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Introduction of an Area Deprivation Index Measuring Patient Socio-economic Status in an Integrated Health System: Implications for Population Health

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Abstract

Introduction: Intermountain Healthcare is a fully integrated delivery system based in Salt Lake City, Utah. As a learning healthcare system with a mission of performance excellence, it became apparent that population health management and our efforts to move towards shared accountability would require additional patient-centric metrics in order to provide the right care to the right patients at the right time. Several European countries have adopted social deprivation indices in measuring the impact that social determinants can have on health. Such indices provide a geographic, area-based measure of how socioeconomically deprived residents of that area are on average. Intermountain's approach was to identify a proxy measure that did not require front-line data collection and could be standardized for our patient population, leading us to the area deprivation index or ADI. This paper describes the specifications and calculation of an ADI for the state of Utah. Results are presented along with introduction of three use cases demonstrating the potential for application of an ADI in quality improvement in a learning healthcare system.

Case Description: The Utah ADI shows promise in providing a proxy for patient-reported measures reflecting key socio-economic indicators useful for tailoring patient interventions to improve health care delivery and patient outcomes. Strengths of this approach include a consistent standardized measurement of social determinants, use of more granular block group level measures and a limited data capture burden for front-line teams. While the methodology is generalizable to other communities, results of this index are limited to block groups within the state of Utah and will differ from national calculations or calculations for other states. The use of composite measures to evaluate individual characteristics must also be approached with care. Other limitations with the use of U.S. Census data include use of estimates and missing data.

Conclusion: Initial applications in three meaningfully different areas of an integrated health system provide initial evidence of its broad applicability in addressing the impact of social determinants on health. The variation in socio-economic status by quintile also has potential for clinical significance, though more research is needed to link variation in ADI with variation in health outcomes overall and by disease type.

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Keywords

Learning health system, patient-reported outcomes, data analysis method, individual who live in rural areas, individuals who live in inner-city areas, population health, health services research, delivery of health care, patient-centered care

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eGEMs
Generating Evidence & Methods to improve patient outcomes

Introduction of an Area Deprivation Index Measuring Patient Socioeconomic Status in an Integrated Health System: Implications for Population Health

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ABSTRACT

Introduction: Intermountain Healthcare is a fully integrated delivery system based in Salt Lake City, Utah. As a learning healthcare system with a mission of performance excellence, it became apparent that population health management and our efforts to move towards shared accountability would require additional patient-centric metrics in order to provide the right care to the right patients at the right time. Several European countries have adopted social deprivation indices in measuring the impact that social determinants can have on health. Such indices provide a geographic, area-based measure of how socioeconomically deprived residents of that area are on average. Intermountain's approach was to identify a proxy measure that did not require front-line data collection and could be standardized for our patient population, leading us to the area deprivation index or ADI. This paper describes the specifications and calculation of an ADI for the state of Utah. Results are presented along with introduction of three use cases demonstrating the potential for application of an ADI in quality improvement in a learning healthcare system.

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Introduction

Health care organizations continue moving toward more patient-centered approaches to care in an effort to improve patient health and achieve Triple Aim objectives.[1] Patient-centered approaches to care require more complete patient-reported measures that describe not only the immediate episode of care but characterize the patient's life course and circumstances, which can influence patient health outcomes.[2] Many electronic medical record systems are not designed to capture patient-reported measurement information in structured ways. Manual collection systems can be inefficient and risk burdening frontline clinicians and patients. Identifying efficient methods for capturing and utilizing patient-reported measures, including measures of social determinants, could fill an important gap in clinicians' understanding of patient health risks and in determining best approaches to care.[3]

Intermountain Healthcare (Intermountain) is a fully integrated delivery system based in Salt Lake City, Utah with 22 hospitals, 185 outpatient clinics, and an owned health plan that provides services to upward of 50 percent of the Utah population. As a learning health care system with a mission of performance excellence, Intermountain adapted G.K. Singh's Area Deprivation Index (ADI) as a proxy measure for socioeconomic status to capture patient-level social risk factors not currently available in clinical information systems. Geographic deprivation indices based upon census data have been developed, validated, and used in Western Europe to characterize an individual's socioeconomic condition given their address of residence in support of ongoing public health initiatives.[4] Use of geographic indices in the United States for public health and for quality improvement in health care settings is limited.[5-6]

The primary hypothesis is that a surrogate measure of social determinants such as an ADI is useful within a health care context for planning, research, and clinical practice. This paper describes the specifications and calculation of an ADI for the state of Utah using an approach developed by Singh.[7] Results are presented along with the introduction of three use cases demonstrating the application of an ADI in quality improvement in a learning health care system.

