



Transforming Episode Accountability Model (TEAM)

Community Deprivation Index (CDI) Calculation Specifications

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1 COMMUNITY DEPRIVATION INDEX CALCULATION OVERVIEW

The following document describes the specifications used to calculate the Community Deprivation Index (CDI) for the Transforming Episode Accountability Model (TEAM).¹ The CDI is a census block group-level deprivation index, calculated as a factor-weighted composite measure of 18 variables collected from the Census Bureau through the American Community Survey (ACS) 5-year estimates. Each census block group within the nation is ranked on a percentile scale of 1-100, 1 indicating the lowest level of deprivation and 100 indicating the highest level. The CDI methodology for TEAM is predicated from ACO REACH and modified slightly to accommodate TEAM's operational needs, such as using an internally-constructed CDI codebase to align with TEAM's production runs and support TEAM participant technical assistance.² CDI is used in TEAM as one of three components to construct the beneficiary economic risk adjustment factor.³ If a TEAM beneficiary's CDI is above the 80th percentile, the TEAM beneficiary is assigned a value of yes = 1 on the beneficiary economic risk adjustment factor.

In order to calculate the CDI for TEAM, the values (step 1) and the margins of error (step 2) of each of the 18 components are calculated first. Then, invalid values are flagged for replacement (step 3). Third, a shrinkage factor is applied to account for sampling error (step 4). Fourth, invalid data such as denominator values of 0 are replaced by values calculated for higher levels of geography (step 5). Fifth, components are standardized (step 6). Sixth, principal component analysis is applied to generate the factor weights and the raw CDI score is calculated (step 7). Then, the raw CDI score is standardized to have a mean of 100 and standard deviation of 20 (step 8). Lastly, the CDI values of each census block group are ranked and sorted into percentiles to receive a CDI score between 1-100 for each census block group (step 9). The specifications below describe the steps listed above in additional detail.

¹ Use of the CDI in TEAM was finalized in the FY26 IPPS/LTCH PPS Final Rule.

² ACO REACH CDI methodology is informed from this research (<https://pmc.ncbi.nlm.nih.gov/articles/PMC11629994/>) and outlined in (<https://www.cms.gov/files/document/aco-reach-py25-fin-op-ovw.pdf>)

³ The other two components are dual eligibility (receiving both full Medicare and Medicaid benefits) and eligibility for the Medicare Part D Low Income Subsidy (LIS).

2 INPUTS

Table 1 below contains the components used to calculate the CDI for TEAM. The components are derived from the American Community Survey (ACS) 5-year estimates. For Performance Year 1 (PY1), the ASC data used will be based on a 5-year estimate from 2019 to 2023.

Table 1: CDI components

	Component
1	12 years or less of education, no diploma, %
2	16+ years of schooling, %
3	Employed in white collar jobs, %
4	Families living below 100% of the federal poverty line, %
5	Crowding (households with more than 1 person per room), %
6	Households without high-speed internet, %
7	Households with no vehicle, %
8	Households with incomplete plumbing, %
9	Income disparity
10	Median household income (\$)
11	Median gross rent (\$)
12	Median home value (\$)
13	Median monthly mortgage (\$)
14	One-parent households, %
15	Owner occupied housing, %
16	Population living below 150% of the federal poverty line, %
17	Unemployed, %
18	Uninsured, %

3 STEPS TO CALCULATE THE CDI

For all sections below, the following notation will be used:

- j denotes the CDI components
- i denotes census block groups
- k denotes census tracts. Each census block group corresponds to a census tract.⁴ When i and k are used together, it should be interpreted as i^{th} census block group that corresponds to k^{th} census tract.

Step 1: Calculate the value of each component.

Each component of the CDI corresponds to a data table from the ACS. The numerator and denominator value of each component is calculated using specific items of the ACS data tables. Data are available at the census block group, census tract, county, and state levels.

For example, the numerator of component 1 (12 years or less of education, no diploma, %) is calculated using the sum of items B15003_002 to B15003_016, and the denominator is item B15003_001 (total population 25 years and older). All items used to calculate the numerator and denominator values of the 18 components are detailed in Appendix Table 2. The values for all components are calculated at all levels of geography (census block group, census tract, county, state).

- X_{ij} denotes the value for i^{th} block group and j^{th} component.
- Z_{jk} denotes the value for k^{th} tract and j^{th} component.

The following special considerations are made for the income disparity component:

- The income disparity component value conceptually represents the ratio of low-income households (income \leq \$20,000) to high-income households (income \geq \$100,000) in the specific block group.
- A numerator of 0 indicates that there are no low-income households in the block group.
- A denominator of 0 indicates that there are no high-income households in the block group.
- To calculate the values of the income disparity component, follow the steps below:
 - Calculate the ratio for all block groups that have non-zero numerator and denominator.
 - Identify the highest disparity ratio and lowest disparity ratio calculated in the previous step.

