The Multidimensional Deprivation Index Using Different Neighborhood Quality Definitions

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Abstract

The Census Bureau released a report on Multidimensional Deprivation in the spring of 2019. The Multidimensional Deprivation Index (MDI) consists of six dimensions: standard of living, health, education, economic security, housing quality, and neighborhood quality. One criticism of the MDI is that the neighborhood quality dimension was based on county level data. In order to be considered a deprived county, the county had to be in the bottom 10 percent of counties, as measured by crime, pollution, and access to food, for at least two out of the three metrics. Six alternative neighborhood quality measures, available at the census tract or block group level, are discussed in this paper. In order to evaluate these different neighborhood quality measures, three criteria are examined: the geographic level at which the measure is available; the relationship of the neighborhood quality measures to several county level social and economic characteristics; and the relationship of the neighborhood quality measures to tract level social and economic characteristics. Using these criteria, the original measure from the 2019 MDI report performs the worst and the national Area Deprivation Index (ADI) measure performs the best. When the national ADI is used to measure neighborhood quality, the MDI rate is not statistically different than the original MDI for the United States. However, the MDI rate is higher than the original MDI in 21 states, lower than the original MDI in 10 states and the District of Columbia, and not statistically different than the original MDI in19 states.

[1] This paper is released to inform interested parties of ongoing research and to encourage discussion of work in progress. Any views expressed are those of the author and not necessarily if the U.S. Census Bureau.
The Census Bureau reviewed this data product for unauthorized disclosure of confidential information and has approved the disclosure avoidance practices applied to this release. CBDRB-FY20-POP001-0135.

Introduction

The Census Bureau released its first report on multidimensional deprivation in the spring of 2019.[2] Multidimensional deprivation is a method of measuring how deprived people are in areas other than just income. The Multidimensional Deprivation Index (MDI) consists of six dimensions: standard of living, health, education, economic security, housing quality, and neighborhood quality. The first five of these dimensions are at the individual or household level, while neighborhood quality is measured at the county level. In order to be considered a deprived county, the county had to be in the bottom 10 percent of counties, as measured by crime, pollution, and access to food, for at least two out of the three categories. If the county is deprived, then everyone living in that county is deprived in the neighborhood quality dimension.

Neighborhood quality is an important dimension when measuring well-being for several reasons. First, there is evidence that among people in poverty, there are better outcomes for those living in less deprived areas than in more deprived areas. In a 2012 paper, Ludwig et al. found that moving from a high-poverty to a low-poverty neighborhood led to long-term improvements in adult physical and mental health and subjective well-being. Furthermore, they found that this movement did not change a family's financial situation. In a 2015 paper, Chetty and Hendren found that low-income children were more likely to succeed in counties with lower poverty, lower income inequality, lower crime, better schools, and a larger share of two-parent families. Neighborhood disadvantage may also influence health independently of a person's socioeconomic status: studies have suggested that, among people in poverty, those who live in extremely disadvantaged neighborhoods may have worse health outcomes than those who live in wealthier neighborhoods (Ludwig et al. 2011, Hu et al. 2018).

Second, there is evidence that there are independent negative effects for people living in deprived areas over and above the effects of living in a poor or deprived household. In Ludwig et al. 2013, the authors stated that "living in a disadvantaged social environment may depress life outcomes by, for example, shaping exposure to peer norms or access to resources such as schools or job referrals." Numerous studies have found that people living in more disadvantaged neighborhoods fare worse with respect to earnings, education, health, crime involvement, and other life outcomes (Jencks and Mayer 1990; Ellen and Turner 1997; Sampson, Raudenbush, and Earls 1997; Kawachi and Berkman 2003; Sampson, Morenoff, and Gannon-Rowley 2002; Sampson 2012).

This is important evidence for why a neighborhood quality measure is necessary when examining multidimensional deprivation. Despite this evidence, neighborhood quality as a measure of disadvantage or deprivation has largely been left out of multidimensional deprivation analysis. In my review, I only found one paper, other than the 2019 Census Bureau MDI report, that included an area measure as a means to measure disadvantage (Reeves et al. 2016). That paper defined disadvantaged areas as Public Use Microdata Areas (PUMAs) (areas within states containing at least 100,000 people) in which poverty exceeded 20 percent. The 2019 Census Bureau MDI report used counties to measure neighborhood quality which are mostly smaller than PUMAs.

However, for neighborhood quality to be a useful metric, it has to be defined and measured in a meaningful way. In the 2019 Census report, neighborhood quality was proxied by crime, pollution, and access to food at the county level. For small rural counties this may be reasonable, but even mid-sized

[2] See https://www.census.gov/content/dam/Census/library/publications/2019/demo/acs-40.pdf.

counties have a significant amount of heterogeneity that is not captured by county-level measures.[3] Furthermore, since the cutoff values were based on national numbers, there were a significant number of states which had no deprived counties.

The purpose of this paper is to choose an appropriate level of geography to measure neighborhoods, the census tract or block group level, and to review several different measures of neighborhood deprivation in order to determine how to measure neighborhood quality going forward.

The tract and block group level are examined since they are geographic units smaller than counties and neighborhood quality measures were available at these levels of geography. A Census tract is a statistical subdivision of a county which contains between 1,200 and 8,000 people with an ideal size of 4,000. A Census block group is a statistical division of a Census tract defined to contain between 600 and 3,000 people.

