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ASSISTANT SECRETARY FOR PLANNING AND EVALUATION
OFFICE OF HEALTH POLICY

CONTRACTOR PROJECT REPORT

Landscape of Area-Level Deprivation Measures and Other Approaches to Account for Social Risk and Social Determinants of Health in Health Care Payments

Prepared for
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ASPE Project Team

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ASPE Executive Summary

Improving health equity in the United States is a priority for the Biden-Harris Administration in order to address longstanding disparities in health outcomes. According to the Centers for Disease Control and Prevention (CDC), health equity is achieved when every person has the opportunity to "attain his or her full health potential" and no one is "disadvantaged from achieving this potential because of social position or other socially determined circumstances."[1] Health inequities are reflected in differences in outcome measures such as rates and severity of disease, quality of life, rates of disability, and length of life. These inequities can also be conceptualized and measured in terms of the drivers of differences in health outcomes.[2] These begin upstream with structural discrimination which results in differences in social drivers of health (social determinants of health (SDOH),[3] health-related social needs (HRSN),[4] and social risk factors (SRF)[5]), access to care, and, finally, differential quality of care within the health care system. Recent efforts to quantify the contributions of different factors to health outcomes suggest that social and economic factors play a larger role than clinical care. For example, the County Health Rankings weights social and economic factors as the largest contributor to overall length and quality of life at 40%, while clinical care (both quality and access) contributes only 20%.[6]

The Department of Health and Human Services (HHS) has focused research efforts on better understanding the social drivers of health inequities and developing policies intended to improve equity. There is a greater focus on the critical role structural discrimination and racism play in determining the distribution of SDOH and the downstream impact on HRSN. A comprehensive set of policies across the federal government, states, and local communities will be needed to address the multiple drivers of health inequities to improve health outcomes for the population as a whole.

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[1] https://www.cdc.gov/chronicdisease/healthequity/index.htm.

[2] Health equity is achieved when every person has the opportunity to "attain his or her full health potential" and no one is "disadvantaged from achieving this potential because of social position or other socially determined circumstances." Health inequities, the inverse of health equity, are reflected in differences in length of life; quality of life; rates of disease, disability, and death; severity of disease; and access to treatment. See https://www.cdc.gov/chronicdisease/healthequity/index.htm.

[3] SDOH are the conditions in the environments where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks. See https://health.gov/healthypeople/priority-areas/social-determinants-health.

[4] HRSN are individual-level manifestations of SDOH.

[5] SRF are adverse social conditions that are associated with poor health. See Green K, Zook M, 2019. When Talking About Social Determinants, Precision Matters, Health Affairs Forefront, October 29. https://www.healthaffairs.org/do/10.1377/forefront.20191025.776011.

[6] Booske BC, Athens JK, Kindig DA, Park H, Remington PL, 2010. Different Perspectives for Assigning Weights to Determinants of Health. Available at http://www.countyhealthrankings.org/sites/default/files/differentPerspectivesForAssigningWeightsToDeterminantsOfHealth.pdf.

One important element in this effort is to measure and understand the impact that SDOH at the community level have on HRSN of individuals; this information can then inform policies to address these needs. For example, the federal government can adopt Medicare payment policies that offer resources to and incentivize providers to screen patients for HRSN and refer them to appropriate social and behavioral services. In an ideal situation, providers would participate in closed loop systems to assure that the services are available and track when they have been used. In addition, policies to fund and assist communities in establishing these systems can be considered, such as the pilot opportunities through the Administration for Community Living's Social Care Referrals Challenge[7] and the Office of the National Coordinator for Health IT's Leading Edge Accelerator Projects.[8]

In order to implement such payments, they need to be targeted and tied to appropriate performance measures for accountability. A key policy question is what measures the federal government should use to target various payments to screen patients for HRSN and refer them to appropriate services. At this time, individual-level HRSN information is not widely available and, thus, developing measures to directly target funds based on these needs is not currently feasible. As an interim step, area-level measures of social needs or deprivation could be used, since they are already available for immediate policy use.[9] It is important, therefore, to understand the existing indices in terms of their validity, the SDOH and HRSN components they reflect, their availability and timeliness, the geographic level for which they are calculated, and usefulness for focusing funding in communities with the greatest need.

To better understand the options for using area-level and/or administrative data to target Medicare payments to providers treating greater proportions of beneficiaries with HRSN, the HHS Office of the Assistant Secretary for Planning and Evaluation (ASPE) commissioned RAND to conduct three environmental scans looking for: (1) area-level indices of social risk, (2) measures used in the United States' state and federal government programs that target areas, providers, or populations with social risk, and (3) existing payment models within the United States that incorporate measures of social risk.

The Federal government has already begun to incorporate SRF into Medicare payments. Using administrative data, hospital payments have been adjusted using the disproportionate share hospital (DSH) patient percentage, a measure of low-income patient days, since 1986.[10] More recently, the CMS proposes to increase payments to new Accountable Care Organizations (ACOs) caring for beneficiaries dually eligible or who live in areas with high deprivation, as measured by the ADI.

As potential policies to address HRSN are considered and implemented, it will be critical to focus limited funding on communities and providers most in need. Based on our analysis of the RAND report, none of the existing indices are ideal for policies directed at addressing either SDOH or HRSN. The effectiveness

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[7] https://acl.gov/socialcarereferrals.

[8] https://www.healthit.gov/buzz-blog/interoperability/by-leaps-and-bounds-newest-round-of-awardees-seek-to-advance-health-equity-and-research.

[9] Phillips RL, Ostrovsky A, Bazemore AW, 2021. Adjusting Medicare Payments for Social Risk to Better Support Social Needs, Health Affairs Forefront, June 1. Available at https://www.healthaffairs.org/do/10.1377/forefront.20210526.933567.

[10] https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/dsh.

of targeting funding for specific uses will be dependent on the correlation between the index used and the policy objectives. For example, if the objective is to address immediate needs for food or housing, how well does the area index correlate with these needs among communities? Existing area level indices are mostly comprised of socioeconomic SRF. A recent study suggests that socioeconomic factors such as dual-eligibility status and income are imperfect proxies for the number of HRSN experienced by beneficiaries.[11] While it will be important to confirm this finding using national data, the implication of this finding is that the correlation between the area deprivation indices and specific social needs may be less than ideal.

With improving health equity and addressing SDOH/HRSN moving to the forefront of health policy, it is understandable that there is a need to move ahead with existing measures as opposed to either waiting for new data or potentially modifying current indices based on careful evaluation of their performance. For immediate policy development addressing HRSNs, the ADI and SDI are the best choices given our selection criteria. However, using them area-level indices for other purposes (such as ACO benchmarks) may have other considerations. Moreover, we recommend continued study of how these indices would target funds, as well as development of indices that more directly target funds to HRSNs at the geographic level. It is important to consider, however, that once measures that distribute funds in a particular manner are put in place, even as a temporary policy, it can be difficult to make changes in response to new data or research. Indeed, communities and providers may quickly begin making investments based on new funding distributions.

It is therefore important to rapidly research the potential consequences of using the available indices. These studies can include: using survey and other data to examine overlap between SRF proxies such as dual-enrollment status and the specific HRSN they are intended to capture; examining the similarities and differences in area rankings based on different indices; examining rankings based on the indices in contrast with rankings based on administrative measures such as disproportionate share hospital patient percentages; examining how well the indices used at the area level target the specific providers, such as safety net hospitals, with the most disadvantaged patients; examining how the private sector and other countries have used area-level indices in provider payments. These studies can pinpoint issues that arise prior to more widespread policy use of the existing measures and potentially suggest alternatives that might mitigate any unintended consequences.

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[11] Long CL, Franklin SM, Hagan AS, Li Y, Rastegar JS, Glasheen B, Shrank WH, Powers BW, 2022. Health-Related Social Needs Among Older Adults Enrolled in Medicare Advantage, Health Affairs, 41:4, p557-562. https://doi.org/10.1377/hlthaff.2021.01547.

Project Report

Landscape of Area-Level Deprivation Measures and Other Approaches to Account for Social Risk and Social Determinants of Health in Health Care Payments

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About This Report

To inform efforts to design health care payment models that mitigate the potential negative impacts of value-based payments on patients with social risk factors and the health care providers who care for them, the U.S. Department of Health and Human Services Assistant Secretary for Planning and Evaluation (ASPE) engaged the RAND Corporation to conduct environmental scans of indices of social deprivation, administrative measures of social risk, and existing payment models that incorporate measures of social risk.

This report was funded by ASPE and carried out within the Payment, Cost, and Coverage Program in RAND Health Care.

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Summary

The term *social risk factors* refers to a broad set of characteristics that, because of structural social inequalities, are associated with adverse health and health care outcomes. The importance of addressing social risk factors in the design of health care payment models was highlighted in the Assistant Secretary for Planning and Evaluation's (ASPE's) 2020 *Report to Congress: Social Risk Factors and Performance in Medicare's Value-Based Purchasing Program* (Office of the Assistant Secretary for Planning and Evaluation, 2020). In that report, ASPE focused on the need to give additional supports and resources to providers to address beneficiaries' social risk and to improve care and outcomes in Medicare's value-based payment models. More broadly, ASPE and other federal partners are focusing on social risk factors in their efforts to develop and assess policies that address systemic drivers of inequality in health and health care. For any policies that are considered to address social risk, the methods for measurement of social risk at the patient, area, and provider levels will be an important concern.

This report is intended to provide an informational resource that will support emerging policy strategies. Specifically, we examine existing methods for measuring social risk within geographic areas using area-level social deprivation measures and for incorporating these and other measures into payment models. For the purposes of this report, social risk factors include measures of both (1) social determinants of health (SDOH), or structural inequalities that are associated with poor health, such as income or education, and (2) health-related social needs (HRSN), or individual-level consequences of SDOH, such as homelessness or food insecurity. The broad focus on social risk factors is important because of the wide variety of policy strategies in which area-level measures of social deprivation may be used to allocate resources, some of which may focus more on SDOH and others on HRSN.

To capture a variety of social risk factors, we expanded a classification of social risk factors that was developed by the National Academies of Sciences, Engineering, and Medicine (NASEM) in a report titled *Accounting for Social Risk Factors in Medicare Payment: Identifying Social Risk Factors* (NASEM, 2016). In the NASEM framework, race is used as a proxy for the social risk factors of racism and discrimination because persistent systemic and institutionalized racism has denied members of certain racial groups equitable access to social, economic, and educational resources—such as stable housing, access to food, and safe neighborhoods—that affect health-related outcomes. Because the NASEM classification focuses primarily on SDOH, we expanded the classification by adding HRSN, drawing on a screening tool developed for the Accountable Health Communities program (Billioux et al., 2017).

Combining these two sources, our classification includes the following six domains (with examples of related indicators):

- socioeconomic position: income or wealth, education, occupation
- race, ethnicity, and cultural context: race/ethnicity, language, nativity, acculturation
- gender: gender, gender identity, sexual orientation
- social relationships: marital status, social support
- residential and community context: community socioeconomic composition, built environment
- social needs: housing instability, food insecurity, interpersonal safety.

This report is based on three environmental scans. First, we examined *area-level indices of social risk*. There is a long history of development of composite indices designed to summarize multiple aspects of social stratification into a single number in the social science and public health literatures. We identified and summarized 21 indices that met our inclusion criteria. This group of measures tends to cover most domains of social risk, but the measures are at the area level as opposed to the individual level.

Second, we examined *measures used to administer government programs* that target areas, providers, or populations with social risk. There is also a long history of government programs that target disadvantaged areas or populations for which standard measures of social risk are used. We examined measures used in Medicaid and Medicare disproportionate share hospital payment programs, measures used to determine eligibility for health care shortage designations, measures used in the Medicare program, and measures derived from clinical data. With the exception of the clinical data, these measures tend to cover the domains of social risk more sparsely than the social deprivation indices, with an almost exclusive focus on income.

Third, we examined *existing payment models* that incorporate measures of social risk, including models for paying providers or health plans. The report describes seven such models in detail. The measures of social risk used in payment models may differ from those identified in the other two scans, which focus more on the social needs domain; the payment models tend to include homelessness, incarceration or involvement in the criminal justice or legal system, other measures reflecting an individual's transitory status, and behavioral health issues that can exacerbate social needs. In addition, the report highlights examples of initiatives outside of traditional payment systems that are designed to provide targeted funding to providers and other organizations to build capacity to address social needs.

Although there are many precedents for assessing social risk in the study of health care and administration of health care systems in the United States, there remains considerable heterogeneity in how social risk is measured. In particular, there are a large number of area-level indices of social deprivation; Appendix B provides detailed characteristics of 21 of these indices that are supported by methodological studies, and there are many ad hoc measures created in the context of specific research studies that are not reviewed in detail in this report. Among the three environmental scans of social risk measures, there were important variations with respect to coverage of the social risk factor domains and the level of measurement.

Coverage of Social Risk Factor Domains

Area-level deprivation indices tend to have the broadest coverage across the entire range of social risk factors. In contrast, the measures that have historically been used in the context of administering government programs have covered the narrowest range, limited to the share of a population that is low income as the only measure of social risk. The only other (far less common) measure identified was the availability of providers. Existing payment models tend to focus on the social needs domain, although some include indices of area-level deprivation that effectively broaden their range. The limited attention to social needs outside of the payment models is a notable finding of our review. We also note that broader coverage across domains of social risk factors might not always be desirable, as some factors might be considered legitimate reasons for payment differentials and some might not.

Level of Measurement

Area-level deprivation indices are, by definition, measured for geographic areas, which presents challenges in including them in payment models because a provider's patients are unlikely to be representative of the population of the geographic area in which the provider is located. Variation in social risk factors within areas may be a barrier to using these measures in payment models. Measures used administratively have been a mix of area- and individual-level measures. Where these measures have used individual-level data, they have tended to use data collected in simplified form—for instance, information on whether or not a person meets criteria for being low income (yes or no) rather than detailed information on income from all enrollees (amount). There are efforts to increase data collection on a broader range of social risk factors at an individual level through clinical care, but those efforts have not yet been demonstrated to be feasible, given the complexity of systematically collecting and recording information on social risk factors in this way. The payment models tend to use a combination of area and individual measures. Information on the implementation of these models, and their success in collecting valid individual-level information on social needs and other social risk factors, should be closely studied to inform the future use of these approaches.