In this paper, the terms "social risk factors" and "social determinants" are used interchangeably to describe those social processes and social relationships, including socioeconomic position, which may influence key health outcomes.[8] ADI is primarily focused on the measurement of economic

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characteristics of a neighborhood, though there are social components. The terms "deprivation" and "material deprivation" describe neighborhood characteristics being measured using the ADI and equate generally to socioeconomic position.[2]

Case Description/Methods

Several European countries have adopted deprivation indices in measuring the impact that social determinants can have on health. Such indices provide a geographic area-based measure of the average degree to which residents of that area are socioeconomically deprived A similar measure was developed and validated by Singh (2003) that uses 17 United States Census measures including the following: education, employment, income and poverty, and housing—to characterize the level of deprivation by neighborhood.[8] The Census indicators in the Singh index were identified using factor analysis, and were selected for their theoretical relevance and on the basis of empirical research linking United States Census measures with mortality.[8] Factor score coefficients (hereafter referred to as "Singh coefficients") were used to weight each of the 17 Census indicators comprising the index.[8] Specific measures by category from the United States Census, along with the relevant Census tables used to capture United States Census data, are listed in Table 1. The ADI has been associated with increased prevalence of adverse health and health care outcomes.[9] Other deprivation indices have shown similar results.[2,4-6,7]

For this study the ADI was generated for each Utah Census block group (BG) in existence (n=1,690) as of the 2013 (ACS). The 2009–2013 American Community Survey (ACS) five-year estimates were the primary source of data used to generate the ADI. The ACS uses a continuous measurement approach to data collection and is updated annually using a smaller population sample (about 2.5 percent of the population versus 16.7 percent for the historical decennial long form).[10] The five-year ACS estimates provide more stable estimates of demographic characteristics for small geographic areas such as BGs.

Intermountain elected to generate and analyze ADI information at the BG level, as this provides the most detailed measure of ADI feasible and would allow Intermountain to examine differences in ADI within areas served by individual Intermountain hospitals. The BG is the smallest geographic entity for which the ACS tabulates and publishes sample data. Each BG consists of between one and nine Census blocks with between 600 and 3,000 residents. Each Census tract contains at least one BG, and BGs are uniquely numbered within the Census tract. Within the standard Census geographic hierarchy, BGs never cross state, county, or Census tract boundaries—but can cross the boundaries of any other geographic entity.[11] Intermountain patients were assigned an ADI score based upon the Census BG of their residence. Address of residence was based upon the most recent address of record.

The BG-level factor coefficients for the original Singh ADI were calculated in 2003 based upon 1990 United States Census data.[8-9] These coefficients were subsequently updated by the University of Wisconsin–Madison based upon 2000 Census results. The year 2000 coefficients were made available by the University of Wisconsin–Madison and used in our updated Utah ADI calculation.

Calculation of the Utah ADI followed a three-step process:

1. The first step required calculation of the base score for each BG (n=1,690). This was done by multiplying each of the 17 United States Census indicators for a particular BG by their applicable Singh coefficient. The overall base score for the BG was then calculated by summing the 17 weighted measures for each BG.