The Health Rankings and Roadmaps dataset used to create the original neighborhood quality dimension is only available at the county level. However, there are a number of alternative measures that are available at the census tract or block group level. These smaller geographic areas better approximate neighborhoods and allow for more variation and accuracy in the neighborhood quality dimension.

Six measures are discussed in this paper. The first alters the original neighborhood quality variable by adding the requirement that the census tract have a poverty rate in the top ten percent of U.S. census tracts measured by the American Community Survey as well as being in a county that is high in crime, high in pollution, or has poor access to food in order for the tract to be considered deprived.

The second measure uses the Area Deprivation Index (ADI) created by the University of Wisconsin-Madison. The third measure is the social deprivation index (SDI) created by researchers at the Robert Graham Center. The fourth measure is a generational mobility measure produce by Raj Chetty and Opportunity Insights at Harvard University. The final two measures are based on a state ADI and a state SDI which ranks areas in each state by decile without consideration to the national ADI or SDI.

In order to evaluate these different neighborhood quality measures, three criteria are examined: the geographic level for which the measure is available; the relationship of the neighborhood quality measures to several county social and economic characteristics; and the relationship of the neighborhood quality measures to tract level social and economic characteristics. Using these criteria, the original measure from the 2019 Census report performs the worst while the national ADI measure performs the best.

Section 2 of this paper presents the data and methods, section 3 shows the alternative neighborhood quality measures and MDI rates at the state and national level, section 4 is an evaluation of those neighborhood quality measures, and section 5 concludes.

Data and Methods

Before delving into alternate forms of the neighborhood quality dimension, the multidimensional deprivation index is defined and discussed in order to provide needed context. Table 1 lists the six

[3] The 2016 Reeves et al. paper used PUMAs which also contain significant heterogeneity.

dimensions as well as how they were defined in the 2019 Census report. The data for the standard of living, health, education, economic security, and housing quality dimensions comes from the 2018 American Community Survey. The crime, air quality, and food environment data[4] come from the 2018 Health Rankings and Roadmaps dataset.[5]

Table 1: The Multidimensional Deprivation Index Defined	
Dimensions	**How Dimensions are Defined**
Standard of living	In poverty according to the official poverty measure.
Education	Person is without a high school degree or GED[a]
Health	Predicted health status[b] is poor - based on a cutoff value for 3 for people under age 65 and 3.5 for people age 65 and over.
Economic Security	At least two of the following conditions hold[c]: • Lacked health insurance, • Unemployed[a], or • Average hours worked in a normal week per adult in the family was less than 20 hours and there was no retirement income in the family.
Housing Quality	At least two of the following conditions: • Lacked complete kitchen, • Lacked complete plumbing, • Overcrowded housing unit, or • High cost burden
Neighborhood quality	Lived in a county with at least two of the following: • High crime, • Poor air quality, or • Poor food environment
[a] For people age 18 and under, this is with respect to the household reference person. [b] There are no questions about health status in the ACS. However, data on both age and disabilities are available in both the ACS and the Current Population Survey Annual Social and Economic Supplement (CPS ASEC) and the CPS ASEC asks about health status. Health status is regressed on age and reported disabilities in the CPS ASEC and these values are used to predict health status on a scale of 1.5 to 5.2 (output of the regression) in the ACS. [c] For people age 65 and over, only one of these conditions is required.	

As mentioned in the introduction, the purpose of this paper is to investigate alternative measures of the neighborhood quality dimension.[6] There are two issues with the current measure of neighborhood quality. The first is that counties is not the appropriate geographic area to examine neighborhoods. The second is that crime, pollution, and food environment are not adequate measures of quality.

Six alternative neighborhood quality measures are discussed in this paper. The first measure addresses the first of the two issues by allowing the original measure to vary by census tract. More

[4] Crime is the number of violent crimes per 100,000 people; air quality is the average daily density of particulate matter; and food environment is an index based on proximity to grocery stores and access to a reliable food source.
[5] The County Health Rankings and Roadmaps dataset is compiled by a collaboration between the Robert Wood Johnson Foundation and the University of Wisconsin Population Health Institute. The rankings and the data are compiled from different sources and released on an annual basis. The 2018 rankings include data from 2012 to 2016. See www.countyhealthrankings.org for more information.
[6] For more information about the other MDI dimensions, see https://www.census.gov/content/dam/Census/library/publications/2019/demo/acs-40.pdf.

specifically, the original neighborhood quality variable is altered by adding the requirement that the census tract have a poverty rate in the top ten percent of U.S. census tracts at the national level measured by the American Community Survey as well as being in a county that is high in crime, high in pollution, or has poor access to food in order for the tract to be considered deprived. A census tract is only considered deprived if it is located in a county that meets one of the original three criteria and the census tract has a high poverty rate.

The second measure uses the Area Deprivation Index (ADI) created by the University of Wisconsin-Madison.[7] The ADI is an index of seventeen socioeconomic indicators from the American Community Survey 5-year sample at the block group level. The ADI score includes block group measures of education (percent with less than 9 years of education; percent with at least a high school diploma), employment (percent employed in a white-collar occupation; unemployment rate), income (median family income; income disparity;[8] percent below poverty level; percent below 150 percent of poverty level), housing (median home value; median gross rent; median monthly mortgage; home ownership rate), household composition (percent of single parent households), and household resources (percent without a car; percent without a telephone; percent without complete plumbing; percent of housing units with more than one person per room). The ADI measure is constructed by ranking the ADI score from low to high for the nation and grouping the block groups into bins corresponding to each 1 percent range of the ADI score. The national ADI ranks block groups from 1, least disadvantaged, to 100, most disadvantaged in the U.S.