As our review of payment models demonstrates, the incorporation of measures of social risk into health care payment remains uncommon; only a handful of such models are being implemented at the state level. Studies of these models will be valuable in informing future policy in this area. The measures used in future models will need to be carefully selected to ensure that they accurately target resources, and the models will need to be rigorously tested to determine their impacts on patient care and outcomes.

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1. Measuring Social Risk for Health Care Payment

The Assistant Secretary for Planning and Evaluation's (ASPE's) 2020 report to Congress, titled *Report to Congress: Social Risk Factors and Performance in Medicare's Value-Based Purchasing Program*, focused on achieving fairness in the context of value-based payment (Office of the Assistant Secretary for Planning and Evaluation, 2020). In contrast with fee-for-service payment models, which reward volume of care, value-based payment models aim to incentivize high-value care by allowing plans and providers flexibility in how health care dollars are spent while holding them accountable for costs and quality of care (Rosenthal, 2008). Concerns about fairness have emerged in policy discussions of value-based payment because of the potential for these models to disadvantage plans or providers that care for patients who, because of social, economic, and educational inequities and institutional racism and discrimination, face disproportionate barriers to health and health care (Sheingold et al., 2018). The ASPE report recognized that value-based payment models that allocate resources according to quality measures that are affected by social risk factors could disadvantage the providers who care for vulnerable patients and exacerbate social disparities in health care and health status. The report included a recommendation that Medicare's value-based purchasing programs "reward and support better outcomes for beneficiaries with social risk factors" (Office of the Assistant Secretary for Planning and Evaluation, 2020). A critical challenge, however, is that methods for successfully meeting this recommendation are still nascent, in part because of a lack of clarity around how to best measure social risk.

To inform the design of payment models that better support plans and providers that care for patients with social risk factors, we examined the landscape of measurement of area-level indices. The report is composed of three interrelated environmental scans. The first scan examines indices of social risk that are used in research and policy to combine information on multiple domains of social risk into single composite measures. These measures primarily rely on population-based data, such as data collected by the U.S. Census Bureau. The second scan examines current measurement of social risk through policies and administrative systems. In this case, the measures are mostly used to allocate resources to high-need areas or recipients. The third scan examines how social risk measures could be implemented through current health care payment models that incorporate measures of social risk, including models for paying providers or health plans or programs that provide targeted funding to providers and other organizations to build capacity to address patients' social needs.

What Are Social Risk Factors?

For the purposes of this project, it is important to have a clear definition of the term *social risk factors* so that relevant area-level indices can be identified and assessed. Because of our interest in casting a wide net to identify potential indices that might be relevant to a variety of policy strategies, we adopted an inclusive definition, in which *social risk factors* includes a broad range of characteristics, assessed at the individual, group, or area levels, that reflect inequitable social conditions and are associated with health-related outcomes. In this sense, social risk factors encompass social determinants of health (SDOH) as well as health-related social needs (HRSN), two related concepts currently used in the health equity literature.[1] SDOH are inequitably distributed health-related exposures and resources that affect individuals' health, access to health care, and ability to adhere to indicated treatment. Healthy People 2030, the guiding document of the U.S. Department of Health and Human Services (HHS) for public health policy, defines SDOH as "the conditions in the environments where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks" (HHS, Office of Disease Prevention and Health Promotion, undated). HRSN are acute circumstances, such as unstable housing and food insecurity, that result from SDOH and other structural disadvantages and constitute immediate threats to health or health care (Billioux et al., 2017).

Measures of social risk may include information on SDOH, HRSN, or structural factors related to both. Social risk factors may be directly or indirectly related to health outcomes. For instance, racial/ethnic identity may be considered a social risk factor not because it is a cause of health-related outcomes but because it is a proxy for the influence of social inequalities and institutional racism. To characterize the broad domain of social risk, we drew on two sources (Table 1.1). The first was a 2016 report from the National Academies of Sciences, Engineering, and Medicine (NASEM) that examined social risk factors likely to influence health care utilization and identified five domains that should be accounted for in policies to address inequity in health care payments: (1) socioeconomic position; (2) race, ethnicity, and cultural context; (3) gender; (4) social relationships; and (5) residential and community context (NASEM, 2016). Each of these domains is characterized by multiple indicators, examples of which are shown in the table. The NASEM model for social risk factors has been adopted in prior ASPE reports (such as Office of the Assistant Secretary for Planning and Evaluation, 2020).

A potential limitation of the NASEM model is that it does not adequately cover HRSN, which are critical to policy strategies for addressing social risk factors. To cover HRSN, we drew

[1] Usage of these terms differs in the literature. Other writers define social risk factors as specific adverse social conditions and differentiate them from SDOH, which refer to a broader set of social structural factors (Alderwick and Gottlieb, 2019). In this report, we follow the definitions established in prior reports by the National Academies of Sciences, Engineering, and Medicine and ASPE on social risk factors in health care payment models.

on a second source, the Accountable Health Communities (AHC) HRSN screening tool, developed at the Centers for Medicare & Medicaid Services (CMS) (Billioux et al., 2017). The tool covers five indicators of social needs that can be addressed by community services: (1) housing instability, (2) food insecurity, (3) transportation problems, (4) utility help needs, and (5) interpersonal safety. It also includes assessments of behavioral health conditions, disabilities, and physical activity, which we consider distinct from social risk factors, and some domains also covered in the NASEM model.

Table 1.1. Domains and Indicators of Social Risk

Domain	Example Indicators
Socioeconomic position	• Income or wealth • Insurance • Education • Occupation
Race, ethnicity, and cultural context	• Race/ethnicity • Language • Nativity
Gender	• Gender • Gender identity • Sexual orientation
Social relationships	• Marital status • Living alone • Social support
Residential and community context	• Community socioeconomic composition • Built environment • Social environment
Social needs	• Housing instability • Food insecurity • Transportation problems • Utility help needs • Interpersonal safety

SOURCES: Billioux et al., 2017; NASEM, 2016.

Organization of This Report

This report presents the results of the three environmental scans. In Chapter 2, we examine indices of social risk that have been used in the research literature. In Chapter 3, we examine measures of social risk that have been used in administrative programs, primarily by agencies within the federal government. In Chapter 4, we examine existing models for paying providers or health plans that incorporate measures of social risk. These three central chapters of the report focus on summarizing information on the measures of social risk identified in each scan, and the appendixes provide additional details. Appendix A describes the search methods used in the

environmental scans. Appendix B provides details on each of the indices of social deprivation that were identified, including the data sources, weighting of components, and frequency of updates. Appendix C provides details on administrative measures of social risk, and Appendix D provides details on payment models that incorporate measures of social risk. Chapter 5 presents our conclusions.

2. Area-Level Indices of Social Risk

Although there is no shortage of measures to capture how individuals or communities fare on a single aspect of social risk (e.g., income, housing, access to care), researchers widely recognize that social risk and related constructs, such as social vulnerability, are multidimensional. With this recognition has come the development of indices of social risk that include multiple dimensions in a single score, allowing for more-robust analyses and comparisons of both populations and geographic regions. We reviewed published and grey literature to identify existing area-level indices of social risk that could be used to inform payment model adjustment. This chapter is organized around three types of indices, each with its own strengths and limitations. The first type is indices available for use at the census-tract level or smaller. The second is indices available for use at the county level. Finally, we summarize indices that would require additional analysis to generate scores, meaning that relevant documentation is available but the scores themselves are not readily available for use. We conclude this chapter by summarizing key characteristics of each index that might be useful in weighing the relative merit and potential use for ASPE's objectives.

Detailed information on our approach to identifying indices of social risk can be found in Appendix A. Briefly, we used the following criteria:

- An index had to include two or more domains of social risk. Indices that focus on one domain, such as food insecurity, were excluded given that social risk is widely considered to be multidimensional and individual measures often have geographic patterns distinct from one another that can generate divergent results of social risk when viewed in isolation. We also excluded compilations of individual measures that are examined separately (e.g., the Robert Wood Johnson Foundation County Health Rankings), which are common in online dashboards, and other data visualization tools.
- Indices had to be created for use with U.S. data. International indices were excluded unless they had been adapted for use in the United States.
- Indices had to use data that were readily accessible and designed to estimate population-level social risk. Indices based on localized or one-time survey data or designed to assess the social risk of individuals without the intent to aggregate to a geographic area were excluded.
- Indices had to generate estimates at the county level or smaller. Indices that generate estimates at only the state or national level (to facilitate cross-country comparisons) were excluded.
- Indices had to be developed for, and have some evidence of, wider use. Indices that were developed ad hoc as part of a single research study were excluded.

Indices Available for Use at the Zip Code Level or Smaller

In this section, we summarize indices with data available for use at the zip code, census-tract, or census block-group level. These indices have advantages in that the data are publicly available and, with one exception, free to use. Detailed methodology is also available for these indices, and many have been widely studied, lending further credibility to their use. With these benefits, however, come limitations that should be considered, particularly in the context of ASPE's proposed use case. The majority of these indices are updated every few years, and there is no guarantee that the organization responsible for an index will release an additional update. Many indices are also utilizing data from 2010–2018, which could pose a challenge if communities experience a significant demographic shift or displacement, as may have occurred with the coronavirus disease 2019 (COVID-19) pandemic or natural disasters, for example. Table 2.1 provides a high-level summary of these indices. Appendix B provides additional details for each index, including a description of each variable in the index, considerations related to timeliness or generalizability, full citations, and locations for accessing relevant data. To help facilitate cross-index comparisons, Table 2.4 provides a summary of key characteristics among all of these indices.

Table 2.1. Area-Level Indices of Social Risk Available for Use at the Zip Code Level or Smaller

Index	Level of Disaggregation	Description
Area Deprivation Index (ADI)	Census block group	Developed to inform health care delivery and policy, especially for disadvantaged areas. Includes 17 measures across four domains: income, education, employment, and housing quality.
Census Bureau Community Resilience Estimates	Census tract	Developed to help local planners assess resiliency of communities and plan disaster mitigation strategies. Includes ten measures: income-to-poverty ratio, single or no caregiver, crowding, communication barriers, unemployment, disability, health insurance, over age 65, access to a vehicle, and broadband access.
Child Opportunity Index (COI) 2.0	Census tract	Developed to capture resources and conditions that matter for children's health and development. Includes 29 measures across three domains: education, health and environment, and social and economic.
Distressed Communities Index	Zip code (with 500+ residents)	Developed to provide a single, comparative measure of economic well-being across communities. Includes seven measures related to high school diploma, housing vacancy, unemployment, poverty, median income ratio, change in employment, and change in business establishments.
Neighborhood Deprivation Index	Census tract	Developed through the Accumulating Data to Optimally Predict Obesity Treatment (ADOPT) project to establish a standard set of core measures for use in obesity research (National Cancer Institute, 2022). Includes ten measures related to wealth and income, education, occupation, and housing conditions.
Neighborhood Socioeconomic Status (NSES)	Census tract	Developed to assess neighborhood-level socioeconomic status (SES). Includes five measures related to household income, poverty, education, unemployment rate, and children living in "female-headed" households.

Index	Level of Disaggregation	Description
Social Deprivation Index (SDI)	County, census tract, Zip Code Tabulation Area, Primary Care Service Area	Developed to examine relationships between levels of social disadvantage and health and health care. Includes seven measures related to poverty, education, single-parent household, rented housing, overcrowding, access to a vehicle, and unemployment.
Social Vulnerability Index (SVI)	County, census tract	Developed to identify areas most likely to need support related to hazardous events. Includes 15 measures across four themes: SES, household composition and disability, minority status and language, and housing type and transportation.

NOTE: Full citations for each index and locations for accessing relevant data are presented in Appendix B.

Indices Available for Use at the County Level

Through our environmental scan, we identified additional indices that met our inclusion criteria but for which data are only available for use at the county level. Although county-level estimates of social risk can be useful for research and other purposes, their utility may be limited, given the potential for increased heterogeneity in the population, resources, and social risk within a larger geographic boundary, such as a county. In some cases, it might be possible to refine these indices to generate smaller-area estimates, but we encourage discussing this possibility with the original developer (see Appendix B for citations). Table 2.2 provides a high-level summary of these indices, and Appendix B provides additional details. A summary of key characteristics across all of these indices is included in Table 2.4 to facilitate comparisons.

Table 2.2. Area-Level Indices of Social Risk Available for Use at the County Level

Index	Level of Disaggregation	Description
Baseline Resilience Indicators for Communities (BRIC)	County	Developed to identify communities that will need help in a hazardous event and to facilitate comparisons of community resilience. Includes 48 measures across six categories of resilience: social, economic, community capital, institutional, infrastructural, and environmental.
COVID-19 Vaccine Coverage Index	County	Developed to identify communities where there are challenges with vaccine rollout and coverage. Includes 28 measures across five themes: historic undervaccination, sociodemographic barriers, resource-constrained health system, health care accessibility barriers, and irregular care-seeking behavior.
Minority Health SVI	County	Developed as an expansion of the SVI (see Table 2.1). Includes 29 measures across six themes: SES, household composition and disability, minority status and language, housing and transportation, health care infrastructure, and medical vulnerability.
Opportunity Index	County	Developed to describe opportunity in the United States. Includes 20 measures across four dimensions: economy, education, health, and community.
Social Capital Index	County	Developed to encourage more research on social capital and to support policy solutions. Includes 32 measures on family unity, family interaction,

Index	Level of Disaggregation	Description
		social support, community health, institutional health, collective efficacy, and philanthropic health.
Social Vulnerability to Environmental Hazards Index (SoVI)	County	Developed to show geographic variation in social vulnerability to, and recovery from, environmental hazards. Includes 29 measures related to race, ethnicity, age, poverty, income and benefits, sex, language, insurance, education, housing, employment, and transportation.

NOTE: Full citations for each index and locations for accessing relevant data are presented in Appendix B.