2. The second step involved converting the base score to a standardized base score. This was done for each BG by dividing the difference between the individual BG base score (b) and the Utah BG population mean base score (p) by Utah BG population standard deviation (sp).

$$Std\ Base = \frac{b-p}{s_p}$$

   The sample mean is the individual BG base value (i.e., sum of the weighted 17 measures). The population mean is the mean value of the sum of all the individual BG base values. The population standard deviation is the standard deviation of the sum of the individual BG base values. The population mean and standard deviation values were based only upon Utah.
3. The third step involved adjusting the standardized value to a base mean of 100 and a standard deviation of 20. This was done by taking the defined mean value (100) plus the standardized value for each BG calculated in step 2 multiplied by the defined standard deviation (20).

A sample calculation of a Utah ADI score for a BG is presented in Table 1. BGs can then be grouped or stratified as needed for comparison purposes.

Associating a patient address of residence with a BG was done by identifying the cohort of patients receiving treatment at an Intermountain facility from 1994 to August 2015 (n=5.7 million patients) and identifying their last known address. Patient's self-reported addresses are recorded electronically by employees as part of the patient registration process associated with each encounter. This leads to variation in how common addresses may be recorded. From the patient population, a file was generated containing approximately 2.1 million unique address text strings for the purpose of matching each address to a unique Census BG code. This address file could contain multiple, different address text strings that correspond to the same unique address. For example, if two members of a family living at the same address reported their address at registration in a slightly different format, two addresses were generated. The address file was securely shared based on a Business Associate Agreement with the University of Utah GIS Lab for geocoding.

Addresses were cleaned using several algorithms to match the city to the list of standardized city names provided by the United States Census and United States Postal Service. Street names and house numbers were parsed and extraneous information, such as apartment numbers, were removed. The cleaned addresses were geocoded using three address locators: the most current state roads feature class and an incomplete set of address points for the state, (both provided by the Utah Automatedgis.utah.gov), and the TomTom 2007 street network, using ArcGIS (version 10.3, Redlands, Calif.). The 2007 file predates "9-1-1" readdressing in Utah; thus it was possible to geocode older addresses that had been subsequently updated. The quality of each geocoded point was assessed by comparing each element of the original cleaned address to the address associated with the geocoded point. The coordinates from the address locator that produced the most accurate match were used as the patient's residential location.

These points were spatially joined to the 2000 United States Census BG feature class, and the ADI for that BG was assigned to that address. These addresses were subsequently relinked to the patient file. The data tables that associate ADI with a patient are maintained in the Intermountain electronic data warehouse (EDW). Included in the ADI calculation table are all the individual census elements by BG used to calculate the ADI. Data analysts interested in using the ADI data tables to support information applications request access.

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Table 1. Sample Calculation of the Utah Area Deprivation Index Score for a Census Block Group (Minor calculation differences due to rounding.)

CATEGORY	US CENSUS INDICATOR	2013 ACS OR 2010 SF1 CENSUS TABLE REFERENCE	2010/2013 CENSUS RESULT	2000 SINGH COEFFICIENT	BASE SCORE
Poverty	Median family income, $	B19113	36,250.00	(0.1082)	(3,922.250)
	Income disparity	B19001	1.19	0.0823	0.098
	Families below poverty level, %	B17010	0.00	0.1074	0.000
	% population below 150% poverty threshold, %	C17002	0.50	0.1157	0.057
	Single parent households with dependents <18, %	SF1P20	0.73	0.0810	0.059
	Households without a motor vehicle, %	B25044	0.02	0.0806	0.002
	Households without a telephone, %	B25043	0.11	0.0809	0.009
	Occupied housing units without complete plumbing, %	B25016	0.00	0.0422	0.000
Housing	Owner occupied housing units, %	B25003	0.41	(0.0708)	(0.029)
	Households with >1 person per room, %	B25014	0.00	0.0731	0.000
	Median monthly mortgage, $	B25088	996.00	(0.0823)	(81.941)
	Median gross rent, $	B25064	706.00	(0.0675)	(47.683)
	Median home value, $	B25077	183,500.00	(0.0764)	(14,021.235)
Employment	Employed person 16+ in white collar occupation, %	C24010	0.31	(0.0942)	(0.029)
	Civilian labor force unemployed (aged 16+), %	B23025	0.06	0.0826	0.005
Education	Population aged 25+ with <9yr education, %	B15003	0.02	0.0969	0.002
	Population aged 25+ with at least a high school education, %	B15003	0.88	(0.1090)	(0.096)
Total base score					(18,073.03)
Population base score mean (All block groups in Utah)					(24,539.59)
Population base score standard dev (All block groups in Utah)					10,835.40
Standardized base score					0.597
Area deprivation score					111.9
Rounded area deprivation score					112