The third measure is the social deprivation index (SDI) created by researchers at the Robert Graham Center which is a composite measure of seven demographic variables from the 5-year American Community Survey.[9] The variables included in the measure are: percent living in poverty, percent with less than 12 years of education, percent single-parent households, percent living in a rented housing unit, percent living in overcrowded housing unit, percent of households without a car, and percent non-employed adults under 65 years of age. Tracts are ranked, in the same way as the ADI, from 1, least disadvantaged, to 100, most disadvantaged, in the U.S.

The fourth measure is a generational mobility measure produce by Raj Chetty and Opportunity Insights at Harvard University. Opportunity Insights produces mean predicted outcomes for children with parents at different parts of the national household income distribution. The specific measure of mobility used in this paper is the percent of children ending up in the top 20 percent of the income distribution given parents at the 50th percentile of the income distribution. This is a reflection of the quality of the neighborhood children are being born into. A short description of each measure along with the geographic unit of analysis are presented in Table 2.

[7] This project was supported by National Institute on Aging Award (RF1AG057784 [PI Kind, MPI Bendlin]) and National Institute on Minority Health and Health Disparities Award (R01MD010243 [PI Kind]). This material is the result of work also supported with the resources and the use of facilities at the University of Wisconsin Department of Medicine Health Services and Care Research Program. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

[8] Defined as the ratio of households with income less than $10,000 to households with income greater than $50,000.

[9] For more information about the SDI, see https://www.graham-center.org/rgc/maps-data-tools/sdi/social-deprivation-index.html.

Table 2: Alternative Definitions of Neighborhood Quality		
Measure	**Definition**	**Geography**
Original measure	The county is in the bottom 10 percent of counties, as measured by crime, pollution, and access to food, for at least two out of the three categories.	County
Adjusted measure	The tract is in a county in the bottom 10 percent of counties, as measured by crime, pollution, or access to food, AND it is a high poverty (highest 10 percent of U.S.) census tract.	Tract
ADI	Block groups ranked from 1, least disadvantaged to 100, most disadvantaged in the country based on an index of 17 socioeconomic factors. A deprived block group has an ADI greater than 90.	Block group
SDI	Tracts ranked from 1, least disadvantaged to 100, most disadvantaged in the country based on an index of 7 socioeconomic factors. A deprived tract has an SDI greater than 90.	Tract
Mobility Index	Mobility is the chance of children ending up in the top 20 percent of the income distribution given parents at the 50th percentile of the income distribution. Tracts in the bottom 10 percent of mobility were considered deprived.	Tract
State ADI	Block groups ranked from 1, least disadvantaged to 10, most disadvantaged in each state based on an index of 17 socioeconomic factors. A deprived block group has an ADI equal to 10.	Block group
State SDI	Tracts ranked from 1, least disadvantaged to 10, most disadvantaged in each state based on an index of 7 socioeconomic factors. A deprived block group has an SDI equal to 10.	Tract

The final measures are state ranks based on the ADI and SDI. The state ADI, also created by the University of Wisconsin-Madison, ranks block groups in each state by decile, from 1 to 10, without consideration to the national ADI. The state SDI, created for the purposes of this paper, ranks tracts in each state by decile, from 1 to 10, without consideration to the national SDI. The state and national indexes allow for separate relative comparisons. For instance, a state may have no areas ranked as most disadvantaged in the U.S., but the state SDI will identify the relatively disadvantaged areas in the state.

In Table 3, some descriptive statistics of the neighborhood quality measures are shown along with the cutoff values for a deprived area. This table is useful in providing context to the cutoff values for each of the measures by viewing the minimum value, maximum value, and mean value of each measure.