Indices that Require Analysis to Generate Scores

In addition to the indices described above, which have data readily available for download and use, we identified several indices that hold promise but would require additional analysis to generate scores. These indices were often developed for specific, time-limited use cases, but the authors provide ample documentation or technical appendixes for generating scores, and, in many cases, the developers explicitly encourage wider use of these indices. Taking on the task of generating scores for one or more of these indices will require resources and a potentially longer start-up time to review documentation and to work with the original developer to ensure accuracy and fidelity to the original approach. However, this approach might be preferable in that it ensures that scores can be updated on a schedule consistent with the end user's needs and would ensure use of the most-recent data available. Table 2.3 provides a high-level summary of these indices, and Appendix B provides additional details. As with the rest of the indices, we provide a summary of key characteristics in Table 2.4.

Table 2.3. Area-Level Indices of Social Risk that Require Analysis to Generate Scores

Index	Level of Disaggregation	Description
Agency for Healthcare Research and Quality (AHRQ) SES Index	Census block group	Developed to provide an SES index for use in distinguishing race/ethnicity and SES associations with Medicare outcomes. Includes seven measures related to unemployment, poverty, median income, property values, low education, high education, and crowding.
Composite Index of SES	Census tract	Developed to evaluate the relationship between SES and cancer outcomes, to minimize risk of disclosure of identifying information. Includes 19 measures related to occupation, employment, poverty, income, education, home value, home ownership, and crowding.
Multidimensional Deprivation Index	Individual	Developed to expand income-based poverty measures of deprivation. Includes six measures related to standard of living, education, health, economic security, housing quality, and neighborhood quality.
Multidimensional SDOH Index	Census tract	Developed to quantify SDOH within small geographic areas to examine the relationship between SDOH and premature mortality. Includes 15 measures of demographic characteristics, economic status, social and neighborhood characteristics, and housing and transportation accessibility and affordability.

Index	Level of Disaggregation	Description
Neighborhood Concentrated Disadvantage Index	Census tract	Developed to assess the relationship between concentrated disadvantage, residential instability, and collective efficacy. Includes six measures related to poverty, public assistance, female-headed households, unemployment, age, and race.
Neighborhood Stress Score 7 (NSS7)	Census block group	Developed to support risk adjustment for MassHealth payment models by incorporating SDOH. Includes seven measures related to income, poverty, employment, public assistance, transportation, single-parent households, and education.
Townsend Index (adapted for the United States)	Census tract	Developed to measure material deprivation in England in relation to poor health outcomes. Includes four measures related to transportation access, overcrowding, renter-occupied dwellings, and unemployment.

NOTE: Full citations for each index and locations for accessing relevant data are presented in Appendix B.

Emerging Strategies

We identified emerging strategies for characterizing geographic variation in social risk factors that are not yet developed to the point that they can be used but should be considered as work in this area progresses. Many of the indices noted above were derived using principal components analysis, with researchers examining factor loadings and making judgment calls around index development. In the past few years, however, researchers have begun using machine-learning methods for data-driven index development. While both methods aim to identify patterns within the data, a major difference is that machine-learning methods rely on automated statistical procedures to do so. For instance, researchers developed a multidimensional SDOH model by applying unsupervised dimension reduction and clustering machine-learning algorithms to national data on 15 social risk factors at the census-tract level (Kolak et al., 2020). The model resulted in four indices that together accounted for 71 percent of the variation across census tracts and were found to be associated with premature mortality in a validation study that used data from Chicago (Kolak et al., 2020). Other studies have used machine-learning approaches to develop predictive models, which examine predictive associations between multiple social risk factors and a public health outcome, such as life expectancy (Lines, 2021) or COVID-19 outcomes (Wylezinski et al., 2021). How these approaches will perform remains unclear, and they have the disadvantage of being opaque to users because they are driven by automated model-development procedures.

Considerations for Selecting Indices

To facilitate discussion of which indices hold the most promise for a given use case, Table 2.4 summarizes the 21 indices described in this chapter, in alphabetical order. For each index, the table shows the most recent year for which data are available; frequency of data release; data source; and cost to access the data, if applicable. In reviewing this information and the

corresponding details in Appendix B, it might be helpful to keep the following questions in mind, which could help identify those indices that are the most promising for a given use case:

- **What is the tolerance for data lag?** Many of the indices are updated every few years, sometimes inconsistently, and many use data that are a few years old (e.g., a 2019 index might use 2017 data). If there is a need for more frequent and regular updates, it might be possible to generate the index in house as updated data are made available, affording more control over the timeline.
- **What are one's cost and time constraints?** Only one of the indices includes proprietary data and requires a fee to access the data; the others largely draw upon publicly available data. However, use of the other indices is not without cost, particularly if one opts to generate scores internally or ask developers to generate more frequent updates of their index. Time constraints might also affect one's choice, as indices that have readily available data could be deployed more quickly.
- **What is the ideal level of geographic disaggregation?** Indices vary in level of geographic disaggregation. Many are available at the census-tract or census block-group level; only one is available at the primary care services area level. In many cases, the indices are constrained by the data and variables used, but a discussion with the developers could confirm whether it is possible to generate a particular index of interest at a smaller level of disaggregation.
- **Are there specific social risks that must be reflected in the index?** For example, one might wish to ensure that certain social risks are included in the index to facilitate alignment with HHS or with priorities or initiatives that are in place or expected to launch in the near future.
- **Does the index reflect the current state of the science on social risk?** While scores from all of the indices in Table 2.4 can be updated with more-recent data, some developers have made updates to the indices themselves to better reflect the current state of the science on social risk. For example, in some cases, such as the Census Bureau Community Resilience Estimates, developers have included new or revised variables that were not available at the time of development. In other cases, such as the Area Deprivation Index (ADI), developers have applied new methods to strengthen the index. Although such changes could pose challenges for longitudinal assessments, a more current point-in-time index might be of greater value, depending on the use case.

Table 2.4. Comparison of Indices on Key Characteristics

Index	Available for Download	Level of Disaggregation	Most Recent Year	Frequency of Data Release	Data Source	Cost to Access Data
AHRQ SES Index	No	Census block group	2008	Needs to be calculated	2000 census	N/A
ADI	Yes	Census block group	2019	Unknown; last update was in 2018	ACS five-year estimates, 2014–2018	N/A
BRIC	Yes	County	2015	Unknown; last update was in 2010	Multiple (see Cutter et al., 2014)	N/A
Census Bureau Community Resilience Estimates	Yes	Census tract	2019	Annual; last update was in 2018	ACS individual- and household-level restricted ACS microdata; Census Bureau's Population Estimates Program	N/A
COVID-19 Vaccine Coverage Index	Yes	County	2021	Unknown	Multiple (see Surgo Ventures, 2021)	N/A
COI 2.0	Yes	Census tract	2015	Unknown; report also included 2010	Multiple (see Noelke et al., 2020)	N/A
Composite Index of SES	No	Census tract	2013	Needs to be calculated	2000 decennial census; ACS five-year estimates, 2005–2009	N/A
Distressed Communities Index	Yes	Zip code (500+ residents)	2020	Four updates since 2015	ACS five-year estimates, 2014–2018; Census Bureau Business Patterns data sets for same years	$500
Minority Health SVI	Yes	County	2021	Unknown	ACS five-year estimates, 2014–2018; others (see Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, and U.S. Department of Health and Human Services Office of Minority Health, undated; HHS, Office of Minority Health, undated; Wolkin et al., 2022)	N/A
Multidimensional Deprivation Index	No	Individual, then aggregated	2021	Needs to be calculated; last update was in 2017	ACS one-year sample, 2019 and 2018; block-group estimates from ADI	N/A
Multidimensional SDOH Index	No	Census tract	2014	Needs to be calculated	ACS five-year estimates, 2010–2014	N/A

Index	Available for Download	Level of Disaggregation	Most Recent Year	Frequency of Data Release	Data Source	Cost to Access Data
Neighborhood Concentrated Disadvantage Index	No	Census tract	2016	Needs to be calculated	Census Bureau decennial census, American FactFinder, ACS five-year estimates	N/A
Neighborhood Deprivation Index	Yes	Census tract	2020	Unknown	ACS five-year estimates, 2013–2017	N/A
NSES	Yes	Census tract	2017	Unknown	ACS five-year estimates, 2011–2015	N/A
NSS7	No	Census block group	2017	Needs to be calculated	Massachusetts Medicaid data, developed using 2013 data	N/A
Opportunity Index	Yes	County	2019	Annual; last update was in 2019	ACS 2017; others (see Child Trends, Opportunity Nation, and Forum for Youth Investment, 2019)	N/A
Social Capital Index	Yes	County	2018	Unknown	Multiple 2006–2016 sources (see Vice Chairman's Staff of the Joint Economic Committee, 2018)	N/A
SDI	Yes, for 2015	Census tract, Zip Code Tabulation Area, Primary Care Service Area	2015	Documentation says annual, but posted data files are from 2015	ACS five-year estimates	N/A
SoVI	Yes	County	2015	Unknown; last update was in 2000	ACS five-year estimates, 2010–2014	N/A
SVI	Yes	Census tract	2020	Every few years: 2018, 2016, 2014, 2010	ACS five-year estimates; 2018 update used ACS data from 2014–2018	N/A
Townsend Index (adapted for the United States)	No	Census tract	2015	Needs to be calculated	ACS five-year estimates, 2008–2012	N/A

NOTES: N/A = not applicable. Full citations for each index and locations for accessing relevant data are presented in Appendix B.

Discussion

This chapter outlines 21 area-level indices that capture a diverse set of social risks. It is important to note that they were each developed for a different purpose, and some of the challenge will be thinking through which, if any, are not only substantively aligned with the user's priorities but also meet necessary parameters around level of disaggregation, data lag, resource needs, and alignment with the current state of the science.

Collectively, the indices reflect the domains and indicators offered in the NASEM report and the CMS AHC screening tool, although some domains and indicators were reflected more frequently in the indices than others (Table 2.5). The majority of the indices captured domains of social risk at a community level (e.g., percentage of residents who are employed), but, for a few, data were collected at the individual level (e.g., "Are you currently employed?") and aggregated up to a given geographic level. For the purpose of Table 2.5, an index was counted as including a given domain if data relevant to that domain were collected at the individual level or a community level.

Several indicators were prevalent in the identified indices but were not explicitly included as indicators in the NASEM report or the CMS AHC screening tool. We have added these to the table, using italics to indicate new or expanded indicators identified during our review. It is important to note that our review of indices was a point-in-time effort, and coding indicators against those included in the NASEM report and CMS AHC screening tool was not an explicit objective of this project. As a result, this table should be viewed as preliminary, and it is offered to inform understanding of general patterns only.

Table 2.5. Percentage of Reviewed Indices that Include Indicator of Social Risk

Domain	Indicators	Percentage of Indices that Include Indicator	Percentage of Indices Available at Zip Code Level that Include Indicator
Socioeconomic position	Income or wealth	90	100
	Insurance	43	25
	Education	81	88
	Occupation/*employment/unemployment*	90	33
Race, ethnicity, and cultural context	Race/ethnicity	29	13
	Language/*limited English proficiency*	33	25
	Nativity	5	0
Gender	Gender	5	0
	Sexual orientation	0	0
Social relationships	Marital status/*single-parent/female-headed household*	67	88
	Living alone	0	0
	Social support	5	0

Domain	Indicators	Percentage of Indices that Include Indicator	Percentage of Indices Available at Zip Code Level that Include Indicator
Residential and community context	Community socioeconomic composition	(folded in above)	
	Built environment	24	25
	Social environment	19	13
	Own/rent, housing type, cost burden, vacancy	67	75
	Health system infrastructure	24	0
Social needs	Housing instability*/crowding/quality of home*	52	50
		5	0
	Food insecurity	62	63
	Transportation problems*/car ownership/access*	33	25
	Utility help needs*/internet-telephone access*	5	0
	Interpersonal safety*/violent crime in neighborhood*	24	25
		14	0
	Disability		
	Health outcomes		

SOURCES: Billioux et al., 2017; NASEM, 2016.
NOTES: Table includes all indices reviewed in this chapter. Italics indicate indicators found in reviewed indices but not explicitly listed in the NASEM report or the CMS AHC screening tool.

As part of the environmental scan, we came across a few methodological papers that call into question the validity of using a single index to assess the social risk of the entire United States at a small geographic level. For example, Lavoie and colleagues examined the validity of several social vulnerability indices in Alaska fishing communities by comparing scores given to local communities with in-depth in-person assessments (Lavoie et al., 2018). While most of the indices were "representative of community vulnerability . . . some variables utilized to create the indices could be modified to better reflect realities in Alaska" (p. 359). The authors noted that the indices did not capture several political or ecological factors that affect community vulnerability and that more-tailored questions related to the fishing industry were more reliable than general measures of socioeconomic status. Developers noted, for example, that some of the included measures (e.g., access to services, transportation) are more relevant for urban settings. While the indices included in this chapter have been used in important research and policy efforts and have contributed to both gains in knowledge and localized solutions to existing challenges, it will be important to consider whether they work equally well in predicting social risk for all types of communities and populations (i.e., whether they are one-size-fits-all measures) or should be modified to better reflect community context.

3. Administrative Measures of Social Risk

There are many government programs that employ measures of social risk to allocate resources. Programs that are targeted to underserved, under-resourced, or historically marginalized groups with the purpose of addressing inequities need to have administrative means of identifying their targets to fulfill their legislative mandates. In this chapter, we focus on existing programs designed to address social risk factors in patient populations and the providers that serve them and highlight the measurement methods that these programs used to determine appropriate uses of public funds.

As described in Appendix A, we conducted an environmental scan for programs that use administrative definitions of social risk to identify health care providers and populations. These programs were designed to fill gaps in access to care affecting disadvantaged communities and to compensate providers who care for patient populations with high health burden and low ability to pay, concerns that broadly align with ASPE's current concerns with using payment to address social risk factors. For each program, we describe the underlying rationale and structure, the measures and how they fit into the overall program, and the details of the data sources and measure calculations.