Block Group 1, Census Tract 1001, Salt Lake County, Utah 490351001001.00

Descriptive statistical methods were applied to evaluate the reliability of calculated results. To further evaluate the potential value of classifying Census characteristics by quintile, a one-way analysis of variance (ANOVA) was performed by Census indicator to measure statistical differences separately for each of the 17 Census indicators by quintile.

Findings

Utah had an estimated population of 2.9 million—representing 0.9 percent of the United States population as of 2013. When compared with the general population of the United States, Utah is younger and less racially diverse, with significantly higher numbers of children <18 years of age. Utah residents have slightly higher levels of home ownership with median home values that are about 20 percent higher than national averages. The number of persons per household is meaningfully higher than national averages. Mean household income is 11 percent higher than the national average ($58,821versus $53,046). As a result, poverty rates in Utah are slightly lower than national averages (13 versus 15 percent). High school graduation rates and percentage of people with a college education are comparable with national averages.[12]

The Utah population is distributed among 1,690 BGs as of the 2010 United States Census (1,686 of them were populated). Utah BGs had a mean population of 1,639 (SD: 864) ranging from 25 to 11,672 people. The population interquartile range (25^{th}–75^{th} percentile) was 1,142–1,933 people per BG. The average BG in Utah includes 521 households and 395 families. The mean Utah BG ADI score was 100 (SD: 19.6) with a median score of 104. The Utah BG ADI scores ranged between -40.0 and 139.4, suggesting substantial disparity between those least- and most deprived. The distribution is left-skewed with a substantial tail among the least deprived BGs (first quintile ranges from -40.0 to 88.3). Grouping the ADI scores by quintile (one to five, with one being least deprived), mean deprivation scores by quintile ranged from a mean score of 69.9 in the first quintile (least deprived) to 118.9 in the fifth quintile (most deprived). A profile of the BG population by ADI is included in Table 2. Figure 1 characterizes the individual Census indicators by BG.

Conducting a one-way ANOVA, statistically significant differences were identified by quintile separately for each of the 17 Census indicators ($p<.001$). A mean BG level profile is noted in Table 3.

Regarding the ratio of Census indicator values by quintile, observed differences between the first quintile (least deprived) and fifth quintile (most deprived) were substantial, suggesting meaningful variation in material deprivation that may have an impact on population health and health care delivery.

A review of specific measures of income and poverty, on an unadjusted basis, shows that people living in more deprived areas have mean incomes less than half of those living in least deprived areas (40 percent). Differences in income levels by quintile increase further, when considering only disposable income (mean family income less median monthly mortgage value). Forty percent of people in most deprived areas live below 150 percent of the Federal Poverty Level (20 percent live below 100 percent of the Federal Poverty Level) and are 3 to 5 times more likely than those in least deprived areas to live in poverty. They are 3.8 times more likely to not own a car, which suggests they would have challenges with accessing medical care.

With regard to social support measures, 13 percent of people living in the most deprived areas were single parents with dependent children, a more than 2.3 times higher prevalence than for those people living in least deprived areas.

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Table 2. Overall Utah Area Deprivation Index Scores by Block Group