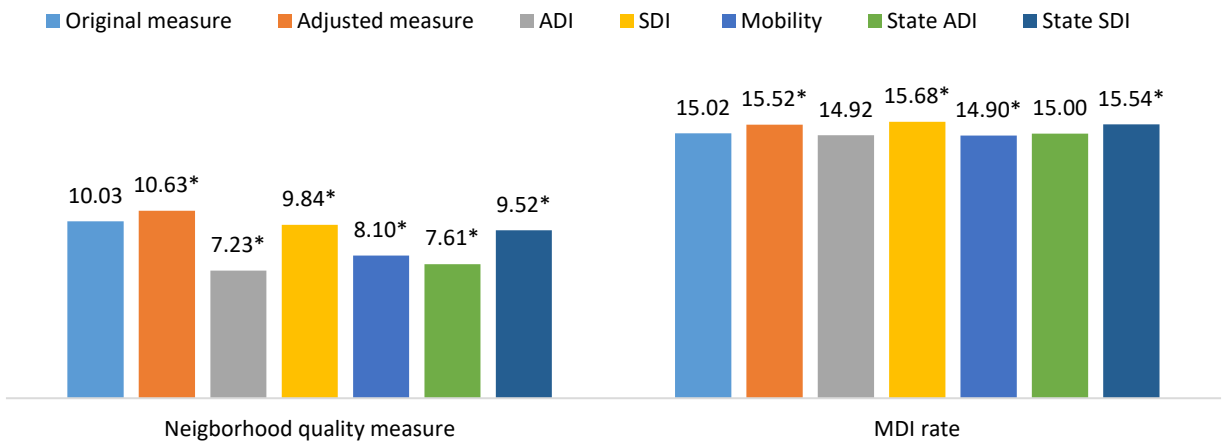
Table 3: Descriptive Statistics of the Neighborhood Quality Measures: 2018					
Measure	**Mean**	**S.E.**	**Min value**	**Max Value**	**Cutoff value**
Crime	382.30	0.0292	0	1820	>500
Pollution	10.09	0.0002	3	20	>11
Access to food	7.84	0.0001	0	10	<6
Tract poverty	12.01	0.0031	0	69	>17.25
ADI	46.47	0.0174	1	100	>90
SDI	49.95	0.0207	1	100	>90
Mobility	18.57	0.0035	0	78	<10.59
State ADI	5.11	0.0018	1	10	=10
State SDI	5.45	0.0022	1	10	=10
Note: Crime is the number of violent crimes per 100,000 people; pollution is the average daily density of particulate matter; and food environment is an index based on proximity to grocery stores and access to a reliable food source. Source: 2018 American Community Survey, 2018 Health Rankings and Roadmaps dataset, Neighborhood Atlas, Robert Graham Center, and opportunityinsights.org.					

Alternative Neighborhood Quality and MDI Results

In Figure 1, the percent of the U.S. population deprived in neighborhood quality along with the percent of the U.S. population deprived according to the MDI are listed for the original measure and each alternative measure of neighborhood quality.[10] Neighborhood deprivation is lower using the original measure compared to the adjusted measure, while the original measure shows higher neighborhood deprivation when using all other measures.

The MDI rate is higher than the original when using the adjusted measure and the SDI measures, lower than the original when using the mobility measure, and not significantly different than the original measure when using the two ADI measures. However, these national averages mask a significant amount of heterogeneity by state.

Figure 1: Alternative Neighborhood Quality Measures and MDI Rates: 2018



Note: * indicates difference between the measure and the original measure is statistically significant at the 90 percent confidence level.
Source: 2018 American Community Survey, 2018 Health Rankings and Roadmaps dataset, Neighborhood Atlas, Robert Graham Center, and opportunityinsights.org.

In Table 4, there are summary results for state differences of the alternative MDI rates from the original MDI rate. A listing of each MDI rate by state is in appendix Table A-1. There are a few important things to note. First, while the national MDI rates using the ADI measures are not significantly different than the original MDI rate, there are 21 (ADI) to 31 (state ADI) states in which the new MDI rates are significantly higher than the original MDI rate and 11 (ADI) to 13 (state ADI) states in which the new MDI rates are significantly lower than the original MDI rate. Second, while the national MDI rates using the adjusted measure and the SDI measures are significantly higher than the original MDI rate, there are 8

[10] For a table of these values including standard errors, see Table A-2.

(adjusted) to 10 (SDI) states in which the new MDI rates are lower than the original MDI rate when using these measures, and 8 (state SDI) to 20 (SDI) states in which the new MDI rates are not significantly different from original values.

Third, while the national MDI rate using the mobility measure is significantly lower than the original MDI rate, there are 15 states in which the new MDI rate is higher than the original MDI rate and 21 states in which the new MDI rate is not significantly different than the original MDI rate. Furthermore, the new MDI rates vary widely in magnitude as well as is shown by the range of percentage point differences.

Table 4: Comparisons of the Original MDI rate to the Alternative MDI Rates: 2018

	National	States and D.C.		
	Compared to original MDI	Higher than original MDI	Lower than original MDI	Range of statistically significant percentage point differences from original MDI
Adjusted measure	0.5 pp higher	19	8	-5.3 to 4.2
ADI	Not significantly different	21	11	-7.3 to 2.8
SDI	0.7 pp higher	21	10	-5.9 to 4.7
Mobility	0.1 pp lower	15	15	-6.2 to 4.4
State ADI	Not significantly different	31	13	-6.9 to 3.2
State SDI	0.5 pp higher	34	9	-6.2 to 2.8

Source: 2018 American Community Survey, 2018 Health Rankings and Roadmaps dataset, Neighborhood Atlas, Robert Graham Center, and opportunityinsights.org.

Focusing on specific states in Table A-1, there are 9 states (Arizona, Florida, Kansas, Massachusetts, Nevada, New Jersey, New York, Oklahoma, and South Carolina) in which all of the new MDI rates are significantly higher than the original MDI rate, 5 states (Alabama, Illinois, Michigan, Texas, and Wisconsin) in which all of the new MDI rates are significantly lower than the original MDI rate, and 7 states (Arkansas, California, Indiana, Louisiana, Maryland, North Carolina, and Ohio) in which at least one new MDI rate was higher and one new MDI was lower than the original MDI rate.

Evaluation of measures

In this section, the new neighborhood quality measures are evaluated based on three criteria: the geographic level for which the measure is available; the relationship of the neighborhood quality measures to several county variables; and the relationship of the neighborhood quality measures to tract level variables.