Disproportionate Share Hospital Programs

The federal government provides supplemental payments to safety-net hospitals through two disproportionate share hospital (DSH) programs, one in Medicare and one in Medicaid. Both programs are designed to financially compensate hospitals that provide care to uninsured or low-income patients; Medicaid coverage is frequently used as the indicator of low income. The justification for these programs is based on the financial implications for the hospitals of treating these patients; Medicaid reimbursement is generally lower than reimbursement by Medicare or commercial insurance for the same services, which creates disadvantages for hospitals where a large portion of patients are Medicaid beneficiaries. Uninsured patients are likely to be unable to pay medical bills in full and more likely to have their care covered by funds set aside for uncompensated care or counted as a financial loss. Although these programs are focused on the financial impact on hospitals, in effect, they are identifying hospitals according to the proportion of their patients with certain social risk factors, based primarily on income and health insurance coverage. Medicaid coverage is simultaneously a measure of social risk (because having low income is a criterion for eligibility) and a financial burden on the hospitals that treat Medicaid beneficiaries. The measures used in the DSH programs are described in Table 3.1, and additional details on the formulas used to calculate each measure are provided in Figure C.1 in Appendix C.

Table 3.1. Measures Used in the Medicare and Medicaid Disproportionate Share Hospital Payment Programs

Program	Measure	Level of Measurement	Data Source	Time Lag	Description
Medicare	Disproportionate patient percentage (DPP)	Hospital	Healthcare Provider Cost Reporting Information System	2 years	Used to identify hospitals that qualify for DSH payment in Medicare. Defined by two measures of the proportion of inpatient days attributable to low-income patients.
Medicare	Alternate special exception method	Hospital	Healthcare Provider Cost Reporting Information System	2 years	Used to identify hospitals that require financial support but do not meet criteria based on the DPP. Defined by location in an urban area, large size, and percentage of revenue from state and local government sources for indigent care (other than Medicare and Medicaid).
Medicaid	Medicaid inpatient utilization rate	Hospital	DSH hospital audit	5 years	Used to identify hospitals that qualify for DSH payment in Medicaid. Defined by the proportion of inpatient days attributable to Medicaid beneficiaries.
Medicaid	Low-income utilization rate	Hospital	DSH hospital audit	5 years	Used to identify hospitals that qualify for DSH payment in Medicaid. Defined by the proportion of revenues that derive from public sources and the proportion of inpatient charges attributed to charity care.

Medicare Disproportionate Share Hospital Program

Eligibility for the Medicare DSH payment is determined by a hospital's disproportionate patient percentage (DPP), a measure of the proportion of the hospital's inpatient services that are attributable to low-income patients (CMS, 2022a). DPP, as shown in Table 3.1, is defined as the sum of two components (see Figure C.1 for the formula). One component is the proportion of total Medicare days attributable to patients with low income, as indicated by receipt of Supplemental Security Income. The other component is the proportion of total patient days attributable to patients who have Medicaid coverage and no Medicare coverage. Data for calculating the DPP are reported to CMS by hospitals through annual cost reports submitted to the Healthcare Provider Cost Reporting Information System (White, 2018). Although the cost reports are updated annually and the data set is updated quarterly, the lag between the reporting period and the public release of complete cost report data is about two years. Hospitals with a DPP above 15 percent qualify for the Medicare DSH payment program.

There is an alternative method for qualifying for the Medicare DSH payment program that was designed to capture hospitals that might not meet the 15-percent DPP criterion but nonetheless require additional financial support to sustain services for low-income populations. According to the alternative criteria, hospitals can qualify for the program if they are located in an urban area, they have 100 or more beds, and at least 30 percent of their total net inpatient care

revenues come from state and local government sources for indigent care (not including Medicaid and Medicare).

Medicaid Disproportionate Share Hospital Program

In contrast to the Medicare DSH program, the Medicaid DSH program affords states considerable flexibility in allocating payments to hospitals. States are able to select hospitals to receive Medicaid DSH payments according to their own criteria, within some federal guidelines. The measures used in these guidelines, referred to as the *Medicaid inpatient utilization rate* and the *low-income utilization rate*, assess the extent to which the hospitals provide care to low-income patients. Specifically, the guidelines specify that states must allocate DSH payments (1) to all hospitals with a Medicaid inpatient utilization rate of at least one standard deviation above the mean for all hospitals in the state and (2) to all hospitals with a low-income utilization rate exceeding 25 percent. There is also a requirement that all hospitals receiving Medicaid DSH payments must have a Medicaid inpatient utilization rate of at least 1 percent.

As shown in Figure C.1, the Medicaid inpatient utilization rate is defined in law as the number of days of care provided to Medicaid beneficiaries divided by the total number of days the hospital has provided care during the observation period (Section 1923(b)(2) of the Social Security Act [Social Security Administration, undated]). The low-income utilization rate is designed to reflect the proportion of revenues the hospital receives that are attributable to Medicaid or a state or local governmental source. As shown in Figure C.1, it is calculated as the unweighted sum of (1) total hospital revenue from Medicaid or state and local governments divided by total hospital revenue for patient services and (2) total charity care hospital charges for inpatient services minus revenues from state and government divided by total hospital charges (Medicaid and CHIP Payment and Access Commission, 2016; Social Security Administration, undated).

Data used at the federal level to administer the Medicaid DSH program are reported by state Medicaid agencies to CMS through audited financial reports. These reports are submitted only for hospitals receiving Medicaid DSH payments; no comparable information is available from about half of hospitals in the United States because they do not receive these payments. There is a delay of about five years between the time the payments are made and the publishing of data from these reports.

Health Care Shortage Designations

The Health Resources & Services Administration (HRSA) maintains two systems for identifying geographic areas, populations, and facilities that lack adequate access to health care services. In these programs, local need is generally determined by a combination of measures of supply of health care services and measures of underlying medical and social risk. One of these two programs is the Health Professional Shortage Area (HPSA) program, which designates

counties or regions within counties, populations, and facilities as in need of additional clinical capacity. HPSAs are designated for three types of services: primary care, mental health, and dentistry. The HPSA designation is used in a large number of federal programs, including the National Health Service Corps HRSA, undated b) and the CMS HPSA Bonus Payment Program (Medicare Learning Network, 2017). The other program defines medically underserved areas (MUAs) and medically underserved populations (MUPs). (We combine these into a single abbreviation [MUA/P] when discussing the program as a whole.) MUA/P designation is currently used in multiple federal programs, including the HRSA Health Center Program (HRSA, undated a), the CMS Rural Health Clinic Program, and the J-1 Visa Waiver Program (Quigley, 2022).[2]

HPSAs are defined by a process whereby state primary care offices submit applications for HPSA designation according to standard criteria and, after review, can receive approval for designation by HRSA. The criteria are different for each of the three disciplinary HPSA types (Table 3.2). Three criteria apply in all cases: the provider-to-population ratio, the percentage of the population below the federal poverty level (FPL), and the travel time to the nearest source of care. The primary care HPSA criteria also include an infant health index, and the dental health HPSA criteria include a measure of water fluoridation. The mental health HPSA criteria include measures of alcohol and substance use and the proportions of the population that are youth or elderly. HPSA designations are updated on the HRSA public website on a daily basis and reviewed every three years.

Table 3.2. Scoring for Designation as an HPSA, by Type, and Medically Underserved Area or Population

Measure	Level of Measurement	Calculation: Component (weight in points)
Primary care HPSA	0–25 points	Provider-to-population ratio (10 points) + percentage of population below FPL (5 points) + infant health index (5 points) + travel time to NSC (5 points)
Dental health HPSA	0–26 points	Provider-to-population ratio (10 points) + percentage of population below FPL (10 points) + water fluoridation status (1 point) + travel time to NSC (5 points)
Mental health HPSA	0–25 points	Provider-to-population ratio (7 points) + percentage of population below FPL (5 points) + elderly ratio (3 points) + youth ratio (3 points) + alcohol abuse prevalence (1 point) + substance abuse prevalence (1 point) + travel time to NSC (5 points)

[2] Another federal program that designates health care facilities for additional financial support is the Critical Access Hospital (CAH) program. However, the criteria for designation as a CAH do not include any reference to social risk factors. CAH designation criteria refer to rural location (non-urbanized, as defined by the Census Bureau), the number of acute care inpatient beds, the average length of stay for acute care patients, provision of emergency care 24 hours per day and seven days per week, and distance from other hospitals.

Measure	Level of Measurement	Calculation: Component (weight in points)
Index of Medical Underservice (IMU)	0–100 points	Provider-to-population ratio (28.7 points) + percentage of population below FPL (25.1 points) + percentage of population age 65 or over (20.2 points) + infant mortality rate (26 points)

NOTE: NSC = nearest source of care.

HPSAs can be defined for areas, populations, or facilities. Area-based HPSAs can be entire counties or areas within counties that constitute rational areas for the delivery of health services (42 C. F.R. Part 5). Counties can, therefore, be *full-county* HPSAs, if they qualify according to total area, or *partial-county* HPSAs, if they do not qualify as full-county HPSAs but have areas within them that qualify. Population-based HPSAs are defined by the following characteristics: low income (defined as population at or below 200 percent of the FPL); Medicaid-eligible population (30 percent of the population at or below 200 percent of the FPL); migrant farmworkers; migrant seasonal workers; Native American population (American Indian/Alaska Native [single-race] population); homeless population. Facility-based HPSAs can be state or federal correctional facilities, state mental hospitals, or other public or nonprofit medical facilities serving a population or geographic area designated as a HPSA. There is also a category of facilities that receive automatic designation as HPSAs (referred to as *Auto-HPSAs*), which includes Federally Qualified Health Centers (FQHCs), FQHC look-alikes (HRSA-designated clinics that receive partial benefits of the FQHC designation), Indian Health Facilities, and CMS-certified rural health clinics.

MUA/Ps are defined as areas or populations (but not facilities) with a shortage of primary care professional health services. An MUA, which is defined according to the same "rational area for delivery of health care" criteria used to define area-based HPSAs, can be a whole county, a group of contiguous counties, a group of urban census tracts, or a group of county and civil divisions. An MUP, defined according to the same population characteristics as those used for population-based HPSAs, is a population that faces economic, cultural, or linguistic barriers to health care access. In either case, designation is based on the Index of Medical Underservice (IMU), which is a weighted sum of four measures of need for medical services, as shown in Table 3.2: the provider-to-population ratio, the proportion of the population below the FPL, the percentage of the population age 65 or over, and the infant mortality rate. To calculate the IMU, each quantity is scaled so that a higher score indicates better access to care or lower need, and the quantities are summed, using weights that were developed by an expert panel process in 1974, to form the IMU (Health Services Research Group, 1975). A score of 62 or lower qualifies an area or population for MUA/P designation.

The data used to evaluate the HPSA and MUA/P criteria are drawn from the Shortage Designation Management System (SDMS), a standardized database developed for the HPSA program in 2013 (HRSA, 2020). The SDMS draws data from a variety of sources, as shown in

Table C.1. States may provide additional data related to the HPSA or MUA/P criteria. For instance, water fluoridation data may come from the Centers for Disease Control and Prevention (CDC), and data on county-level prevalence of alcohol and substance misuse prevalence may come from the National Survey on Drug Use and Health. Data in the SDMS are updated annually and are publicly available.

It is important to note that both the HPSA and MUA/P programs designate areas for which applications are submitted by state primary care offices. This means that the designation of areas and populations in need depends on their identification by local or state officials. Although the criteria applied to the areas are the same, the definitions of the area boundaries are up to the applicants. There can be many possible ways to define areas or populations that meet the standard of being a rational area for health care delivery. In this sense, these programs are fundamentally different from programs that systematically apply a set of criteria to geographic areas or populations.

Medicare Measures

Medicare makes use of social risk measures in multiple programs, including the Low-Income Subsidy program, also known as Extra Help, and its quality measure reports, which are stratified by patient characteristics (Martino, Elliott, Dembosky, et al., 2021a). In this report, we do not describe all of the uses of these measures within the large and complex Medicare program, but we aim to identify the measures that are used.

Dual Eligibility

Medicare beneficiaries can qualify for a variety of federal and state programs if they concurrently meet eligibility criteria for Medicaid. An important example is eligibility for certain Medicare Special Needs Plans that are designed for specific subgroups of dually enrolled individuals (Medicare.gov, undated). Dual enrollment in Medicare and Medicaid is a marker of low income. Because the specific criteria for eligibility for Medicaid differ across states, *full dual eligibility* is generally granted to recipients of Supplemental Security Income (SSI). Qualification for SSI is established by the federal government using income and asset thresholds. Medicare also defines *partial dual eligibility* for the purpose of determining eligibility for four Medicare Savings Programs, shown in Table C.2.

Low-Income Subsidy

Medicare provides financial support under the Part D prescription drug benefit to beneficiaries with low incomes and financial resources through the Low-Income Subsidy, a program also known as Extra Help. A partial subsidy is available to beneficiaries with incomes below 150 percent of the FPL and limited financial assets. In 2022, the 150-percent FPL limit was $20,385 for individuals and $27,465 for couples. The limit on financial assets is set at

$15,510 for individuals and $30,950 for couples (Social Security Administration, 2022). A higher level of financial support, a full subsidy, is available to beneficiaries with income and assets below lower thresholds.

Stratified Quality Reporting

CMS reports quality measures by several beneficiary characteristics. Stratification of measures is done to create incentives for quality-improvement efforts that address disparities in quality, in addition to improvement in overall quality of care (CMS, 2022b). Currently, CMS reports Medicare quality measures by race and ethnicity, gender, income, and rural location (Martino, Elliott, Haas, et al., 2021c).

Race and Ethnicity

There are two sources of data on race and ethnicity used in Medicare stratified quality measure reports. First, for measures that are based on the Medicare Consumer Assessment of Healthcare Providers and Systems survey, information on race and ethnicity is based on self-report (Martino, Elliott, Haas, et al., 2021c). The survey asks, "Are you of Hispanic or Latino origin or descent?" The response options are "Yes, Hispanic or Latino," and "No, not Hispanic or Latino." The survey then asks, "What is your race? Please mark one or more." Response options are "White," "Black or African American," "Asian," "Native Hawaiian or other Pacific Islander," and "American Indian or Alaska Native." As is done in the U.S. Census, responses to these items are used to classify respondents into seven mutually exclusive categories: *American Indian or Alaska Native*, *Asian or Pacific Islander*, *Black*, *Hispanic*, *multiracial*, *White*, and *unknown*.

