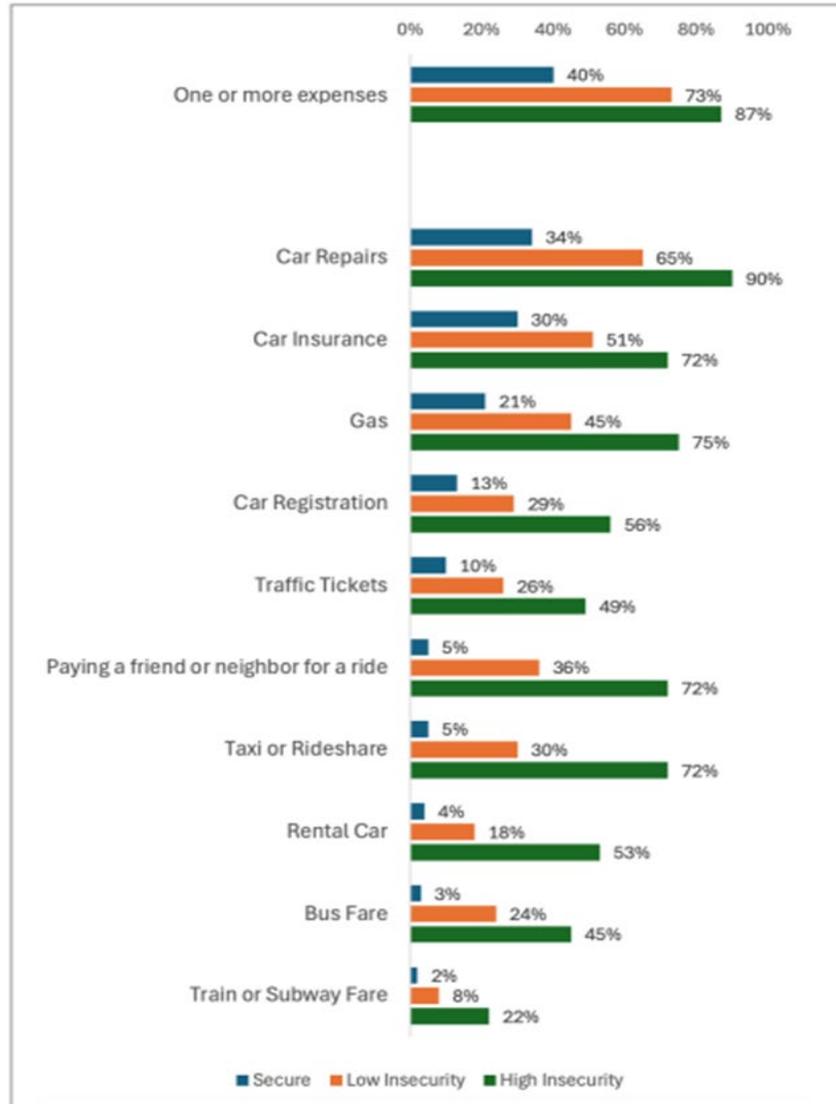


Figure 4. Transportation Insecurity in Detroit by Demographic Group



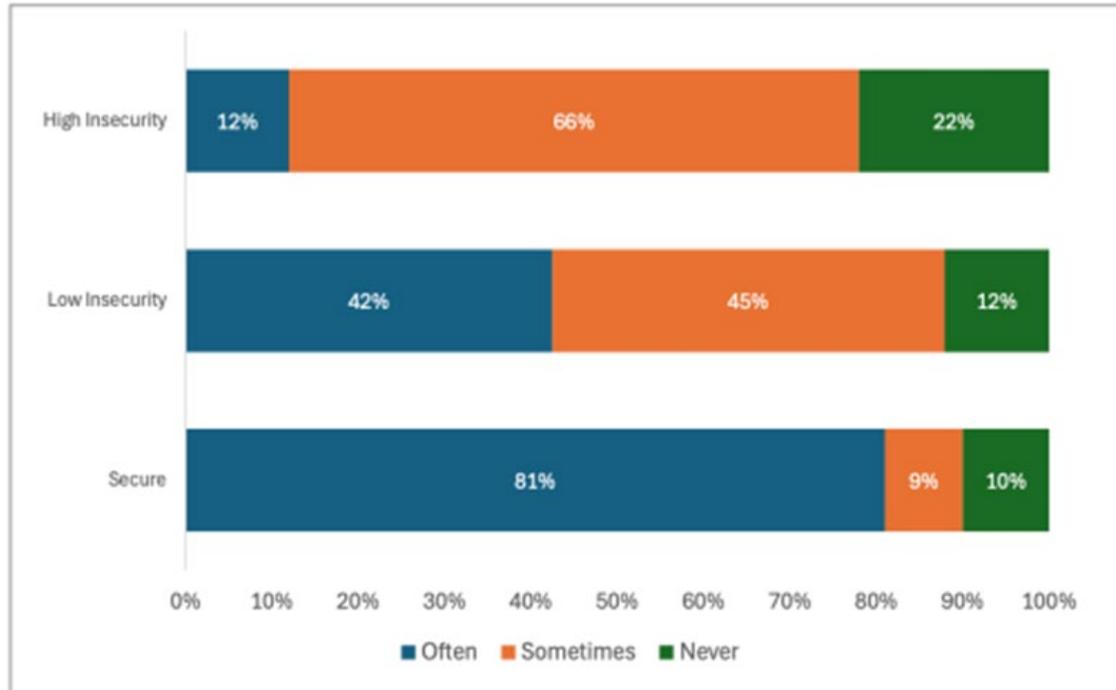
➤ **Disparities in who experiences transportation insecurity in Detroit largely parallel those observed at the national level. In Detroit, and nationally, those with lower incomes, lower education rates, unemployment, children, and disabilities are more likely to experience transportation insecurity.**