As shown in Table 2, the original measure is only available at the county level, the adjusted measure, the mobility measure, and the SDI measures are available at the Census tract level, and the ADI measures are available at the block group level. This first criteria is the main impetus for the writing of this paper. Counties do not adequately represent neighborhoods. Furthermore, one of the issues with the original neighborhood quality measure is that it only applied to a small number of counties in less than half of the states.

In Table 5, the number and percent of states, counties, and tracts with zero percent of the population living in deprived neighborhoods is presented for each neighborhood quality measure. This shows two things. First, measures at the tract and block group level allow for the inclusion of deprived areas that county level measures miss within states. Adding in the requirement of high tract poverty to the

original measure decreases the number of states without neighborhood deprivations from 54.9 percent to 23.5 percent. More states are included by this measure, but it still misses out on other states due to a portion of the measure being county based. There is only one measure, the SDI, which does not have any neighborhood deprivations for one state, Wyoming, while the remaining measures have at least some neighborhood deprivation in each state.[11]

Despite the original measure being calculated at the county level, there were no people living in deprived neighborhoods in 96.7 percent of counties. This is reduced by about 11 percentage points when using the adjusted measure, 27 to 31 percentage points when using the SDI scores, 41 percentage points when using mobility, and about 60 percentage points when using the ADI scores. There are two things going on here. The first is that these scores have different inputs. The second is that the new measures vary by tract or block group while the original measure only varies by county which means that the original measure is masking intra-county differences in neighborhood deprivation.

Finally, there is not a large difference in tract deprivation between the original and the adjusted measure: about 85-89 percent of tracts were not deprived. The SDI scores and mobility had about 70 percent of tracts with no deprivation while the ADI scores had just under 50 percent of tracts without deprivations. The higher percentage of counties and tracts without deprivations for the SDI measures and the mobility measure suggests that tract level neighborhood measures are masking intra-tract differences in neighborhood deprivation.

Based on this discussion, a Census tract or block group measure is preferred to a county measure. However, it is not immediately clear whether using tract level or block group level geography is better for approximating neighborhoods. The main advantages to block group level measures are that they can capture intra-tract differences in deprivation and they represent a more concise area. The importance of this can be seen in Figure 1 where the ADI measures are significantly lower than all the other measures. At least part of this difference is due to block groups having a higher level of homogeneity than Census tracts. The disadvantages of block groups is that they are small and therefore measured imprecisely. This may be an issue due to the ADI being based on 17 indicators. It also may lead to large year to year changes in deprivation that may only be based on a few households.

Table 5: Areas with no people living in deprived neighborhoods: 2018

	State		County		Tract	
	Number	Percent	Number	Percent	Number	Percent
Original measure	28	54.9	3,038	96.7	7,495	88.7
Adjusted measure	12	23.5	2,682	85.4	7,218	85.5
ADI	0	0.0	1,173	37.3	4,119	48.8
SDI	1	2.0	2,206	70.2	5,895	69.8
Mobility	0	0.0	1,749	55.7	5,819	68.9
State ADI	0	0.0	1,108	35.3	4,001	47.4
State SDI	0	0.0	2,068	65.8	5,879	69.6

Source: 2018 American Community Survey, 2018 Health Rankings and Roadmaps dataset, Neighborhood Atlas, Robert Graham Center, and opportunityinsights.org.

For the second criteria, six county level characteristics were taken from the 2018 Health Rankings and Roadmap dataset. Food insecurity is measured by the percent of the county that is food insecure from

[11] The State ADI and state SDI measures will have a deprived area in each state by definition.

Map the Meal Gap, which measures a lack of access to enough food for an active, healthy life for all household members and limited or uncertain availability of nutritionally adequate foods. Free or reduced price lunch is the percent of children eligible for free or reduced price lunch from the National Center for Education Statistics. Frequent physical (or mental) distress is identified as the percent of the days in the average month that people had poor physical (or mental) health days from the Behavioral Risk Factor Surveillance System. Social Associations is defined as the number of membership associations per 10,000 people from County Business Patterns. Income inequality is the ratio of household income at the 80th percentile to income at the 20th percentile from ACS 5-year estimates.

To evaluate the neighborhood quality measures, neighborhood quality deprivation rates are calculated at the county level for the original measure and the six alternative neighborhood quality measures. Simple correlations between county neighborhood quality deprivation rates and the county characteristics are calculated with county level weights[12] and presented in Table 6. The neighborhood measure with the strongest relationship to each county characteristic is in bold. The national ADI measure has the strongest relationship with food insecurity, frequent physical distress, and frequent mental distress. The national SDI measure has the strongest relationship with free or reduced price lunch, social associations, and income inequality. Furthermore, the national ADI measure was also strongly related to free or reduced price lunch and income inequality while the national SDI measure is not very strongly related to food insecurity or frequent physical or mental distress.

Table 6: Correlations of County Characteristics with County Neighborhood Deprivation Rates by Measure: 2018

	Food insecure	Free or reduced price lunch	Frequent physical distress	Frequent mental distress	Social associations	Income inequality
Original measure	0.3482	0.2996	0.1614	0.1718	-0.0721	0.2833
Adjusted measure	0.4461	0.4482	0.4014	0.3711	-0.0704	0.5035
ADI	**0.5531**	0.5238	**0.5873**	**0.5384**	-0.0755	0.4958
SDI	0.3429	**0.5933**	0.3613	0.2638	**-0.3235**	**0.6330**
Mobility	0.3738	0.2716	0.4363	0.5035	-0.1849	0.0230
State ADI	0.3811	0.4821	0.4378	0.3924	-0.0683	0.4394
State SDI	0.4259	0.5529	0.3774	0.3473	-0.1533	0.4850

Source: 2018 American Community Survey, 2018 Health Rankings and Roadmaps dataset, Neighborhood Atlas, Robert Graham Center, and opportunityinsights.org.