Second, for measures drawn from the Healthcare Effectiveness Data and Information Set, race and ethnicity data are imputed using the Medicare Bayesian Improved Surname and Geocoding method, which draws on information from Medicare administrative data, surname, and residential location (Haas et al., 2019). This method achieves high concordance with self-reported race and ethnicity for American Indian/Alaska Native, Asian or Pacific Islander, Black, Hispanic, and White beneficiaries (Martino, Elliott, Dembosky, et al., 2021b). Ongoing work aims to improve concordance for other racial and ethnic groups.

Gender

Information on gender is taken from administrative records. Gender is recorded as male or female.

Income

Beneficiaries are considered low income if they are either dually eligible, as defined above, or recipients of a low-income supplement, as defined above (Martino, Elliott, Dembosky, et al., 2021a).

Rurality

Medicare beneficiaries can be classified as rural or urban by linking their mailing addresses to the Census Bureau core-based statistical areas (CBSAs) in which they are located. Beneficiaries living in a metropolitan statistical area, defined as a CBSA with a core urban area of 50,000 people or more, are classified as *urban*. Beneficiaries living in a micropolitan statistical area, with a core area of between 10,000 and 50,000 people, and beneficiaries living outside a CBSA are classified as *rural*.

Clinical Records

Data on patient-level social risk factors can be collected directly from patients and recorded in electronic health records and medical claims. Data collected in this way have the potential to enhance the measurement of social risk factors, going beyond the demographic characteristics that are commonly collected in enrollment data or available by linking patient data with external sources. In particular, the collection of data on time-varying characteristics of patients, such as current housing situation, would need to be conducted in the course of care. However, these measures are not yet commonly used in administrative programs. Moreover, there is evidence that electronic health records systems do not accurately record information on race and ethnicity, with poorer accuracy for non-Hispanic White individuals. The two most highly developed approaches are the *International Classification of Diseases*, tenth revision, (ICD-10) Z-codes and screening instruments for SDOH.

ICD-10 Z-Codes

Z-codes Z-55–Z-65 are a set of ICD-10 codes used to report social, economic, psychosocial, and environmental factors that contribute to a patient's health status (CMS, 2021). As shown in Table 3.3, the codes cover a very wide variety of circumstances. Some of the codes focus on current circumstances and are likely to change over time. For instance, Z56 covers problems related to the patient's current employment status, and Z64 covers problems related to pregnancy. Other codes focus on conditions that are determined early in life, such as Z61 and Z62, which refer to childhood events. Although there is a focus in this coding system on current circumstances affecting health and health care, which aligns it with the definition of HRSN, the classification also includes SDOH, such as poverty.

Although Z-Codes cover many important aspects of social risk in patients, studies have shown that they are rarely used (Truong et al., 2020; Weeks et al., 2020). For example, CMS reports that, among the 33.1 million Medicare fee-for-service beneficiaries, 1.59 percent had claims with a Z-code in 2019 (CMS, 2021). The low use of Z-codes likely reflects the infrequent and nonsystematic assessment of the conditions that the codes indicate in the course of clinical care. Use of Z-codes requires that clinicians ask about the conditions, patients respond accurately, and the responses are recorded in the health record and on the billing claim form.

Table 3.3. ICD-10 Codes Z55–Z65: Persons with Potential Health Hazards Related to Socioeconomic and Psychosocial Circumstances

Code	Category	Example Subcategories
Z55	Problems related to education and literacy	Illiteracy and low-level literacy; educational maladjustment and discord with teachers and classmates
Z56	Problems related to employment and unemployment	Unemployment, unspecified; discord with boss and workmates; difficult conditions at work
Z57	Occupational exposure to risk factors	Occupational exposure to noise; occupational exposure to vibration; occupational exposure to dust
Z58	Problems related to physical environment	Exposure to noise; exposure to tobacco smoke; exposure to water pollution
Z59	Problems related to housing and economic circumstances	Homelessness; extreme poverty; lack of adequate food
Z60	Problems related to social environment	Atypical parenting situation; acculturation difficulty; target of perceived adverse discrimination and persecution
Z61	Problems related to negative life events in childhood	Removal from home in childhood; problems related to alleged sexual abuse of child by person within primary support group; problems related to alleged physical abuse of child
Z62	Other problems related to upbringing	Inadequate parental supervision and control; institutional upbringing; emotional neglect of child
Z63	Other problems related to primary support group, including family circumstances	Problems in relationship with spouse or partner; absence of family member; disruption of family by separation and divorce
Z64	Problems related to certain psychosocial circumstances	Problems related to unwanted pregnancy; problems related to multiparity; discord with counselors
Z65	Problems related to other psychosocial circumstances	Conviction in civil and criminal proceedings without imprisonment; problems related to release from prison; exposure to disaster, war, and other hostilities

SOURCE: World Health Organization, 1993.

SDOH

While the Z-codes provide one mechanism for recording social risk factors in clinical records, there is also interest among researchers and policymakers in systematic screening for social risk factors (Andermann, 2018; Davidson and McGinn, 2019). Although many screening instruments use the term SDOH, they often focus on what we distinguish in this report as HRSN—i.e., the immediate social circumstances affecting a patient's health or health care. The AHC screening tool, referenced in the introduction to this report, is one example among many of these screening tools that have been proposed or tested (Billioux et al., 2017). While a review of these tools is beyond the scope of this report, this approach is important to mention as an emerging strategy that has yet to be fully examined. Another approach to identifying social risk

factors in medical records that does not make use of screening is to apply natural language processing methods to identify predictors of health or health care (Navathe et al., 2018). This approach draws on any available information in the medical record, which might include a mixture of SDOH and HRSN. Additional research is required to assess the viability of this emerging approach.

Conclusion

Assessment of social risk among patient populations and for the providers who treat them, in the broad sense described in this chapter, has been an important part of multiple federal programs for decades. These programs generally rely on data that are collected administratively. Some of the data are collected for reasons unrelated to the programs in question, such as Medicaid enrollment data, and some are collected as part of administering the programs, such as for HPSA designation. The measures themselves tend to be limited to single measures of socioeconomic position (e.g., income) or aggregate measures of select population characteristics. The population measures tend to be much simpler than the measures of social risk described in the previous chapter. Coverage of the social risk domains and indicators listed in the introduction by the administrative measures described in this chapter is sparse. For the DSH, HPSA, and MUA/P programs, there are no indicators covering the domains of race, ethnicity, and cultural context; gender; social relationships; or social needs. The Medicare program uses income, race and ethnicity, rurality, and gender, but only as univariate measures. The clinical measures provide much more comprehensive coverage of the social risk domains and indicators, but collection of these data has not yet been proven feasible at scale.

4. Payment Models That Incorporate Social Risk Factors

We conducted a search of the peer-reviewed and grey literature to identify payment models currently in use that incorporate one or more social risk factors. We limited our search to (1) prospective or fee-for-service payment models that adjust payments according to one or more measures of social risk and (2) other funding arrangements specifically devoted to building provider capacity to address social needs. We excluded from the review payment models that condition incentive payments on performance addressing social needs or that adjust scores on performance measures based on patients' social risk factors. Appendix A includes a more detailed description of the literature search strategy that we used to identify payment models eligible for the review. We recognize that incorporating social risk factors into payment models is a rapidly evolving field and that the current review might not include all models currently being implemented if details of their methodology have yet to be made public.

In the remainder of this chapter, we describe the seven payment models identified in our search and the context in which these models are used. We then compare the features of the seven models, including the social risk factors used in each model and the data sources used to measure each factor. We highlight the strengths and limitations of these payment models that might be relevant for policymakers as they consider enhancing payment models in the Medicare program. Next, we provide a high-level overview of examples of other payment models that are designed to support provider efforts to address social needs through capacity-building projects but in which payments are not linked to measures of social risk. We conclude with examples of health-sector resource allocation outside the United States that incorporate measures of social need. Detailed information on each payment model can be found in Appendix D.

Seven Payment Models That Incorporate Social Risk Factors

We identified seven payment models that incorporate one or more social risk factors (Table 4.1). Among the models we identified, all were implemented within the past six years and three were implemented in 2020 or later. All seven are used in state Medicaid programs, consistent with the higher level of social need within the Medicaid-eligible population. Three of the models, which are used by four state Medicaid agencies, are used to adjust payments to managed care organizations (MCOs), while the four other models are used to adjust payments to providers. In all four provider payment models, payments are made to organizations that participate in specific value-based care models, including accountable care organizations (ACOs) and health homes. None of the four provider-focused payment models adjust traditional fee-for-service payments according to measures of social risk, nor do they focus on payments to hospitals, with the exception of hospitals participating in these value-based care models. Both fee-for-service

payment models and payment models that target hospitals specifically would have been eligible for inclusion in our review.

Table 4.1. Payment Models Included in the Review

Category	Model	Description
Payments to health plans	MassHealth payments to MCOs	The Massachusetts Medicaid Agency, MassHealth, adjusts capitation payments to MCOs to incorporate three enrollee-level social risk factors and two area-level measures of social risk. The agency uses a statistical model to measure the relationship between each risk factor and annual spending per enrollee and derives a relative risk score for each enrollee that is used to adjust the capitation payment.
	Arizona Health Care Cost Containment System (AHCCCS) Complete Care payments to MCOs	Arizona's Medicaid Agency, AHCCCS, adjusts capitation payments to MCOs participating in the AHCCCS Complete Care program. The adjustment incorporates four enrollee-level social risk factors and one area-level measure.
	Washington state and Hawaii Medicaid agency payments to MCOs	The Washington State Health Care Authority and Hawaii's Medicaid agency make higher capitation payments to MCOs for Medicaid enrollees who are homeless. Both states use a methodology that was developed by their actuary, Milliman.
Payments to providers	MassHealth payments to ACOs	The Massachusetts Medicaid Agency, MassHealth, adjusts payments to ACOs to incorporate three enrollee-level social risk factors and two area-level measures of social risk. The agency uses a statistical model to measure the relationship between each risk factor and annual spending per enrollee and derives a relative risk score for each enrollee that is used to adjust payments. The nature of the payment adjustment varies across the three types of ACO models available in MassHealth: • Accountable Care Partnership Plan: Adjusted capitation payments are made to each partnership involving a provider-led ACO and a single MCO (13 ACOs in 2018). • Primary Care ACO: Fee-for-service payments are made from MassHealth to ACO providers, and savings or losses are determined by comparison with an adjusted total-cost-of-care target (three ACOs in 2018). • MCO-Administered ACO: Adjusted capitation payments are made to MCO (or MCOs), and MCOs pay the ACO according to a state-approved payment arrangement (one ACO in 2018).
	Minnesota Integrated Health Partnership quarterly population-based payments (PBPs)	Minnesota's Medicaid agency adjusts quarterly population-based care-coordination payments to Integrated Health Partnerships (IHPs)—organizations that are accountable for the costs and quality of care for their Medicaid enrollees. The PBPs incorporate measures of social risk for each IHP's enrollees and are included in the total-cost-of-care calculation that determines each IHP's share of savings or losses at the end of each year.
	New York Health Homes Serving Adults	New York's Health Homes program, authorized through Section 2703 of the Affordable Care Act (Pub. L. 111-148, 2010), allows for the reimbursement of selected high-value services, such as outreach and care management, for eligible Medicaid enrollees. For New York's Health Home Serving Adults program, providers receive higher payments for care-management services for enrollees who are identified as high risk.
	MaineCare permanent supportive housing Community Care Teams	MaineCare provides permanent supportive housing support through Community Care Teams, a specialized set of providers that support members with eligible chronic conditions in accessing and sustaining housing and meeting other needs through whole-person care coordination and health

Category	Model	Description
		promotion. Permanent supportive housing Community Care Teams are paid on a per-member, per-month basis that varies across three service tiers (intensive, stabilization, and maintenance).

Comparison of Payment Models That Incorporate Social Risk Factors

The seven payment models vary in the number and types of social risk factors used to adjust payments and the data sources used to measure each risk factor (Table 4.2). The payment models also vary in the methodology used to determine the magnitude of the payment adjustment based on the measures of social risk. These details are included in Appendix D, along with information about the magnitude of the payment adjustment to the extent that this information is available. In five of the seven models, higher payments to health plans and providers made on behalf of enrollees with social risk factors are not linked to requirements to use these payments to address enrollees' HRSN. By contrast, for two payment models, the New York Health Homes Serving Adults and MaineCare permanent supportive housing Community Care Team models, higher payments are linked to care-management and care-coordination services. Payments through MaineCare's program can also be used to cover the costs of health promotion activities, transitional care services, individual and family support services, and referral to community and social support services.

In the remainder of this section, we describe the social risk factors used in each model and the data sources used to measure them.

Table 4.2. Characteristics of Included Payment Models

Category	Model and Implementation Date	Social Risk Factors Included	Data Sources
Payments to health plans	MassHealth payments to MCOs (2016)	• Housing problems • Disability • Serious mental illness (SMI) • Opioid use disorder (OUD) • NSS7 • Rural	Claims (Z-codes and medical diagnoses), state administrative data (addresses, program participation), U.S. Census
	AHCCCS Complete Care payments to MCOs (2020)	• Housing problems • Child/parent problems • Family problems • Criminal problems • SVI	Claims (Z-codes), U.S. Census
	Washington state and Hawaii Medicaid agency payments to MCOs (2020)	• Homelessness	Claims (Z-codes)
Payments to providers	MassHealth payments to ACOs (2018)	• Housing problems • Disability • SMI • OUD • NSS7	Claims (Z-codes and medical diagnoses), state administrative data (addresses, program participation), U.S. Census

Category	Model and Implementation Date	Social Risk Factors Included	Data Sources
		• Rural	
	Minnesota Integrated Health Partnership quarterly population-based payments (2018)	• Deep poverty (below 50 percent of the FPL) • Homelessness • Past incarceration • SMI, severe and persistent mental illness, or substance use disorder (SUD)	Self-report, enrollee addresses, state department of corrections
	New York Health Homes Serving Adults (2016)*	• Homelessness • Criminal justice involvement	Health Home Tracking System High, Medium, Low (HML) assessment
	MaineCare permanent supportive housing Community Care Teams (2022)*	• Homelessness • Experience of abuse or trauma • Legal issues • Social relationships and networks	Service Prioritization Decision Assistance Tool (SPDAT)

NOTES: Appendix D contains additional details for each payment model.
* Higher payments under these models must be linked to care-management and care-coordination services or other support services.