MEASURES, PER BLOCK GROUP	OVERALL	AREA DEPRIVATION INDEX QUINTILES				
		1 (LEAST DEPRIVED)	2	3	4	5 (MOST DEPRIVED
Block group count	1,686.0	338.0	337.0	337.0	337.0	337.0
Mean count, people	1,639.0	1,626.0	1,886.0	1,728.0	1,529.0	1,427.0
Mean count, households	521.0	492.0	587.0	541.0	489.0	493.0
Mean count, families	395.0	406.0	465.0	416.0	358.0	329.0
ADI SCORE:						
Mean	100.0	69.9	94.6	104.1	110.5	118.9
Median	104.0	77.2	94.6	104.3	110.3	117.2
Standard Deviation	19.6	21.4	3.2	2.2	1.8	4.9
Minimum	(40.0)	(40.0)	88.5	100.1	107.6	113.8
25th percentile	91.9	65.5	91.9	102.3	108.9	115.4
75th percentile	104.2	83.4	97.4	105.9	112.1	121.0
Maximum	139.4	88.3	100.0	107.6	113.8	139.4

Figure 1. Mean Value of Census indicators by Area Deprivation Index Quintile for Utah

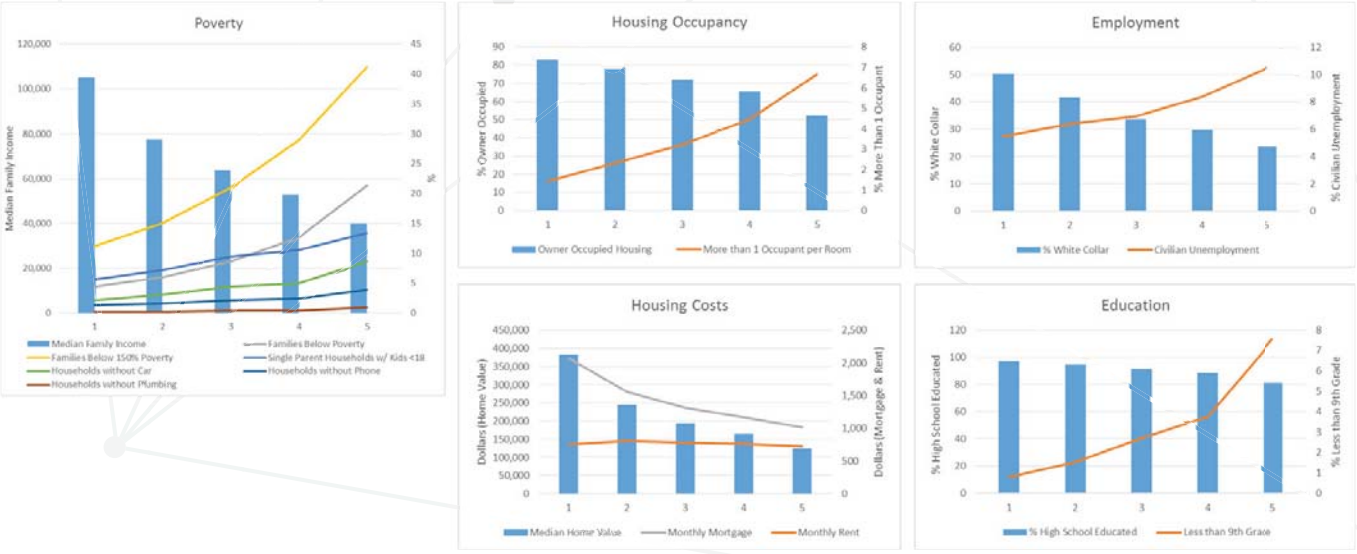

Table 3. Mean Block Group-Level United States Census Indicators by Area Deprivation Index Quintile