In order to adequately evaluate the neighborhood quality measures, ranks are created for the correlations of neighborhood quality with each county characteristic in Table 7. The neighborhood quality measure with the highest correlation with the county characteristic is set equal to one and the other measures are a percentage of the highest correlation. Then an average is calculated so one summary metric can be compared rather than comparing six different county correlations.[13] The national ADI measure has the highest average rank and the original measure has the lowest average rank. Assuming these characteristics are good measures of a poor quality county, the original measure performs relatively poorly and the national ADI measure performs the best for this criteria.

[12] A county weight is the sum total of all the person level weights in the county.

[13] This is not a statistical comparison about which correlations are higher or lower, but rather a method to evaluate how well each measure correlates with county social and economic characteristics.

Table 7: Ranks of Correlations of County Characteristics with County Neighborhood Quality Deprivation Rates: 2018							
	Food insecure	Free or reduced price lunch	Frequent physical distress	Frequent mental distress	Social Associations	Income inequality	Average rank
Original measure	0.63	0.50	0.27	0.32	0.22	0.45	0.40
Adjusted measure	0.81	0.76	0.68	0.69	0.22	0.80	0.66
ADI	**1.00**	0.88	**1.00**	**1.00**	0.23	0.78	0.82
SDI	0.62	**1.00**	0.62	0.49	**1.00**	**1.00**	0.79
Mobility	0.68	0.46	0.74	0.94	0.57	0.04	0.57
State ADI	0.69	0.81	0.75	0.73	0.21	0.69	0.65
State SDI	0.77	0.93	0.64	0.65	0.47	0.77	0.70
Source: 2018 American Community Survey, 2018 Health Rankings and Roadmaps dataset, Neighborhood Atlas, Robert Graham Center, and opportunityinsights.org.							

For the third criteria, the unemployment rate, labor force participation rate, percent without a high school degree, and percent with a college degree were calculated at the tract level from the 1-year ACS. To evaluate the neighborhood quality measures, simple correlations between tract neighborhood quality deprivation rates[14] and the tract characteristics are calculated using tract level weights[15] and presented in Table 8. The neighborhood quality measure with the strongest relationship to each tract characteristic is in bold.[16] The national SDI measure had the strongest relationship with the unemployment rate and the percent of people age 25 and over without a high school degree. The national ADI measure and the mobility measure are most strongly related to the labor force participation rate.

Table 8: Correlations of Tract Characteristics with Tract Neighborhood Quality Deprivation Rates: 2018				
	Unemployment rate	Labor force participation rate	Percent without a high school degree	Percent with a college degree
Original measure	0.2390	-0.0026	0.1317	-0.0276
Adjusted measure	0.4086	-0.1768	0.4038	-0.2199
ADI	0.4527	**-0.2708**	0.4359	**-0.2780**
SDI	**0.4953**	-0.0798	**0.6598**	**-0.2749**
Mobility	0.2378	**-0.2482**	0.1991	**-0.2676**
State ADI	0.4624	-0.2072	0.4365	**-0.2753**
State SDI	0.4576	-0.0757	0.5360	**-0.2567**
Source: 2018 American Community Survey 5-year, 2018 Health Rankings and Roadmaps dataset, Neighborhood Atlas, Robert Graham Center, and opportunityinsights.org.				

Similar to the county characteristics, ranks were created for the measures for each tract characteristic along with an average rank in Table 9. The national ADI measure has the highest average rank and the original measure has the lowest average rank. The original measure performs relatively poorly and the national ADI measure performs the best using tract characteristics.

[14] The ADI rates, measured at the block group level, are aggregated up to tract level rates.

[15] Tract level weights are the sum total of all person weights in the tract.

[16] Multiple bolded estimates in a column mean that those estimates are not significantly different from each other.

Table 9: Correlations of Tract Characteristics with Tract Neighborhood Quality Deprivation Rates: 2018					
	Unemployment rate	Labor force participation rate	Percent without a high school degree	Percent with a college degree	Average Rank
Original measure	0.48	0.01	0.20	0.10	0.20
Adjusted measure	0.82	0.65	0.61	0.79	0.72
ADI	0.91	**1.00**	0.66	**1.00**	0.89
SDI	**1.00**	0.29	**1.00**	0.99	0.82
Mobility	0.48	0.92	0.30	0.96	0.67
State ADI	0.93	0.77	0.66	0.99	0.84
State SDI	0.92	0.28	0.81	0.92	0.73
Source: 2018 American Community Survey.					

Conclusion

The primary purpose of this paper is to introduce and evaluate alternative measures of neighborhood quality for the multidimensional deprivation index. The neighborhood quality measure in the 2019 Census Bureau MDI report was based on crime, pollution, and food availability at the county level. There were two problems with this measure. The first is that a county is too large an area to reasonably capture variations in neighborhood. The second is that food, crime, and pollution may not be an appropriate measure for the overall quality of a neighborhood. The alternate measures in the paper address both of these issues.

