

The TBI Models Systems Neighborhood Socio-economic Disadvantage Index

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Why Study Neighborhood Level Variables for Health Outcomes

A combination of individual-level factors (e.g., education level, health literacy, healthcare access) and neighborhood-level factors (e.g., socioeconomic characteristics, crime, violence, social disorder, built environment) contribute to health disparities.¹ People living in neighborhoods with lower socio-economic status are disproportionately affected by various health issues, like obesity, heart disease, hypertension, diabetes, asthma, cancers, and mental health issues, compared to those living in higher-income neighborhoods.¹ Neighborhood features can either enable or constrain people from developing social networks that provide needed social support – like emotional, informational, and instrumental support – that can improve health outcomes for those living in low-income neighborhoods.²

The Use of Neighborhood Socioeconomic Indices

Several indices measure area-level socioeconomic status and can be used to track and predict health outcomes and health disparities³ and inform place-based policies, allocate resources, and develop interventions aimed at improving neighborhood well-being. They have been used to identify and target disadvantaged communities, ensuring that resources and interventions are directed where they are most needed.⁴ The following are the most commonly used indices:

- **Graham Social Deprivation Index (SDI):** This index measures social deprivation and can predict health outcomes effectively at the county, zip-code, Census-tract, and Census-block-group levels.
- **Neighborhood Atlas Area Deprivation Index (ADI):** The ADI is another commonly used measure of area-level socioeconomic status. It has been compared to other indices and found to be valid in predicting health outcomes.
- **CDC Social Vulnerability Index (SVI):** The SVI measures vulnerability of communities to external stresses on human health, like natural or human-caused disasters or disease outbreaks, to allocate resources and plan interventions for community resilience.

TBI Model Systems Neighborhood Socioeconomic Disadvantage Index (NSDI)

Notably, differences in neighborhood characteristics included in these indices are driven by their different purposes, resulting in related but different constructs associated with socio-economic status (SES) and ‘disadvantage’ captured by each index with no industry standard. Recognizing the importance of neighborhood-level SES for outcomes, the TBI Model System’s Geographic Identifiers Special Interest Group (Geo SIG) formed a neighborhood Socio-Economic Status (SES) Work Group tasked to make recommendations for the content, source, structure, and timing of variables reflecting neighborhood SES that could provide **a calculated variable in the TBI Model Systems National Database.**

Selecting component variables for NSDI

The Work Group reviewed methods used previously to create neighborhood SES indices and determined that census tract characteristics operationalizing five constructs reflected the current evidence: employment, poverty, income, head of household, and education.⁴ The Work Group eliminated race/ethnicity, population density, proportion of older adults, and ownership of dwelling from inclusion in an SES indicator. The consensus was to include measures of both disadvantage (e.g., percent of adults without high school education) and advantage (e.g.,

percent of adults with a BA degree or higher education), with greater sensitivity to disadvantage (see **Table 1** below for eight included variables).

Data Source

We used the American Community Survey (ACS), an ongoing annual national survey conducted by the U.S. that queries information on social, economic, housing, and demographic information at the Census tract level, to get neighborhood-level information for the entire United States to develop our index. We used 5-year average ACS data to account for year-to-year fluctuations and changing trends; for the development of our index we used 2015-2019 data, with a plan to update the index in 10 years. **Table 1** describes the eight ACS variables selected by the Work Group for inclusion in the TBIMS-NSDI.

Table 1: American Community Survey included in the newly developed TBI Model Systems Neighborhood Socioeconomic Disadvantage Index (TBIMS-NSDI)

Construct name	Variables operationalizing each construct
Employment status	1) % of adults in civilian labor force who are unemployed
Poverty status	2) % of households with incomes at or below the poverty level 3) % of households qualifying for SNAP (Food Stamps)
Income	4) median family income (reflects resources across living arrangements e.g., singles, roommates, couples, families) 5) median household income (restricted to related individuals)
Head of household	6) % of single parent headed households containing children <18
Educational attainment	7) % ≥ 25 years old without high school diploma or GED 8) % ≥ 25 years old with bachelor’s degree

Statistical Analysis to Develop the NSDI

We conducted a principal components analysis (PCA) to calculate our NSDI score using the input variables from **Table 1**. PCA is the most common method used to develop neighborhood socioeconomic indices using a group of related neighborhood-level variables. PCA examines how variables covary within a census tract, allowing us to generate a summary scores of neighborhood disadvantage in a given census tract from several neighborhood-level variables. PCA results of our eight input variables indicated that that one component sufficiently summarized our data (**Figure 1**). Therefore, our NSDI was calculated from our first principal component (PC1). The extent to which each variable contributed to NSDI score was based on the loadings of the PCA; that is, the NSDI is calculated as the weighted sum of these variables as shown in the equation below.