Social Risk Factors

Homelessness or housing instability features prominently in all seven payment models, which may reflect extensive, empirical evidence that housing problems are associated with increased health care spending or simply that the seven Medicaid agencies have placed a high level of priority on addressing housing problems in their states. Criminal justice involvement, legal problems, or both are incorporated into four of the seven payment models. Inclusion of these measures is notable because they are not commonly included in models of SDOH or in screening measures of HRSN. Only a single payment model, used in Minnesota's Integrated Health Partnership (IHP) program, incorporates an enrollee's economic status (an indicator of income less than 50 percent of the FPL). Behavioral health conditions, including serious mental illness (SMI) and substance use disorder (SUD), or opioid use disorder (OUD) specifically, are explicitly incorporated in three models used in two states, even though behavioral health conditions are already incorporated in medical risk scores used to adjust payments in both states. The inclusion of behavioral health conditions in these models is presumably based on evidence that behavioral health conditions independently predict higher health care spending above and beyond an individual's risk score and may be a better proxy for social needs.

The seven payment models draw overwhelmingly on two of the six domains of our SDOH framework. All of the payment models include indicators from the social needs domain, and most include some measures of residential and community context. However, few models incorporate socioeconomic position; race, ethnicity, and cultural context; gender; or social relationships. This could be due to the fact that these factors might not have a strong or direct relationship with health care expenditures or that state Medicaid agencies might be unwilling to make resource-allocation decisions that favor certain groups over others.

Area-level indices of social need, such as those described in Chapter 2, are not used in isolation in any of the payment models we identified in our review. Rather, in two of the seven models in which area-level indices are used, they supplement person-level measures of social risk. The Massachusetts Medicaid Agency, MassHealth, uses the NSS7, a seven-item composite measure of socioeconomic indicators measured at the enrollee census block-group level along with five person-level social risk factors. MassHealth also uses residence in a rural area to adjust payments, but this is the only Medicaid agency we identified that includes a measure of rurality. Arizona's Medicaid agency includes a modified version of the Social Vulnerability Index (SVI) in its payment model.

Six of the seven payment models use multiple social risk factors to adjust payments. The only exception is the model used in both Washington state and Hawaii, which uses a single risk factor, homelessness. This observation, along with the fact that housing problems are included in all seven payment models in our review, might reflect a deliberate decision by these two states to focus on a single, high-need population that could lay the groundwork for subsequent expansions of their adjustment methodology. Finally, in all but one model, person-level measures reflect discrete risk factors. However, as discussed below, Arizona's Medicaid agency, the Arizona Health Care Cost Containment System (AHCCCS), uses ranges of SDOH codes (Z-codes) that combine multiple domains of social needs into a single measure.

Data Sources

The seven payment models use four different data sources: (1) U.S. Census data, (2) claims data, (3) state administrative data, and (4) provider or agency assessments. U.S. Census data are used to construct the two area-level social risk factors discussed above, while the three other types of data sources support the measurement of person-level social risk factors. In this section, we limit our discussion to the latter three data sources.

Claims Data

Four models use claims data to measure SDOH or behavioral health conditions, including all three health plan payment models. In three of the four models, Z-codes are used in combination with other administrative data. For example, MassHealth measures homelessness using Z-codes but also uses documentation of three or more different addresses for the enrollee within a single calendar year in its enrollment data to measure housing instability. The combined measure provides a more comprehensive measure of "housing problems." Payment models might also vary in their use of a single Z-code or multiple Z-codes for a single construct. For example, Washington and Hawaii use code Z59.0 for homelessness, whereas Arizona uses all codes nested within Z59 to create a single indicator. Thus, in Arizona, this indicator includes Z59.4 ("lack of adequate food"), Z59.5 ("extreme poverty"), Z59.6 ("low income"), and Z59.7 ("insufficient social insurance and welfare support"). The low prevalence of Z-code reporting on claims raises some question about the validity of payment adjustments that rely entirely on Z-codes. However,

supplementing social risk factors derived from Z-codes with area-level risk factors, a strategy that MassHealth and AHCCCS appear to have pursued, could mitigate this problem. The impact of including Z-codes in payment models on the frequency of their use and their validity has not been examined in rigorous studies. However, evidence from the Medicare Advantage program suggests that conditioning payments on the reporting of diagnosis codes can significantly affect the use of these codes (Kronick and Welch, 2014).

Administrative Data

Three payment models leverage state administrative data to measure social risk factors. Addresses in Medicaid enrollment data and self-reported homelessness captured in the state's existing enrollment process are used to measure homelessness or housing instability in the MassHealth and Minnesota payment models.[3] Disability, income, and history of incarceration are also measured using databases from state agencies within these states. Using administrative databases like these might be more difficult for CMS than for state Medicaid agencies. For example, states might have better access to data from their correctional facilities or homeless shelters, while nationwide implementation of social risk adjustment in payment models might necessitate linking state-level data from all states, depending on the risk factor.

Provider or Agency Assessments

Two payment models measure social risk factors through an assessment tool. In New York's Health Homes Serving Adults program, a semiannual assessment known as the High, Medium, Low (HML) assessment[4] supports the program's two-tier payment structure by collecting information that is used to classify patients into risk groups. The Service Prioritization Decision Assistance Tool (SPDAT) is an assessment tool that was developed to support agencies that provide services to homeless populations and helps identify individuals with the greatest need for services. Details on the frequency of the SPDAT assessment used in MaineCare's Permanent Supporting Housing Community Care Team program are not available. While these assessment tools provide rich, person-level data on medical and social conditions, the burden of administering them might limit their feasibility for use on a national scale.

Funding Targeted Toward Building Capacity to Address Social Needs

Our review identified several initiatives designed to provide targeted funding to providers and other organizations to build capacity to address social needs through staffing, technology,

[3] As noted above, MassHealth identifies enrollees with three or more address changes in a year as having housing instability. Minnesota's Medicaid agency uses addresses corresponding to either homeless shelters or transitional housing to identify homelessness.

[4] HML refers to high, medium, or low risk. Although New York previously used a three-tier rating structure for adults, it now uses two tiers (*high-risk* and *non-high risk*).

and other care-redesign strategies. We anticipate that many other local, state, and federal initiatives have similar infrastructure-building components. Therefore, we highlight three examples that are mentioned frequently in the literature and that CMS might consider as it identifies opportunities to address social needs for Medicare beneficiaries outside of traditional payment systems. Table 4.3 displays activities that are supported by these capacity-building initiatives:

- **AHC Model.** In this payment model, which is currently being tested by the Center for Medicare and Medicaid Innovation, "bridge organizations" receive up-front funding to develop and implement processes to systematically screen Medicare beneficiaries for social risks and refer them to social service providers. If an evaluation of the payment model finds that it is budget neutral for the federal government, the model could be expanded by the Secretary of HHS under authority granted by the Affordable Care Act. This payment model is noteworthy in that it provides funds to organizations that might not be providers or health plans and deliberately targets both screening and referral for social needs—two key interventions that are widely viewed by policymakers as critical to addressing social needs.
- **New York's Delivery System Reform Incentive Payment (DSRIP) SDOH projects.** As part of this initiative, providers who participated in value-based care models with MCOs in the state were eligible to receive up-front funding from MCOs to support delivery system improvements if they focused on addressing SDOH. While providers were given the flexibility to choose the specific projects that aligned with their needs, the state provided a comprehensive menu of options. Although subsequent project funds were drawn down because of the achievement of milestones, the up-front payments used in this program and the menu of projects are two features of this model that CMS might consider in a future payment model.
- **Medi-Cal's Whole Person Care initiative.** Medi-Cal, California's Medicaid agency, operated this program from 2015 to 2020 and recently extended it through the California Advancing and Innovating Medi-Cal program. The program provided funding to counties to conduct pilot studies that focused on addressing SDOH. Many of the funded projects included care-coordination programs, data- and information-sharing initiatives, and other supportive services and interventions. Although funding for the projects provided by the state to the counties was deliverable-based rather than prospective, the program provides a model for local jurisdictions (as opposed to providers) to invest in high-priority capacity-building projects.

Table 4.3. Activities Supported by Selected Funding Programs That Address Social Needs

Activity*	AHC Model	New York's DSRIP SDOH Projects	Medi-Cal's Whole Person Care Initiative
Social risk screening	X	X	X
Referrals for community services	X	X	X
Workforce development	X	X	X
Data- and information-sharing	X	X	X
Continuous quality-improvement programs	X	X	X
Supportive services		X	X
Local jurisdiction capacity-building projects		X	X

* Activities are not exhaustive.

Health-Sector Financing Based on Social Need—Examples from Outside the United States

U.S. policymakers might draw on the experiences of other countries that have a long history of using measures of social risk to allocate funding for health service delivery. In this section, we highlight the resource-allocation models used in two countries identified in our review: New Zealand and the United Kingdom, whose models appear to be among the most widely cited models in the literature. Although these models might be useful to inform efforts in the United States, we caution that they might not be representative of all resource-allocation approaches used outside the United States. In addition, a more in-depth examination of the performance of these models would help identify key lessons about their use, but such an assessment was beyond the scope of our review.

New Zealand has adjusted payments to providers since the 1980s using a nine-item area-level measure of socioeconomic deprivation called the New Zealand Index of Deprivation (NZDep) (Huffstetler and Phillips, 2019).[5] The measure uses New Zealand census data to calculate a deprivation decile for each geographic unit. The measure is updated every five years in tandem with the country's quinquennial census, and the items used to construct the measure are refined or replaced during each update. In the most recent version, NZDep2018, the items were (1) no internet access at home, (2) enrollment in means-tested programs, (3) low household income, (4) unemployment, (5) low educational attainment and/or lack of certificates, (6) not living in own home, (7) living in single-parent household, (8) low bedroom occupancy rate in household, and (9) presence of dampness or mold in living space (Atkinson, Salmond, and Crampton, 2019). The government uses the index to adjust funding to its 20 district health boards, which includes adjustments to capitation payments for primary care services and funding for both specialist

[5] The current measure uses approximately 24,000 areas in the country known as *Statistical Area 1s* that have an average of 100 to 200 residents each.

services and hospital care. One estimate based on the 1997 version of the index noted that the payment adjustments could increase funding by as much as threefold (Huffstetler and Phillips, 2019).

The United Kingdom uses a methodology called the *global sum allocation formula* (sometimes referred to as the *Carr-Hill formula*) to determine the amount of core funding for each general practitioner, which is supplemented with incentive-based payments (Kontopantelis et al., 2018). The formula indirectly addresses "additional needs of patients" by accounting for the association between the frequency of patient visits to each practice and two area-level measures: (1) standardized mortality ratios and (2) standardized limited long-standing illness (SLLI) (Kontopantelis et al., 2018). SLLI measures the extent to which adults report having one or more chronic conditions that limit their activities (NHS Digital, 2014), and it reflects data collected through the Health Survey for England between 1998 and 2000. Stakeholders have raised concerns that the current formula does not sufficiently account for social deprivation, and, because of these concerns, the minimum practice income guarantee was introduced in 2004 to ensure that core funding did not drop below historical levels (Kontopantelis et al., 2018).

Conclusion

We identified seven payment models, all of which are used to adjust payments to health plans or providers participating in state Medicaid programs, that each incorporate one or more social risk factors. All seven payment models incorporate enrollee housing problems, and all but one incorporate other social risk factors. The common focus on homelessness and related issues, such as behavioral health, disability, trauma, family or social problems, and past incarceration, highlights how these social problems affect health care use. While most of the measures are captured in our model of SDOH, some of the payment models use measures related to legal problems and criminal justice involvement that are not included in our model. Some of the payment models also recognize and work to build capacity in the community to address these social issues.

In terms of data sources, several payment models draw on social risk factors measured in claims while several others use administrative data sources (often in combination with claims) or assessments completed by providers or representatives of state agencies. The limited number of examples identified in our review indicates that, despite widespread interest, these types of payment adjustments remain relatively novel. Moreover, in a few cases, the models have evolved over time and their current features might differ from those described above, depending on the publication dates of the sources included in our review. More in-depth engagement with state officials could provide greater insight into the rationale for the selection of specific risk factors, implementation challenges, and perceptions of model effectiveness in channeling additional payments to health plans or providers that serve patients with higher levels of social need. Additional interviews with health care providers could help identify how these additional

payments may have helped support individuals with social needs. Apart from provider payment models, federal policymakers could draw on examples of targeted funding programs that are designed to build capacity to address social needs through up-front funding streams and that give stakeholders the flexibility to address local priorities. Finally, the decades-long experience of other countries that have used measures of social need to allocate funding for health services could provide valuable lessons to U.S. policymakers.

5. Conclusion

In its prior reports to Congress, ASPE has highlighted the need to address social risk factors in the design of health care payment models as an important part of the broader effort to develop and assess policies that address systemic drivers of inequality in health and health care. As ASPE continues to contribute to the design of payment models that address underlying issues of health equity, measurement of social risk factors will be a prime concern. This report contributes to those ongoing efforts by providing an informational resource on existing methods for measuring social risk factors through area-level indices and administrative data and incorporating these measures into health care payment models. Specifically, we have surveyed indices of social deprivation that are used in the scientific literature, measures used in administrative programs to identify providers and patients with social risk factors, and current payment models that incorporate measures of social risk—a rapidly evolving area.

There is a long history of measuring social risk using indices that combine indicators across multiple domains in the social science and public health literatures, as reflected in the large number of indices described in Chapter 2. While there is wide variation in the specific indicators used in these measures, as a group they have relatively broad coverage of the domains of social risk displayed in Table 1.1 that are discussed in current payment policy literature. However, these measures tend to have poorer coverage of indicators in the social needs domain, such as interpersonal safety and food insecurity. In addition, these measures have the weakest connections to specific health care providers, although these connections could potentially be strengthened with additional methodological research.