Figure 11. Trouble Affording Common Transportation Expenses by Transportation Insecurity Category**



➤ **A major driver of transportation insecurity in Detroit is difficulty paying for transportation-related expenses.** Nearly 80% of those experiencing transportation insecurity report having difficulty paying for at least one transportation-related expense. For car owners, the cost of repairs followed by car insurance and gas are the expenses transportation insecure people most struggle with. Among those without cars, paying friends and family for rides or using a taxi or rideshare rank among the expenses those experiencing insecurity most struggle with.

Figure 13. Detroiters' Satisfaction with Their Ability to Get Around by Transportation Insecurity Category



➤ **Detroit is a city with significant “unmet demand.”** Not only are rates of transportation insecurity high in the city, but almost 50% of residents who experience transportation insecurity report that they do not use any mode of transportation to get around daily. At the same time, residents who experience both high transportation insecurity and low transportation insecurity are much more likely than transportation-secure Detroiters to report either not being satisfied, or only sometimes being satisfied, with their ability to get around. Taken together, these findings suggest that there are a sizeable number of Detroiters who wish to travel more than their current situations allow.

Steps for Implementation

Step 1: Administer the TSI-6 on your surveys

- 1.** To get to the places they need to go, people might walk, bike, take a bus, train or taxi, drive a car, or get a ride. In the past 30 days, how often did you have to reschedule an appointment because of a problem with transportation?
[Often/Sometimes/Never]
- 2.** In the past 30 days, how often did you skip going somewhere because of a problem with transportation? [Often/Sometimes/Never]
- 3.** In the past 30 days, how often were you **not** able to leave the house when you wanted to because of a problem with transportation? [Often/Sometimes/Never]
- 4.** In the past 30 days, how often did you feel bad because you did not have the transportation you needed? [Often/Sometimes/Never]
- 5.** In the past 30 days, how often did you worry about inconveniencing your friends, family, or neighbors because you needed help with transportation?
[Often/Sometimes/Never]
- 6.** In the past 30 days, how often did problems with transportation affect your relationships with others? [Often/Sometimes/Never]

Step 2: Score respondent's individual responses

6-Item Transportation Security Index

1. To get to the places they need to go, people might walk, bike, take a bus, train or taxi, drive a car, or get a ride. In the past 30 days, how often did you have to reschedule an appointment because of a problem with transportation?
Often
Sometimes
Never
2. In the past 30 days, how often did you skip going somewhere because of a problem with transportation?
Often
Sometimes
Never
3. In the past 30 days, how often were you **not** able to leave the house when you wanted to because of a problem with transportation?
Often
Sometimes
Never
4. In the past 30 days, how often did you feel bad because you did not have the transportation you needed?
Often
Sometimes
Never
5. In the past 30 days, how often did you worry about inconveniencing your friends, family, or neighbors because you needed help with transportation?
Often
Sometimes
Never
6. In the past 30 days, how often did problems with transportation affect your relationships with others?
Often
Sometimes
Never

➤ Assign each item in the TSI a score

Never = 0

Sometimes = 1

Often = 2

➤ In this example:

Q1 = 1

Q2 = 2

Q3 = 0

Q4 = 1

Q5 = 2

Q6 = 1

Step 3: Identify the respondent's individual TSI sum score

➤ In this example the respondent's sum score = 7

➤ To identify the respondent's individual TSI sum score, add the score of each individual TSI item.

$$Q1 = 1 +$$

$$Q2 = 2 +$$

$$Q3 = 0 +$$

$$Q4 = 1 +$$

$$Q5 = 2 +$$

$$\underline{Q6 = 1 +}$$

$$\text{Total} = 7$$

Step 4: Assign the respondent to a transportation insecurity category

➤ To assign the respondent to a transportation insecurity category, use their individual sum score and the following categorization:

Sum score 0-1 = No insecurity/Secure

Sum score 2-5 = Marginal/Low insecurity

Sum Score 6-12 = Moderate/High Insecurity

➤ In this example, if the respondent sum score = 7 then she would be considered to be experiencing moderate/high insecurity.