CATEGORY	CENSUS INDICATORS	CENSUS INDICATOR MEAN VALUES, BY AREA DEPRIVATION INDEX QUINTILE			RATIOS	
		Q1 (LEAST DEPRIVED)	Q3	Q5 (MOST DEPRIVED)	Q5/Q1	Q5/Q3
Income/ Poverty	Median family income, $	$ 105,045	$ 65,252	$ 41,539	0.40	0.64
	Income disparity	0.40	0.65	1.24	3.10	1.91
	Families below poverty level, %	4.4%	7.7%	20.2%	4.59	2.62
	% population below 150% poverty threshold, %	11.2%	19.4%	39.6%	3.54	2.04
	Single parent households with dependents <18, %	5.6%	9.2%	13.0%	2.32	1.41
	Households without a motor vehicle, %	2.1%	4.2%	8.0%	3.81	1.90
	Households without a telephone, %	1.3%	2.2%	3.6%	2.77	1.64
	Occupied housing units without complete plumbing, %	0.2%	0.4%	0.8%	4.00	2.00
Housing	Owner occupied housing units, %	83.0%	73.1%	53.8%	0.65	0.74
	Households with >1 person per room, %	1.4%	3.0%	6.4%	4.57	2.13
	Median monthly mortgage, $	$ 2,077	$ 1,337	$ 1,032	0.50	0.77
	Median gross rent, $	$ 760	$ 799	$ 723	0.95	0.90
	Median home value, $	$ 383,380	$ 197,560	$ 126,620	0.33	0.64
Employment	Employed person 16+ in white collar occupation, %	50.3%	34.6%	24.5%	0.49	0.71
	Civilian labor force unemployed (aged 16+), %	5.5%	7.0%	10.4%	1.89	1.49
Education	Population aged 25+ with <9 yr education, %	0.8%	2.7%	7.0%	8.75	2.59
	Population aged 25+ with high school education, %	97.1%	91.8%	81.9%	0.84	0.89

A review of specific measures of living condition shows that median home values for those living in the most deprived areas are 33 percent of those living in least deprived areas and households are 4.6 times more likely to have more than one person per room. On average, only 1 in 4 people have white-collar occupations and the unemployment rate is almost twice that of those living in least deprived areas, with 1 in 10 people being unemployed. An examination of education measures shows that 7 percent of adults living in the most deprived areas have less than 10 years of education, more than 8.8 times higher than those living in least deprived areas. High school education rates are 84 percent as high as those in the highest quintile.

Applications of ADI at Intermountain Healthcare

Several projects utilizing the ADI are being conducted at Intermountain. These use cases are presented below.

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Development of a Community Health Needs Assessment (CHNA)

Under the Affordable Care Act, the Internal Revenue Service (IRS) has strengthened the requirement that nonprofit hospitals conduct a triannual Community Health Needs Assessment (CHNA) with community stakeholders. The goal of CHNA is to promote shared ownership of community health between the various community stakeholders including the hospital, public health agencies, community-based services, and other community partners. To assist with this evaluation, the strategic planning team at Intermountain established geographically based regions to evaluate socioeconomic diversity using the ADI to identify deprived areas. A data analyst used the ADI data stored in the Intermountain EDW to generate visualizations using a geographic information system application.

A detailed map by BG was developed by region and shared with community stakeholders to identify and develop implementation plans to address needs in more deprived areas. Figure 2 provides a sample mid-level map for a largely urban, local Intermountain service region in Ogden that highlights disparities in deprivation across the region. Each BG is color coded by ADI quintile with less-deprived areas in green and more-deprived areas in orange and red. Intermountain's use of ADI maps during CHNA discussions provided a common language for understanding the local socioeconomic characteristics of a hospital service region and fostered informed conversation on local population needs.

Identification of High-Risk Patients for Care Management Interventions

Patients with higher deprivation are likely to be disproportionally represented among high-cost patient cohorts with multiple, complex chronic conditions. The goal of risk identification is to target those patients that need navigation support available through community-based care management interventions. To support high-risk patient identification, Intermountain's community health programs evaluated use of an ADI score in a risk-detection algorithm with the goal being to improve identification of high-risk patients who will benefit most directly from enhanced care management services. In an unpublished analysis, the community health programs found that ADI was a significant incremental risk factor in the identification of high-risk patients and incorporated ADI into their existing algorithm to identify high-risk patients.[13] The high-risk patient score, including ADI, is now being used by the care management teams to identify and conduct outreach with patients requiring community-based care management interventions.