Three criteria are used to evaluate the original neighborhood quality measure and the six alternative neighborhood quality measures: the geographic level for which the measure is available; the relationship of the neighborhood quality measures to several county characteristics; and the relationship of the neighborhood quality measures to tract level characteristics. Reviewing the three criteria together, there are two important conclusions. First, the original measure used in the 2019 MDI report performs the worst of all the measures examined in this paper. Second, the national ADI measure performs the best of all the measures reviewed in this paper. When the national ADI is used to measure neighborhood quality, the MDI rate is not statistically different than the original MDI for the United States. However, the MDI rate is higher than the original MDI in 21 states, lower than the original MDI in 10 states and the District of Columbia, and not statistically different than the original MDI in19 states.

A secondary purpose is to emphasize the importance of including a neighborhood quality dimension measured over a small geographic area in the calculation of multidimensional deprivation indices. The introduction to this paper demonstrates the need for a crossover between the neighborhood quality and the multidimensional deprivation literatures.

In the future, I plan to update the 2019 MDI report, which has estimates for 2009 through 2017, with a new report which includes the national ADI measure as a replacement for the original neighborhood quality measure as well as new estimates for 2018 and 2019.[17] Based on the results of this paper, I do not expect this to change the national MDI rate significantly, but state MDI rates will differ. I also plan to examine the relationship between MDI rates and different outcomes at the county level: volunteerism, health outcomes, voting behavior, civic engagement, and internet accessibility and usage.

[17] In this paper, the 2015 ADI was used because that was all that was available. I am in the process of getting access to the annual ADI for 2009 through 2018 in order to use an annually updated new ADI rate for each year.