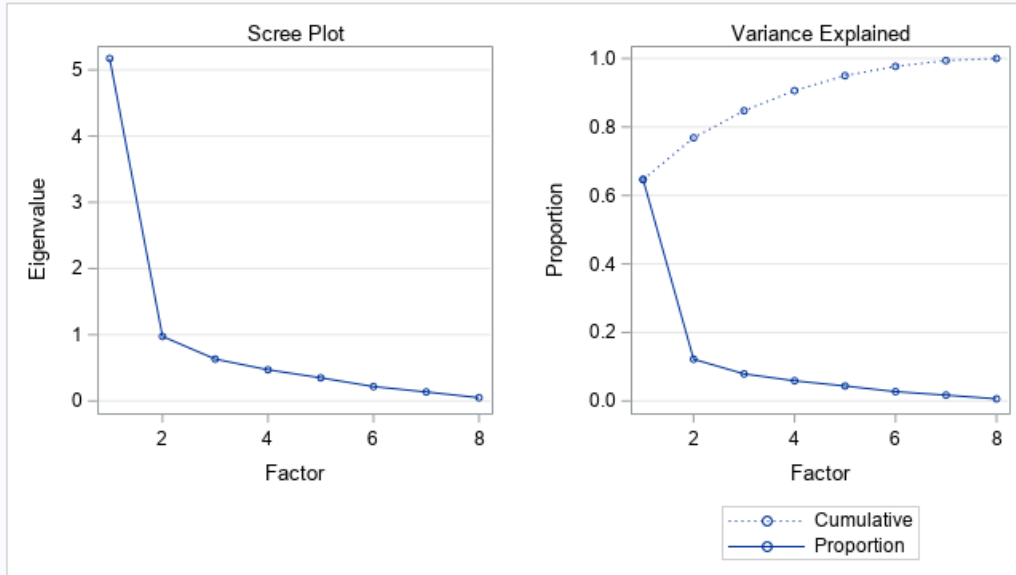


Figure 1. Scree Plot of PCA - a figure that shows the variance explained as we increase the number of components – showing evidence of a one component (one summary score) solution.

Equation: The weighted derivation of the Neighborhood Socioeconomic Disadvantage Index (NSDI)

$$NSDI_i = [(0.127) * (\%unemployed)_i + (0.145) * (\%single\ parent\ HoH)_i + (0.141) * (\%noHS\ or\ GED)_i + (-0.150) * (\%BA\ or\ higher)_i + (0.161) * (\%below\ poverty)_i + (0.165) * (\%SNP)_i + (-0.164) * (Median\ HH\ income)_i]$$

Where i is a given U.S. Census tract.

We used standardized values, relative to the entire United States (n=72,497 U.S. Census tracts), for input each variable, NOT raw values. The mean NSDI = 0, standard deviation = 1. The histogram distribution of the calculated NSDI scores is provided in **Figure 2**.

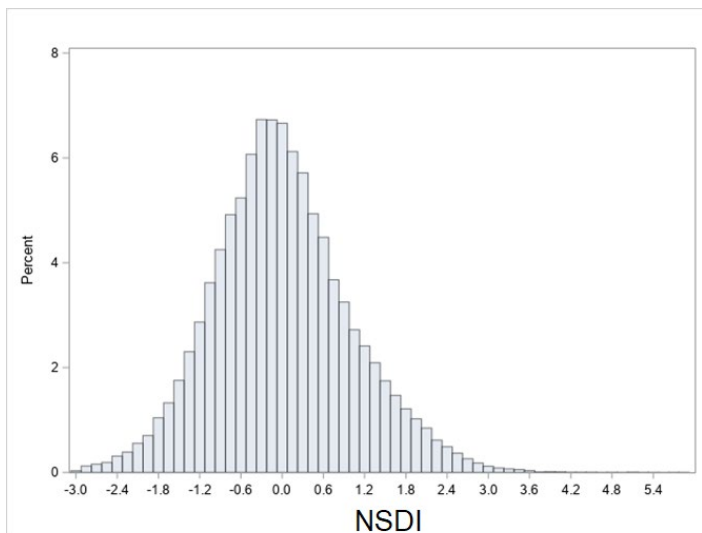


Figure 2. Histogram distribution of the NSDI across all U.S. Census Tracts (Mean=0, SD=1)

Potential applications of the NSDI

Neighborhood socioeconomic status is an important social determinant of health known to contribute to health disparities. The TBI Model Systems National Database is the large longitudinal study of long-term outcomes after TBI, so including a calculated neighborhood-level socioeconomic status variable in the database creates new opportunities for understanding how neighborhood-level social determinants of health contribute to outcomes and affect people's lives. Use of the TBIMS-NSDI could help us understand the consequences of different exposures, the differences in outcome trajectories, and the effectiveness of interventions *in different places*. This approach aligns not only with the Social Model of Disability but also with the U.S. Department of Health and Human Services' Health People initiative and the National Institute on Neurological Disorders and Strokes Social Determinants of Health Framework.^{5,6} Notably, because the TBIMS-NSDI was developed in the entire U.S. population, other studies with Census tract information may be able to link this variable to their studies for research, which also facilitates opportunities for cross-study harmonization and cohort comparisons.

The TBIMS-NSDI:

1. provides a standardized (to the U.S. population) composite measure of neighborhood socioeconomic disadvantage that
2. is already calculated as a single score included in the TBI Model Systems National Database, so no effort is required to acquire neighborhood-level data (e.g., other indices such as those described above) and link it to participants, so
3. it can be included in the *publicly* available TBI Model Systems National Database as it does not include any Protected Health Information (e.g., address).
4. May also be linked with other studies with Census Tract information.

References

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