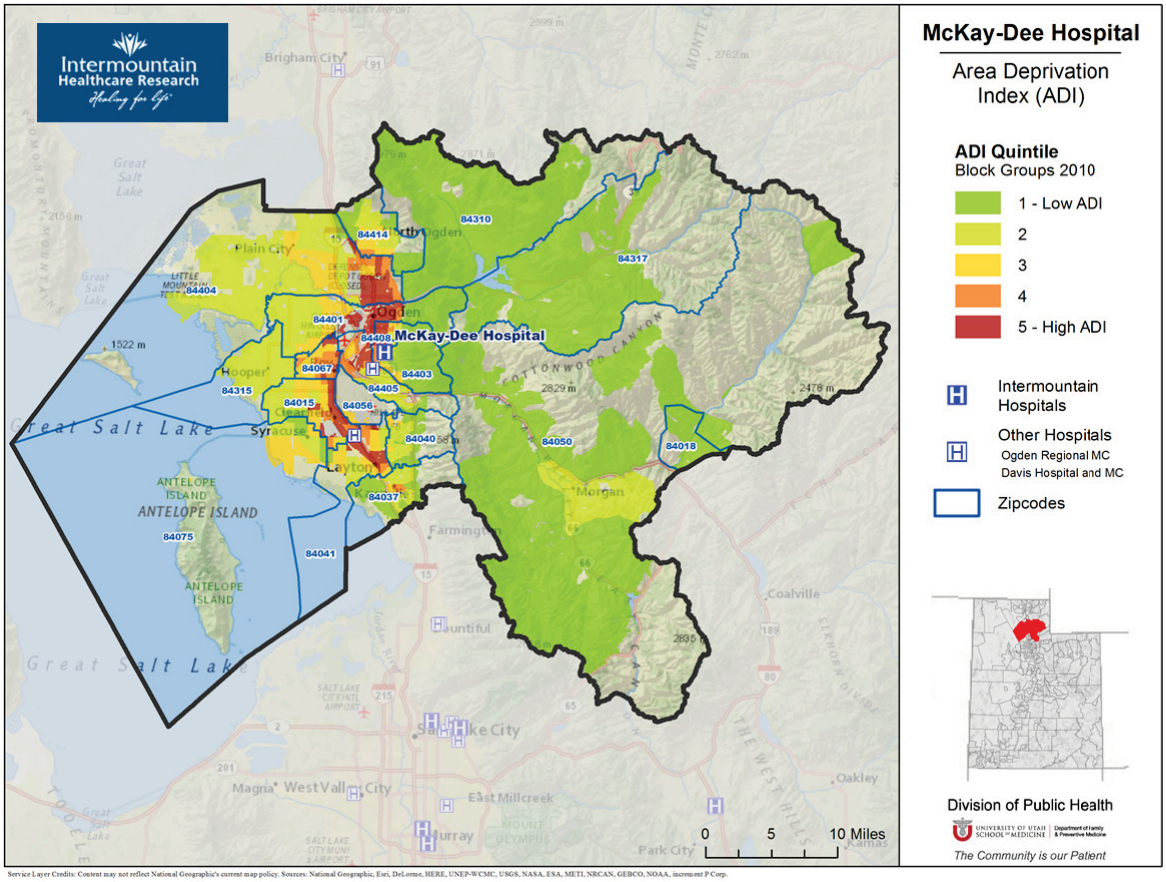
Assessing the Impact of Deprivation on Treatment of Patients with Hypertension

More deprived patients with chronic illness are believed to be at risk for poor adherence to prescribed medication and treatment. Intermountain's Primary Care Clinical Program is assessing the impact that deprivation has on medication adherence (and hypertension control) with the goal of potentially modifying education to improve adherence. ADI scores are being used as an explanatory variable to address the impact of material deprivation on patient outcomes. Results of this work can inform the design of improved care management interventions for materially deprived patients.

Lessons Learned

The Utah ADI shows promise in providing a proxy measure—useful in tailoring patient-centered care—for neighborhood material deprivation. There are strengths and limitations to this approach.