In contrast, the measures that have historically been used in administrative programs tend to have much more limited coverage across the domains of social risk but stronger connections to individual providers. The most frequently used indicator of social risk in these measures is income, specifically low income versus non–low income as a binary indicator of risk. The data for some of the administrative measures are collected in ways that are consistent, in that they follow a common set of procedures, but not systematic, in that they rely on local initiatives or clinical practices. The emerging efforts to collect social risk information from patients in the course of clinical care or through screening have the broadest coverage of the social needs domain. However, collection of this information is not common in current practice, and evidence that these data can be validly and equitably collected on a much larger scale is lacking.

In contrast with the social deprivation indices and administrative measures, the measures used in existing payment models tend to focus more on current HRSN, such as homelessness, rather than underlying structural factors, such as racial identity or educational attainment. The most commonly measured indicators in these models are related to current housing status. Where other domains are included, the payment models make use of indices of area-level measures,

such as those reviewed in Chapter 2, or administrative measures derived from data collected by state agencies (e.g., Medicaid, behavioral health, criminal justice), rather than collecting new patient-level information. There is also wide variation in the measures used. Other than housing status, no indicator appears in a majority of the models examined. In addition, the models take account of factors outside the identified social risk domains, such as criminal justice involvement, experiences of trauma, and behavioral health conditions.

Despite the long history of measuring social risk factors and using such information to administer programs, the inclusion of such measures in payment models remains uncommon, with only a handful of such models being implemented at the state level. The catalog of approaches to measuring social risk that we have provided in this report should serve as a resource for ASPE as it considers designs for payment models that address social risk going forward. Implementation of new payment models that use these measures will require rigorous methodological and empirical study. The results of this project will provide important background for those future efforts.

Appendix A. Methods

In this appendix, we provide details on the methods we used to conduct the environmental scans to identify area-level indices of social risk, administrative data that signal social risk, and payment models that adjust for social risk.

Area-Level Indices of Social Risk

Search Strategy

We engaged a RAND librarian to help develop a search strategy of peer-reviewed and grey literature published between 2010 and 2022 to identify existing area-level indices of social risk. We used the AHC HRSN screening tool as a reference to develop search terms relevant to community services. The tool consists of five core domains (housing instability, food insecurity, transportation problems, utility help needs, and interpersonal safety) and eight supplemental domains (financial strain, employment, family and community support, education, physical activity, substance use, mental health, and disabilities).

We began with a comprehensive list of search terms that included terms representing core categories of measure type (e.g., *index*, *indices*, *inventory*, *atlas*), risk and resilience (e.g., *social risk*, *social vulnerability*, *social determinants*, and keywords related to specific types of social determinants), and area (i.e., *population*, *neighborhood*, *community*, *county*, *state*, *national*, *zip code*, *census tract*, *block group*). We narrowed and refined the list of terms after a series of test searches to yield articles of highest relevance. We searched for terms using the title, abstract, and subject fields to capture articles that mentioned the use of an index in the methods. Databases searched were the Academic Search Complete, PubMed, Scopus, Sociological Abstracts, and Web of Science. The final search strategy yielded 1,428 de-duplicated publications. We then reviewed the publication abstracts for promising indices; this step yielded 94 relevant indices for further review.

Inclusion and Exclusion Criteria

Before reviewing the indices, we developed a series of exclusion criteria:

- Indices that focus on one domain were excluded given that social risk is widely considered to be multidimensional and individual measures often have geographic patterns distinct from one another that can generate divergent results of social risk when viewed in isolation. We also excluded compilations of individual measures that are examined separately (e.g., the Robert Wood Johnson Foundation County Health Rankings), which were common in dashboards, and other data visualization tools.

- International indices were excluded unless they had been adapted for use in the United States.
- Indices based on localized or one-time survey data or designed to assess the social risk of individuals without the intent to aggregate to a geographic area were excluded.
- Indices that generate estimates at only the state or national level (to facilitate cross-country comparisons) were excluded.
- Indices that were developed ad hoc as part of a single research study were excluded.

Three members of our team reviewed the manuscripts for additional details on the indexes and did additional ad hoc searching to learn more about each index, which included identifying the original methods papers and any relevant websites. In about 90 percent of cases, a clear inclusion or exclusion call was able to be made. For the remaining 10 percent, we discussed each index and came to a consensus. Of the 94 indices identified, 26 moved on to full abstraction.

Abstraction Process

We abstracted the following information from each index using a standardized abstraction form: developer; intended use; components and data sources; methodology for deriving index values, including weights; level of disaggregation (e.g., census tract, county); frequency of updates; data availability; cost; and other relevant index characteristics. We drew on multiple sources of information for each index to complete the abstraction form. Through this process, an additional five indices were deemed out of scope, yielding a final selection of 21 indices.

Administrative Measures of Social Risk

Search Strategy

The search for administrative measures of social risk started from a preliminary list provided by ASPE. Building on this list, we created a list of programs that use indicators of social risk that were referenced in reports from ASPE and NASEM on social risk factors or in studies identified in the literature review for area indicators of social risk. A preliminary list of programs and the measures that they use was shared with ASPE and other federal partners for their review. An additional list of relevant programs that was provided by HRSA was incorporated into the final list.

Inclusion and Exclusion Criteria

Measures were included if they are used in administrative systems to identify social risk. Measures were considered to be measures of social risk if they were designed to identify individuals, providers, or areas that are socially disadvantaged. Measures were included if they have a social risk component, even if they also have other components that are not assessments of social risk. Measures that are entirely based on health status and measures that are not used on a national level were excluded.

Abstraction Process

We reviewed information available through government websites and related documentation on the identified programs to identify the measures that each program uses to assess social risk. We conducted searches of government websites, grey literature reports, and peer-reviewed literature to characterize each measure in detail. The features of the measures that were collected were the purpose for which the measure was developed, the original source of data for the measure and its availability, the components of the measure, and any weighting used in its calculation.

Payment Models That Incorporate Social Risk Factors

Search Strategy

We conducted searches of both the peer-reviewed literature and the grey literature. We used the PubMed database to search the peer-reviewed literature spanning 2010 to 2022. To scan the grey literature, we conducted a Google Advanced Search that covered the same period. The peer-reviewed literature search covered three concepts or keywords: (1) *payment models* (which included such terms as *accountable care*, *bundled payment*, *capitation*, *value-based payment*, *value-based purchasing*, and *shared savings*); (2) *adjustment*; and (3) *social risk factors* (which included such terms as *homelessness*, *housing instability*, *food insecurity*, *poverty*, *social isolation*, *social needs*, *social risk*, *socioeconomic*, and *transportation*). The Google Advanced Search was limited to a single search with two concepts: *value-based payment* and *social determinants of health*. For both searches, we identified specific payment models contained in each publication, and then we conducted additional searches to find more-detailed information about each model.

Inclusion and Exclusion Criteria

We included payment arrangements that involved either prospective payments to providers or health plans or fee-for-service payments to providers that adjust payments according to one or more measures of social risk. We also included other funding arrangements specifically devoted to building provider capacity to address social needs. We excluded payment models that condition incentive payments on performance addressing social needs or that adjust scores on performance measures based on patients' social risk factors. We also excluded models in which payments are made for the delivery of social services or for care-coordination services without an explicit payment adjustment based on one or more social risk factors.

Abstraction Process

We abstracted information about provider or health plan payment models into an abstraction form. The abstraction form included fields for the social risk measures used, data sources used to

construct each measure, algorithm or statistical model used to determine the magnitude of the payment adjustment, magnitude of payment adjustment, year of first implementation, and information about implementation challenges. Few studies reported specific implementation challenges. We developed narrative summaries for the most commonly cited capacity-building payment models identified in the search.

Appendix B. Social Vulnerability Indices

This appendix provides more-detailed abstraction tables for each index included in Chapter 2, presented in alphabetical order:

1. Agency for Healthcare Research and Quality (AHRQ) Socioeconomic Status (SES) Index
2. ADI
3. Baseline Resilience Indicators for Communities (BRIC)
4. Census Bureau Community Resilience Estimates
5. Child Opportunity Index (COI) 2.0
6. Composite Index of SES
7. COVID-19 Vaccine Coverage Index (CVAC)
8. Distressed Communities Index
9. Minority Health SVI
10. Multidimensional Deprivation Index (MDI)
11. Multidimensional SDOH Index
12. Neighborhood Concentrated Disadvantage Index
13. Neighborhood Deprivation Index
14. Neighborhood Socioeconomic Status (NSES)
15. NSS7
16. Opportunity Index
17. Social Capital Index
18. Social Deprivation Index (SDI)
19. Social Vulnerability to Environmental Hazards Index (SoVI)
20. SVI
21. Townsend Index (adapted for the United States).

AHRQ Socioeconomic Status Index

Table B.1. AHRQ Socioeconomic Status Index

Description	The AHRQ SES Index was developed to facilitate a better understanding of racial and ethnic disparities in health outcomes among the Medicare population. The goal was to develop a multidimensional measure of SES using census data that could help parse out factors associated with observed health disparities, particularly separating race and ethnicity from commonly correlated socioeconomic factors.[1]
Components	*All variable descriptions are quoted from Bonito et al., 2008, Table 2, p. 69.*[1] **Occupation** 1. The percentage of persons in the block group who are 16 years of age and older and in the labor force but are unemployed **Income** 2. The percentage of persons in the block group living below the federal poverty level 3. A standardized measure of the median household income in the block group . . . standardized to range from 0-100

	Wealth 4. A standardized measure of the median value of owner-occupied dwellings in the block group . . . standardized to range from 0-100 **Educational attainment** 5. The percentage of persons 25 years of age or older with less than a 12th grade education 6. The percentage of persons 25 years of age or older who completed at least four years of college **Crowding** 7. The percentage of households that average one or more persons per room
Level of disaggregation	Census block group
Data source	2000 Census
Most recent year and frequency of data update	2008. The developers did not release a data update, but they provide detailed methodology to recreate the index.
Data available for download?	No
How index is calculated	The developers ran a principal components analysis on the seven variables above using data from more than 211,000 block groups. The developers used the loadings on the first principal component to create the variable weight for the index. Scores were "derived by multiplying the measure's values times the respective weights estimated by the principal components analysis and summing them"[1] (p. 42). The developers divided the index into quartiles based on the distribution of scores.
Changes to index over time	None identified
Considerations	• The index was created using a Medicare population, and generalizability to other populations is unknown. • No updates to the index have been released since 2008. • There is no cost to use the index, but it would require programmer time to create updated scores.
Citation	1. Arthur J. Bonito, Carla Bann, Celia Eicheldinger, and Lisa Carpenter, *Creation of New Race-Ethnicity Codes and Socioeconomic Status (SES) Indicators for Medicare Beneficiaries: Final Report*, Rockville, Md.: Agency for Healthcare Research and Quality, AHRQ Publication No. 08-0029-EF, January 2008.
Where to access data	Not applicable

Area Deprivation Index

Table B.2. Area Deprivation Index

Description	The ADI was developed in 2003 by Singh[1] (full citation provided below) to facilitate temporal analyses of health outcomes (originally mortality) in relation to an area-based deprivation measure. The index drew inspiration from and builds upon cross-sectional and place-based work showing the relationships between health outcomes and deprivation, as well as international efforts to document such relationships. The ADI was subsequently adapted by researchers at the University of Wisconsin–Madison, and it was made publicly available so that it could be used more widely in research and to inform policy.[2]

Components	*All variable descriptions are quoted from Kind et al., 2014, Appendix 1.3* **Education** 1. Percentage of population aged 25 years or older with less than 9 years of education 2. Percentage of population aged [25 years or older] with at least a high school diploma **Income** 3. Median family income [in U.S. dollars] 4. Income disparity (defined [in 1990] as the log of 100 x the ratio of the number of households with less than $10 000 in income to the number of households with $50 000 or more in income) 5. Percentage of families below the poverty level 6. Percentage of population below 150% of the poverty threshold **Housing** 7. Median home value 8. Median gross rent 9. Median monthly mortgage 10. Percentage of owner-occupied housing units 11. Percentage of occupied housing units without complete plumbing **Employment** 12. Percentage of employed persons aged 16 years or older in white collar occupations 13. Percentage of civilian labor force population aged 16 years or older unemployed **Household characteristics** 14. Percentage of single-parent households with children younger than 18 15. Percentage of households without a motor vehicle 16. Percentage of households without a telephone 17. Percentage of households with more than 1 person per room
Level of disaggregation	Census block group
Data source	ACS five-year estimates; current scores use 2014–2018[4]
Most recent year and frequency of data update	2019. The frequency of updates is unknown; prior updates occurred in 2018, 2015, and 2013.[4]
Data available for download?	Yes, but accessing data requires login with their system. There is no cost to create a login.
How index is calculated	The index was originally developed using data from the 1990 census. Singh conducted a factor analysis on 21 variables, and two factors were identified.[1] 17 variables (above) clustered together and had larger loadings on the first factor, which formed the basis of the ADI.[1] Singh's methods to create the ADI include weighting the 17 indicators using factor score coefficients.[1] The variables are then "multiplied by their factor weights and then summed for each geographic unit. The result is then transformed into a standardized index (the ADI) by arbitrarily setting the index mean at 100 and SD [standard deviation] at 20" (p. 14).[3]
Changes to index over time	The ADI has evolved slightly over time[1-2,4] and was most recently updated by researchers at the University of Wisconsin–Madison.[2,4] Changes and updates to the ADI are documented in a change log on their website.[6] Recent updates include the use of more-recent ACS data, updates to suppression and imputation criteria, and other changes in methodology.
Considerations	• Validated with a wide variety of health outcomes at the census block-group level.[2,3] • Developers have created a cross reference of "over 69 million nine-digit Zip Codes to allow [the ADI] to be merged with . . . other data resources."[2] • No cost to access the data, although a free login is required to download data. • Website[4] provides maps and an interactive platform to visualize the data.