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Appendix

Table A-1: MDI Rates Using Different Neighborhood Quality Measures: 2018														
	Original		Adjusted		ADI		State ADI		SDI		State SDI		Mobility	
State	Est.	s.e.	Est.	s.e.	Est.	s.e.	Est.	s.e.	Est.	s.e.	Est.	s.e.	Est.	s.e.
United States	15.02	0.05	15.52	0.05	14.92	0.05	15.00	0.05	15.68	0.05	15.54	0.05	14.90	0.05
Alabama	21.74	0.29	19.97	0.28	17.96	0.27	16.84	0.27	17.01	0.28	17.54	0.27	16.46	0.27
Alaska	11.40	0.63	15.00	0.64	11.66	0.63	13.60	0.67	12.29	0.64	13.94	0.66	11.02	0.63
Arizona	13.81	0.23	14.82	0.24	16.50	0.24	15.87	0.24	18.15	0.25	16.59	0.25	17.64	0.24
Arkansas	17.48	0.39	18.65	0.40	17.81	0.41	16.46	0.41	16.78	0.39	17.26	0.39	16.01	0.39
California	18.51	0.11	19.82	0.10	17.26	0.11	18.38	0.10	20.94	0.11	18.89	0.10	20.72	0.10
Colorado	9.20	0.21	9.52	0.22	10.19	0.23	11.18	0.24	10.49	0.24	11.93	0.23	10.00	0.22
Connecticut	11.43	0.25	11.43	0.25	12.03	0.25	13.24	0.28	14.04	0.29	13.58	0.28	13.47	0.25
Delaware	11.91	0.57	12.84	0.59	12.25	0.58	13.35	0.58	12.29	0.59	13.56	0.57	11.13	0.58
District of Columbia	20.80	0.89	16.88	0.81	17.91	0.82	19.10	0.85	21.61	0.86	18.10	0.85	19.89	0.83
Florida	13.48	0.13	15.29	0.14	15.40	0.15	15.11	0.15	15.80	0.14	15.80	0.14	15.53	0.13
Georgia	16.73	0.20	16.77	0.20	15.35	0.20	14.59	0.20	15.56	0.19	15.56	0.19	15.19	0.22
Hawaii	9.47	0.41	9.47	0.41	10.44	0.43	12.64	0.43	10.07	0.43	11.82	0.43	9.21	0.42
Idaho	9.68	0.37	9.68	0.37	10.34	0.38	11.27	0.39	10.01	0.38	12.02	0.42	9.26	0.40
Illinois	20.46	0.18	15.17	0.17	13.15	0.16	13.57	0.16	14.57	0.17	14.25	0.17	14.23	0.16
Indiana	14.78	0.23	15.35	0.24	14.25	0.23	13.87	0.23	14.02	0.23	14.57	0.22	13.57	0.23
Iowa	9.66	0.27	9.66	0.27	10.43	0.26	11.40	0.27	10.32	0.27	11.96	0.26	9.79	0.26
Kansas	10.51	0.27	12.16	0.27	12.43	0.28	12.42	0.28	11.75	0.27	13.25	0.27	11.22	0.28
Kentucky	18.69	0.29	18.15	0.29	18.31	0.28	17.39	0.27	17.09	0.28	17.94	0.28	16.53	0.31
Louisiana	19.93	0.30	21.89	0.30	19.46	0.30	18.13	0.31	19.46	0.29	18.71	0.30	18.88	0.31
Maine	10.67	0.34	10.67	0.34	11.36	0.35	12.40	0.37	11.05	0.34	12.51	0.36	10.37	0.35
Maryland	11.89	0.26	10.12	0.25	10.79	0.26	11.63	0.25	11.41	0.24	12.49	0.24	10.93	0.25
Massachusetts	11.22	0.15	13.36	0.17	11.96	0.15	13.18	0.16	13.80	0.17	13.67	0.17	13.47	0.16
Michigan	16.52	0.17	16.11	0.17	15.82	0.17	14.30	0.15	14.78	0.16	14.99	0.16	14.47	0.16
Minnesota	8.83	0.19	8.83	0.19	9.28	0.19	10.30	0.18	9.75	0.19	10.84	0.20	9.36	0.19
Mississippi	19.28	0.38	21.91	0.40	21.45	0.36	19.02	0.39	20.32	0.36	19.71	0.37	19.61	0.40
Missouri	12.84	0.19	14.27	0.21	13.53	0.20	13.32	0.20	13.00	0.20	14.01	0.21	12.60	0.21
Montana	10.35	0.43	10.51	0.43	10.96	0.46	11.59	0.49	10.32	0.42	11.96	0.48	9.50	0.44
Nebraska	9.21	0.29	9.25	0.29	10.12	0.30	10.77	0.31	10.39	0.31	11.67	0.32	9.78	0.32
Nevada	13.18	0.29	14.71	0.31	15.53	0.30	14.97	0.30	17.20	0.33	15.73	0.32	16.54	0.29
New Hampshire	8.12	0.30	8.12	0.30	8.23	0.29	9.52	0.32	8.57	0.29	9.80	0.30	8.00	0.29
New Jersey	11.43	0.18	12.60	0.17	12.17	0.18	13.44	0.18	14.61	0.19	13.82	0.18	14.24	0.17
New Mexico	20.85	0.52	21.90	0.50	20.72	0.51	19.76	0.51	19.53	0.51	19.82	0.51	18.50	0.53
New York	16.09	0.15	20.27	0.15	18.91	0.16	18.46	0.16	20.75	0.15	18.34	0.15	20.45	0.15
North Carolina	14.42	0.21	13.41	0.21	14.16	0.21	14.34	0.22	14.86	0.21	15.29	0.21	14.44	0.23
North Dakota	8.06	0.48	8.16	0.47	8.79	0.49	9.57	0.47	8.25	0.47	9.86	0.45	7.31	0.47
Ohio	14.78	0.18	16.06	0.18	14.71	0.18	14.08	0.18	14.47	0.19	14.65	0.19	14.09	0.19
Oklahoma	13.34	0.24	16.21	0.26	15.71	0.27	15.16	0.27	15.05	0.25	15.96	0.27	14.55	0.25
Oregon	12.36	0.30	12.39	0.30	13.17	0.30	14.32	0.29	13.62	0.30	14.57	0.29	13.02	0.29
Pennsylvania	14.24	0.16	14.08	0.17	13.48	0.16	13.59	0.16	13.79	0.15	14.10	0.16	13.48	0.15
Rhode Island	13.53	0.62	13.53	0.62	14.14	0.60	15.42	0.61	17.59	0.65	15.65	0.61	16.29	0.61
South Carolina	13.52	0.25	15.87	0.27	15.67	0.27	15.08	0.27	15.04	0.26	15.74	0.27	14.52	0.28
South Dakota	10.67	0.46	11.87	0.44	12.04	0.47	12.57	0.46	11.74	0.43	12.46	0.43	10.89	0.46
Tennessee	16.80	0.25	16.49	0.24	16.15	0.23	16.00	0.24	16.23	0.24	16.61	0.25	15.75	0.25
Texas	18.29	0.13	17.32	0.13	17.61	0.15	16.55	0.15	17.51	0.15	17.14	0.14	17.21	0.14
Utah	7.72	0.26	7.78	0.26	8.25	0.26	9.42	0.28	8.15	0.26	10.01	0.28	7.62	0.26
Vermont	10.74	0.56	10.74	0.56	10.83	0.56	12.13	0.61	10.97	0.56	11.97	0.59	9.86	0.56
Virginia	10.50	0.20	11.53	0.20	11.14	0.21	12.07	0.21	11.24	0.20	12.71	0.22	10.84	0.21
Washington	10.30	0.19	10.51	0.19	11.08	0.19	12.71	0.20	11.29	0.19	12.63	0.20	10.91	0.19
West Virginia	15.81	0.46	16.84	0.49	18.01	0.50	17.31	0.48	16.28	0.49	17.64	0.49	15.31	0.48
Wisconsin	12.45	0.19	11.59	0.18	10.56	0.19	11.58	0.20	11.04	0.18	11.92	0.18	10.68	0.19
Wyoming	8.72	0.65	8.72	0.65	9.24	0.65	10.08	0.67	8.72	0.65	10.49	0.72	7.42	0.66
Source: 2018 American Community Survey.														

Table A-2: Alternative Neighborhood Quality Measures and MDI Rates: 2018				
	Neighborhood quality measures		MDI rates	
Measure	**Estimate**	**S.E.**	**Estimate**	**S.E.**
Original measure	10.03	0.0033	15.02	0.0482
Adjusted measure	10.63	0.0161	15.52	0.0485
ADI	7.23	0.0242	14.92	0.0500
SDI	9.84	0.0259	15.68	0.0484
Mobility	8.10	0.0225	14.90	0.0474
State ADI	7.61	0.0260	15.00	0.0498
State SDI	9.52	0.0243	15.54	0.0478
Source: 2018 American Community Survey.				