⁴ Census block groups are smaller geographic units than census tracts. One census block group contains between 600-3,000 people, and one census tract contains between 1,200-8,000 people, with the optimum size of 4,000 people. Each census block group corresponds to one census tract, and a cluster of census block groups forms a census tract.

- For cases where the numerator of the income disparity component is 0 (i.e. the ACS table indicates no households with low income), set the component value to equal the minimum disparity ratio from the previous step.
- For cases where the denominator of the income disparity component is 0 (i.e. the ACS table indicates no households with high income), set the component value to equal the maximum disparity ratio from the previous step.
- This approach captures the block groups with the greatest disparities by setting those values to the minimum/maximum values, rather than replacing those with the values for higher geographic levels.

Step 2: Calculate the Margin of Error (MOE) of each component. The MOE will be used in step 4 to apply shrinkage to the components.

- For components where only one item is used in the component calculation, use the MOE directly from the ACS data.⁵
- For components which are derived as proportions,⁶ denoting the numerator as X_1 and the denominator as X_2 calculate the MOE as:

$$MOE(P) = \frac{1}{X_2} \sqrt{[MOE(X_1)]^2 - \frac{X_1^2}{X_2^2} [MOE(X_2)]^2}$$

- If the value under the radical is negative or if the component is a ratio⁷, use the following formula instead:

$$MOE(P) = \frac{1}{X_2} \sqrt{[MOE(X_1)]^2 + \frac{X_1^2}{X_2^2} [MOE(X_2)]^2}$$

- If the numerator or denominator is composed of multiple items (e.g., X_1 is calculated as the sum of X_3 and X_4) then calculate the MOE as:

$$MOE(X_1) = \sqrt{[MOE(X_3)]^2 + [MOE(X_4)]^2}$$

- Note: For percentages, multiply the $MOE(P)$ by 100.

⁵ Components in this category are: median household income; median gross rent; median home value; median monthly mortgage.

⁶ Component in this category are: % with 12 years or less of education, no diploma; % with 16+ years of schooling; % employed in white collar jobs; % families below the poverty line; % households with more than 1 person per room; % households without high-speed internet; % households with no vehicle; % households with incomplete plumbing; % one-parent households; % owner-occupied housing; % below 150% of the poverty line; % unemployed; % uninsured.

⁷ Components in this category are: income disparities.

Step 3: Flag values that need replacement.

Identify values that will need to be replaced in Step 5 below. Set flag = 1 if any of the following conditions apply:

- The ACS data table value is invalid.⁸
 - Values with a + or a – at the end indicating that the median falls in the highest/lowest interval of an open-ended distribution will be replaced by the value +/- 1 (e.g., if the value in the ACS data table is \$250,000+ it will be replaced by \$250,001).
 - Other invalid values will be set to 0 at the block group level and will then be replaced with the tract (or higher geography) level information after the shrinkage calculation.
- The denominator for any component is calculated as 0.
- Census block group with excessively low population value: these block groups contain a population of fewer than 100 people (variable: B01001_E001) or fewer than 30 housing units (variable: B25032_E001).

Values flagged for replacement are not included in the shrinkage factor calculation below.

Step 4: Apply shrinkage to account for sampling error.

- Calculate sample variance (inter block group variance) for each component. X_{ij} represents the census block group value of component j for census block group i , and Z_{jk} represents the tract level value of component j for census tract k . There are b census block groups.

$$t_{jk}^2 = \left(\frac{1}{b-1}\right) \sum_{i=1}^b (X_{ij} - Z_{jk})^2$$

- For each component, calculate the standard error at the block group level using the margin of error:⁹

$$S_{ij} = \frac{MOE_{ij}}{1.645}$$

- For each component, the shrinkage adjusted estimate is the weighted average of the census block group and the census tract-level values:

⁸ [Notes on ACS Estimate and Annotation Values](#) outlines all invalid values in ACS data tables.

⁹ ACS estimates use 90% confidence intervals for margin of error. Standard error is calculated as MOE/z-score.

$$X_{ij}^* = w_{ij}X_{ij} + (1 - w_{ij})Z_{jk},$$

where w_{ij} is calculated as:

$$w_{ij} = \left(\frac{1}{S_{ij}^2}\right) / \left(\frac{1}{S_{ij}^2} + \frac{1}{t_{jk}^2}\right)$$

Note: Do not use weights (or use a weight = 1) if S_{ij} or t_{jk} is missing or zero.

Step 5: Replace invalid values from Step 3.