Figure 2. Area Deprivation Index Quintiles by Block Group, Intermountain Healthcare Hospital Service Region



The ADI provides a consistent standardized measure applicable across an integrated health care system with multiple data requirements. Initial applications in three meaningfully different areas of the organization provide initial evidence of its broad applicability in addressing the impact of social determinants such as material deprivation on health care. The use of BG-level United States Census data provides a more robust picture of small-area variation in socioeconomic status than do more traditional ZIP Code or Census tract aggregations. The ZIP Code system was developed by the United States postal service for the express purpose of efficient distribution and routing of mail. In contrast, BGs are smaller, relatively permanent statistical subdivisions of a county or equivalent entity that are updated by local participants for the express purpose of measuring settlement patterns.[14] The categorization of the ADI into quintiles, consistent with applications in Western European countries, has significant statistical variation—both overall and by individual Census measure. The variation in socioeconomic status by quintile also has potential for clinical significance, though more research is needed to link the sensitivity of a variation in ADI with variation in health delivery outcomes by disease type. This research may highlight the presence of "deprivation-sensitive" conditions that warrant tailored care

interventions. Finally, use of an area deprivation measure is not subject to eligibility limitations on the use of other proxy measures such as payer status.

There are limitations to measuring patient-level social determinants such as material deprivation using a small-area measure such as ADI that need to be understood to appropriately estimate statistical relationships.[15] Inherent bias exists in the use of aggregate characteristics to proxy individual deprivation characteristics as reported by Geronimus[15-16] when examining ZIP Code and Census tract-level data as proxy. Soobader[17] confirmed Geronimus's findings in a national study including rural areas and noted that use of BG-level, aggregate data reduces but does not eliminate aggregation bias. Hofer et al.[6] acknowledged the inherent bias but found that the use of aggregated, small-area data in measuring individual patient characteristics remained useful in predicting the qualitative direction and magnitude of socioeconomic variables. When used in a health care setting, social risk factor data attributed to individual patients based on neighborhood ADI scores should be combined with other patient- or family-specific data elements to ensure an accurate and complete patient profile.

United States Census data are based upon estimated and not actual counts. The elimination of the long form and the increase in the use of the ACS data improves the timeliness of available data, but includes a sampling error. Data for this analysis were based upon the reported values of Census indicators by BG. Confidence intervals were not included in the calculation of the ADI. Additional research is needed to evaluate measurement precision.

The Singh coefficients are based upon the 2000 United States Census. The original validated Singh index was based upon coefficients generated using 1990 United States Census data. The University of Wisconsin–Madison team updated these coefficients based upon the 2000 census using a consistent, factor analysis approach. There were no meaningful changes in the relative weightings of the census indicators between 1990 and 2000. The 2000 United States Census coefficients were used to calculate the 2013 Intermountain ADI.

ADI scores are a normalized, relative measure of material deprivation. While the methodology is generalizable to other communities, actual ADI scores presented herein are limited to BGs within Utah and are not comparable as calculated with scores from other communities outside Utah. The ADI score for patients is based upon their most current address. Evidence suggests that the impact of higher deprivation on health and health outcomes is based upon both near-term deprivation and deprivation throughout a person's life course.[2] Previous addresses are not currently available at Intermountain in an accessible format, so longitudinal measures of ADI cannot be created at this time.

Finally, BGs may be missing Census data to calculate the ADI because the population of interest was too small to measure (i.e., rural); therefore, no estimates were calculated. Home values are a significant factor in measuring ADI. However, not all BGs have residential homes or related mortgage costs. Missing home values have a significant impact on how a neighborhood is ranked. To address this issue, a home value was imputed for BGs missing home value data (n=28) using the other 16 indicators. These imputed home value estimates were included in the Census data files used to calculate the ADI. For BGs missing multiple measures due primarily to population size (n=13), an ADI was calculated using the average ADI of all adjoining BGs.

Conclusion

The Utah ADI has potential value in separating populations by socioeconomic status and has demonstrated application in a health care delivery context in planning, research, and clinical practice. The variation in socioeconomic status by quintile has potential for clinical significance, though more research is needed to link variation in ADI with variation in health delivery outcomes overall and by disease type. This may result in adapting care delivery to meet the needs of patients in more deprived areas, and may have application both in Utah and nationally. Intermountain is beginning to evaluate condition-specific interventions designed around the characteristics of patients living in more deprived neighborhoods.

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