If a component has an invalid value for a level of geography, replace it with the value of the higher level of geography. The hierarchy between geographies is as follows: census block group < census tract < county < state. E.g., if a census block group has a missing value for a component, replace it with the tract-level value from Step 1.

Step 6: Standardize the components by subtracting their respective mean and dividing by the standard deviation.

More specifically, each of the component estimates with shrinkage applied are standardized to have a mean of 0 and a standard deviation of 1 across all block groups in the nation as follows:

$$X'_{ij} = \frac{X_{ij}^* - \mu_j}{\sigma_j}$$

where X_{ij}^* is the unstandardized value at the census block group level with shrinkage applied, and μ_j and σ_j are the mean and standard deviation of component j across all block groups. Note that all replaced values are included in the calculations.

Step 7: Conduct Principal Component Analysis.

Use the shrunk, replaced, and standardized data from Step 6 at the block group level¹⁰ and run principal component analysis to obtain the factor weight/loadings for each component.¹¹

Calculate the raw CDI score by multiplying each standardized component by its factor weight:

¹⁰ Please note that the values of some block groups have been replaced by values of the next highest level of geography. Principal Component Analysis is run on the block group level data.

¹¹ Principal Component Analysis standardizes the variables before calculating the factor weights, so the results are the same regardless of whether the standardized or the non-standardized components are used as input variables. Using standardized components is important for the calculation of the raw CDI score.

$$CDI_{raw} = \sum_{j=1}^{18} X'_{ij} \times PCA_{weight_j},$$

where PCA_{weight_j} is the factor weight for component j .

Step 8: Generate the standardized CDI scores.

Calculate the standardized CDI scores such that the mean is 100 and the standard deviation is 20:

$$CDI_{std} = 100 + 20 * \frac{CDI_{raw} - mean_{CDI}}{std_{CDI}}$$

Step 9: Convert the standardized CDI scores to a percentile ranking.

Ordering each census block group within the nation and assigning them their percentiles between 1-100. A high score indicates an area with the higher deprivation relative to other areas.

APPENDIX

Appendix Table 1: ACS Table Populations

Component	ACS Table	ACS Table Universe	Does Universe Include Group Quarters Population? ¹²
12 years or less of education, no diploma, %	B15003	Population 25 Years and Over	Yes
16+ years of schooling, %	B15003	Population 25 Years and Over	Yes
Employed in white collar jobs, %	C24010	Civilian Employed Population 16 Years and Over	Yes
Families living below 100% of the federal poverty line, %	B17010	Families	No
Crowding (households with more than 1 person per room), %	B25014	Occupied Housing Units	No
Households without high-speed internet, %	B28002	Households	No
Households with no vehicle, %	B25044	Occupied Housing Units	No
Households with incomplete plumbing, %	B25047	Housing Units	No
Income disparity	B19001	Households	No
Median household income (\$)	B19013	Households	No
Median gross rent (\$)	B25064	Renter-occupied Housing Units Paying Cash Rent	No
Median home value (\$)	B25077	Owner-occupied Housing Units	No

¹² Group quarters refer to facilities such as university housing, military quarters, or correctional facilities.

Component	ACS Table	ACS Table Universe	Does Universe Include Group Quarters Population? ¹²
Median monthly mortgage (\$)	B25088	Owner-occupied Housing Units	No
One parent households, %	B11003	Families	No
Owner occupied housing, %	B25003	Occupied Housing Units	No
Population living below 150% of the federal poverty line, %	C17002	Population for Whom Poverty Status is Determined	Some (some GQs are excluded such as military group quarters, college dormitories, institutionalized people)
Unemployed, %	B23025	Population 16 years and over	Yes
Uninsured, %	B27010	Civilian noninstitutionalized population	Some (college dormitories included, but correctional facilities, nursing homes, military are excluded)

Appendix Table 2: CDI Component to ACS Data Table Mappings

Note: The table below describes each component of the CDI, its corresponding ACS data table, the description of the ACS data table. The table also displays the items used to calculate the numerators and the denominators of the CDI component values.

Component	ACS Data Table	Table Name	Numerator Calculation	Denominator Calculation	Value Calculation with Description
12 years or less of education, no diploma, %	B15003	Educational attainment for the population over 25 years and over	sum of items B15003_002 to B15003_016	B15003_001	[No schooling (B15003_002) + Nursery school (B15003_003) + ... + 12th grade, no diploma (B15003_016)]/Total (B15003_001)
16+ years of schooling, %	B15003	Educational attainment for the population over 25 years and over	sum of items B15003_022 to B15003_025	B15003_001	[Bachelor's degree (B15003_022) + Master's degree (B15003_023) + Professional school degree (B15003_024) + Doctorate degree (B15003_025)]/Total (B15003_001)
Employed in white collar jobs, %	C24010	Sex by occupation for the civilian employed population 16 years and over	C24010_003 + C24010_027 + C24010_039 + C24010_063	C24010_001	[Male: Management, business, science, and arts occupations (C24010_003) + Male: Sales and office occupations (C24010_027) + Female: Management, business, science, and arts occupations (C24010_039) + Female: Sales and office occupations (C24010_063)]/Total (C24010_001)
Families living below 100% of the federal poverty line, %	B17010	Poverty status in the past 12 months of families by family type by presence of related children	B17010_002	B17010_001	Income in the past 12 months below poverty level (B17010_002) / Total (B17010_001)

Component	ACS Data Table	Table Name	Numerator Calculation	Denominator Calculation	Value Calculation with Description
Crowding (households with more than 1 person per room), %	B25014	Tenure by occupants per room	B25014_005 + B25014_006 + B25014_007 + B25014_011 + B25014_012 + B25014_013	B25014_001	[Owner occupied: 1.01 to 1.50 occupants per room (B25014_005) + Owner occupied: 1.51 to 2.00 occupants per room (B25014_006) + Owner occupied: 2.01 or more occupants per room (B25014_007) + Renter occupied: 1.01 to 1.50 occupants per room (B25014_011) + Renter occupied: 1.51 to 2.00 occupants per room (B25014_012) + Renter occupied: 2.01 or more occupants per room (B25014_013)]/Total (B25014_001)
Households without high-speed internet, %	B28002	Presence and types of internet subscriptions in household	B28002_003 + B28002_013	B28002_001	[Dial-up with no other type of Internet subscription (B28002_003) + No Internet access (B28002_013)]/Total (B28002_001)
Households with no vehicle, %	B25044	Tenure by vehicles available	B25044_003 + B25044_010	B25044_001	[Owner occupied: No vehicle available (B25044_003) + Renter occupied: No vehicle available (B25044_010)]/Total (B25044_001)
Households with incomplete plumbing, %	B25047	Plumbing facilities for all housing units	B25047_003	B25047_001	Lacking complete plumbing facilities (B25047_003)/Total (B25047_001)
Income disparity	B19001	Household income in the past 12 months (in 2021 inflation-adjusted dollars)	sum of items B19001_002 to B19001_004	sum of items B19001_014 to B19001_017	Log {100 * [Less than \$20,000 (B19001_002 + ... + B19001_004)/(\$100,000 to \$124,999 (B19001_014) + ... + \$200,000 or more (B19001_017))]} }

Component	ACS Data Table	Table Name	Numerator Calculation	Denominator Calculation	Value Calculation with Description
Median household income (\$)	B19013	Median household income in the past 12 months (in 2021 inflation-adjusted dollars)	B19013_001	N/A	Median household income in the past 12 months (in 2021 inflation-adjusted dollars) (B19013_001)
Median gross rent (\$)	B25064	Median gross rent (dollars)	B25064_001	N/A	Median gross rent (B25064_001)
Median home value (\$)	B25077	Median value (dollars)	B25077_001	N/A	Median value (dollars) (B25077_001)
Median monthly mortgage (\$)	B25088	Median selected monthly owner costs (dollars) by mortgage status	B25088_002	N/A	Median selected monthly owner costs (dollars) -- Housing units with a mortgage (dollars) (B25088_002)
One parent households, %	B11003	Family type by presence and age of own children under 18 years	(B11003_010 + B11013_016)	B11003_001	[Male w children and no spouse present (B11003_010) + Female w children and no spouse present (B11003_016)]/Total (B11003_001)
Owner occupied housing, %	B25003	Tenure	B25003_002	B25003_001	Owner occupied (B25003_002)/Total (B25003_001)
Population living below 150% of the federal poverty line, %	C17002	Ratio of income to poverty level in the past 12 months	sum of items C17002_002 to C17002_005	C17002_001	[Under .50 (C17002_002) + .50 to .99 (C17002_003) + 1.00 to 1.24 (C17002_004) + 1.25 to 1.49 (C17002_005)]/Total (C17002_001)
Unemployed, %	B23025	Employment status for the population 16 years and over	B23025_005	B23025_002	Unemployed (B23025_005)/Labor Force (B23025_002)

Component	ACS Data Table	Table Name	Numerator Calculation	Denominator Calculation	Value Calculation with Description
Uninsured, %	B27010	Types of health insurance coverage by age	B27010_017 + B27010_033 + B27010_050 + B27010_066	B27010_001	No insurance under 19 (B27010_017) + No insurance 19-34 (B27010_033) + no insurance 35- 65 (B27010_050) + no insurance 65 and over (B27010_066)/ Total (B27010_001)