	• Researchers examining the strength of association between the ADI and hospitalization rates found that the "10-km local ADI estimates had the strongest associations . . . followed by estimates at 20 km, 30 km, and the regional scale."[5]
Citations	1. Gopal K. Singh, "Area Deprivation and Widening Inequalities in US Mortality, 1969–1998," *American Journal of Public Health*, Vol. 93, No. 7, July 2003. 2. Amy J. H. Kind and William R. Buckingham, "Making Neighborhood-Disadvantage Metrics Accessible: The Neighborhood Atlas," *New England Journal of Medicine*, Vol. 378, No. 26, June 28, 2018. 3. Amy J. H. Kind, Steve Jencks, Jane Brock, Menggang Yu, Christie Bartels, William Ehlenbach, Caprice Greenberg, and Maureen Smith, "Neighborhood Socioeconomic Disadvantage and 30-Day Rehospitalization: A Retrospective Cohort Study," *Annals of Internal Medicine*, Vol. 161, No. 11, December 2, 2014. 4. Center for Health Disparities Research, University of Wisconsin School of Medicine and Public Health, Neighborhood Atlas, homepage, May 1, 2018. As of April 28, 2022: https://www.neighborhoodatlas.medicine.wisc.edu 5. Andrew R. Maroko, Thao M. Doan, Peter S. Arno, Megan Hubel, Shirley Yi, and Deborah Viola, "Integrating Social Determinants of Health with Treatment and Prevention: A New Tool to Assess Local Area Deprivation," *Preventing Chronic Disease*, Vol. 13, September 15, 2016. 6. Center for Health Disparities Research, University of Wisconsin School of Medicine and Public Health, Neighborhood Atlas change log, undated. As of April 28, 2022: https://www.neighborhoodatlas.medicine.wisc.edu/changelog
Where to access data	Center for Health Disparities Research, University of Wisconsin School of Medicine and Public Health, Neighborhood Atlas change log, undated. As of April 28, 2022: https://www.neighborhoodatlas.medicine.wisc.edu

Baseline Resilience Indicators for Communities

Table B.3. Baseline Resilience Indicators for Communities

Description	The BRIC was developed to help identify communities that will need help in the face of a hazardous event and to facilitate comparisons of community resilience.[1] Developers note that the index might be particularly useful for public health and emergency response officials for resource allocation.
Components	*All variable descriptions are quoted from Cutter et al., 2014, pp. 69–70, Table 2.2* **Social resilience** 1. Negative absolute difference between % population with college education and % population with less than high school education 2. % of population below 65 years of age 3. % households with at least one vehicle 4. % households with telephone service available 5. % population proficient English speakers 6. % population without sensory, physical, or mental disability 7. % population under age 65 with health insurance 8. Psychosocial support facilities per 10,000 persons 9. Food security rate 10. Physicians per 10,000 persons **Economic resilience** 11. %owner-occupied housing units 12. % labor force employed 13. Negative Gini coefficient

	14. % employees not in farming, fishing, forestry, extractive industry, or tourism 15. Negative absolute difference between male and female median income 16. Ratio of large to small businesses 17. Large retail stores per 10,000 persons 18. % labor force employed by federal government **Community capital** 19. % population not foreign-born persons who came to US within previous five years 20. % population born in state of current residence 21. % voting age population participating in presidential election 22. Persons affiliated with a religious organization per 10,000 persons 23. Civic organizations per 10,000 persons 24. Red cross volunteers per 10,000 persons 25. Red cross training workshop participants per 10,000 persons **Institutional resilience** 26. Ten year average per capita spending for mitigation projects 27. % housing units covered by National Flood Insurance Program 28. Governments and special districts per 10,000 persons 29. Presidential disaster declarations divided by number of loss-causing hazard events from 2000 to 2009 30. % population in communities with Citizen Corps program 31. Proximity of county seat to state capital 32. Proximity of county seat to nearest county seat within a Metropolitan Statistical Area 33. Population change over previous five year period 34. % population within 10 miles of nuclear power plant 35. Crop insurance policies per square mile **Housing/infrastructure resilience** 36. % housing units not manufactured homes 37. % vacant units that are for rent 38. Hospital beds per 10,000 persons 39. Major road egress points per 10,000 persons 40. % housing units built prior to 1970 or after 2000 41. Hotels/motels per 10,000 persons 42. Public schools per 10,000 persons 43. Rail miles per square mile 44. % population with access to broadband internet service **Environmental resilience** 45. Farms marketing products through Community Supported Agriculture per 10,000 persons 46. % land in wetlands 47. Megawatt hours per energy consumer 48. Average percent perviousness 49. Inverted water supply stress index
Level of disaggregation	County
Data sources	30 different data sources from the Census Bureau, the Federal Emergency Management Agency, the U.S. Geological Survey, the U.S. Bureau of Labor Statistics, the U.S. Department of Agriculture, the U.S. Department of Education, the Energy Information Administration, the Federal Communications Commission, the U.S. Forest Service, the Nuclear Regulatory Commission, Oak Ridge National Laboratory, the University of South Carolina Hazards Vulnerability & Resilience Institute, the Association of Religion Data Archives, the Environmental Working Group, Feeding America, *The Guardian*, and the American Red Cross, as well as one proprietary data set from Dun & Bradstreet.
Most recent year and frequency of data update	2015. The frequency of updates unknown; the last update was in 2010.
Data available for download?	Yes

How index is calculated	All variables "are scaled from 0 to 1 with 1 meaning increasing resilience in a procedure called linear min-max scaling (where X-min/max-min). This allows for the unit standardization of the input variables and the normalization of values ranging from 0-1." The values of the variables in each sub-index (resilience category) are then averaged to create an overall score for that category.[2,3] "Once constructed, the sub-index scores are summed to create the overall BRIC score, which theoretically ranges from 0-6 for each county."[3]
Changes to index over time	Unknown
Considerations	• Extensive list of data providers, including one with proprietary data that requires a paid subscription, might make this difficult to update without a significant resource investment. • Data for 2015 update utilized inputs from 2005 to 2013, and frequency of updates to input data sets is not clear.
Citations	1. NAPSG Foundation, "Baseline Resilience Indicators for Communities," index, 2015. As of April 28, 2022: https://experience.arcgis.com/experience/376770c1113943b6b5f6b58ff1c2fb5c%20/page/BRIC/ 2. Susan L. Cutter, Kevin D. Ash, and Christopher T. Emrich, "The Geographies of Community Disaster Resilience," *Global Environmental Change*, Vol. 29, November 2014. 3. University of South Carolina College of Arts and Sciences, "BRIC: Baseline Resilience Indicators for Communities," webpage, undated a. As of April 28, 2022: https://sc.edu/study/colleges_schools/artsandsciences/centers_and_institutes/hvri/data_and_resources/bric/index.php
Where to access data	NAPSG Foundation, "Baseline Resilience Indicators for Communities," index, 2015. As of April 28, 2022: https://experience.arcgis.com/experience/376770c1113943b6b5f6b58ff1c2fb5c/page/BRIC/

Census Bureau Community Resilience Estimates

Table B.4. Census Bureau Community Resilience Estimates

Description	The Community Resilience Estimates were developed by the Census Bureau to help community leaders and stakeholders assess the resiliency of communities and plan potential mitigation and recovery strategies.[1]
Components	*All variable descriptions are quoted from U.S. Census Bureau, 2021, p. 3.*[1] 1. Income-to-Poverty Ratio < 130 percent 2. Single or zero caregiver household - only one or no individuals living in the household who are 18–64 3. Unit-level crowding defined as > 0.75 persons per room 4. Communication barrier defined as either 5. Limited English-speaking households 6. No one in the household over the age of 16 with a high school diploma 7. No one in the household is employed full-time, year-round. The flag is not applied if all residents of the household are aged 65 years or older 8. Disability posing constraint to significant life activity 9. Persons who report having any one of the six disability types: hearing difficulty, vision difficulty, cognitive difficulty, ambulatory difficulty, self-care difficulty, and independent living difficulty 10. No health insurance coverage 11. Being aged 65 years or older 12. Households without a vehicle

	13. Households without broadband Internet access
Level of disaggregation	Census tract
Data sources	2019 ACS individual- and household-level restricted ACS microdata are used to determine the number of individual risk factors. Age, sex, and race and ethnicity data are drawn from the Census Bureau's Population Estimates Program.
Most recent year and frequency of data update	2019. The 2019 quick guide was released August 2021. The frequency of data updates moving forward is unknown.
Data available for download?	Yes
How index is calculated	The Community Resilience Estimates are calculated by adding up the number of risk factors for each person. "For household level variables, if the household meets the criteria for the risk flag, every individual in the household receives that risk flag."[2] Of note, the *communication barrier risk factor* (defined as limited English-speaking households OR no one over the age of 16 with a high school diploma), is not double counted if both criteria are met.[1] The Community Resilience Estimates provide "estimates of the total number of people living in a community by the number of risk factors: 0 risk factors (low risk), 1-2 risk factors (medium risk), 3 or more risk factors (high risk).[2]
Changes to index over time	A prior version of the Community Resilience Estimates was released in 2020, and "estimates utilized the 2018 ACS 1-year microdata, 2018 PEP data, and information from the National Health Interview Survey (NHIS). For [the 2019 Community Resilience Estimates], the NHIS health factors were removed, two ACS risk factors were updated, and 2 risk factors were added. These decisions were made after discussing the data needs of various federal and state agencies, stakeholders, and partners" (p. 3).[1]
Considerations	• Uses one year of data, which might provide more-current assessment of risk. • Informed by stakeholders, policymakers, and partners in community resilience.
Citation	1. U.S. Census Bureau, Department of Commerce, *2019 Community Resilience Estimates: Quick Guide*, updated August 10, 2021. As of April 29, 2022: https://www2.census.gov/programs-surveys/demo/technical-documentation/community-resilience/cre_quickguide_2019.pdf 2. U.S. Census Bureau, "Methodology," webpage, last updated March 2, 2022. As of September 20, 2022: https://www.census.gov/programs-surveys/community-resilience-estimates/technical-documentation/methodology.html
Where to access data	U.S. Census Bureau, "Community Resilience Estimates Datasets," webpage, last revised October 8, 2021. As of May 1, 2022: https://www.census.gov/programs-surveys/community-resilience-estimates/data/datasets.html

Child Opportunity Index 2.0

Table B.5. Child Opportunity Index 2.0

Description	COI 2.0 was developed by diversitydatakids.org[1] to create a measure of resources and conditions that matter for children's health and development and to facilitate comparisons of child opportunity across geographic regions and over time.
Components	*All variable descriptions are quoted from Noelke et al., 2020, p. 10.*[1] **Education** 1. Number of early childhood education centers within a 5-mile radius

	2. Number of NAEYC [National Association for the Education of Young Children] accredited centers within a 5-mile radius 3. Percent 3- and 4-year-olds enrolled in nursery school, preschool or kindergarten 4. Percent third graders scoring proficient on standardized reading test 5. Percent third graders scoring proficient on standardized math tests 6. Percent ninth graders graduating from high school on time 7. Ratio of students enrolled in at least one AP [Advanced Placement] course to the number of 11th and 12th graders 8. Percent 18–24 year-olds enrolled in college within 25-mile radius 9. Percent students in elementary schools eligible for free or reduced-price lunches 10. Percent teachers in their first and second year 11. Percent adults ages 25 and over with a college degree or higher **Health and environment** 12. Percent households without a car located further than a half-mile from the nearest supermarket 13. Percent impenetrable surface areas such as rooftops, roads or parking lots 14. EPA [U.S. Environmental Protection Agency] Walkability Index 15. Percent housing units that are vacant 16. Average number of Superfund sites within a 2-mile radius 17. Index of toxic chemicals released by industrial facilities 18. Mean estimated microparticle concentration 19. Mean estimated 8-hour average ozone concentration 20. Summer days with maximum temperature above 90F 21. Percent individuals ages 0–64 with health insurance coverage **Social and economic** 22. Percent adults ages 25–54 who are employed 23. Percent workers commuting more than one hour one way 24. Percent individuals living in households with incomes below 100% of the federal poverty threshold 25. Percent households receiving cash public assistance or Food Stamps/Supplemental Nutrition Assistance Program 26. Percent owner-occupied housing units 27. Percent individuals ages 16 and over employed in management, business, financial, computer, engineering, science, education, legal, community, service, health care practitioner, health technology, arts and media occupations 28. Median income of all households 29. Percent family households that are single-parent headed.
Level of disaggregation	Census tract
Data sources	COI 2.0 draws on several data sources, including the American Community Survey, EDFacts, the Stanford Education Data Archive, the Civil Rights Data Collection, the National Center for Education Statistics Common Core of Data, the U.S. Department of Agriculture, the CDC, the U.S. Environmental Protection Agency, and other “data collection from state and federal sources” (p. 10).[1] It also includes data licensed from GreatSchools.
Most recent year and frequency of data update	2015. The frequency of updates is unknown. The report released in 2020 provided estimates for 2015 and 2010.
Data available for download?	Yes
How index is calculated	Raw variables were first standardized through *z*-score transformation and sorted according to one of three domains (education, health and environment, and social and economic; see above). After standardization, each indicator was measured on the same scale in both time periods to facilitate comparisons over time. Some scores were multiplied by –1 to ensure standardization in directionality. Weights were then generated through a multistep process. (See Noelke et al., 2020,[1] for the detailed approach.) Each standardized indicator was “multiplied by the respective weights and summed across weighted indicators to calculate domain scores for

	both periods" (p. 17). A similar approach was taken to calculate the overall COI scores, "regressing the respective outcomes on the domain scores, calculating weights and computing the overall COI score" (p. 17).
Changes to index over time	For COI 2.0, the developers increased the number of indicators to 29 from 19. COI 2.0 is available for almost all census tracts in the United States, a significant increase from those included in COI 1.0. In COI 2.0, individual component indicators and the composite index itself are comparable over time and across geographic areas, whereas, in COI 1.0, comparisons were limited to those within metropolitan areas. Modifications were also made to the weights; in COI 2.0, indicators have individual, varying weights depending on how strongly they predict health and economic outcomes, whereas all indicators were weighted equally in COI 1.0.[1]
Considerations	• Focus is on child opportunity. Generalizability to the larger population is unclear, although, as the developers note, "the neighborhoods where children live, learn, and play influence their later life outcomes, including their economic mobility, educational attainment and health" (p. 6).[1] • Some challenges with census tract reading and math proficiency estimates. • Some school-level data are proprietary, such as math and reading achievement and high school graduation data.
Citation(s)	1. Clemens Noelke, Nancy McArdle, Mikyung Baek, Nick Huntington, Rebecca Huber, Erin Hardy, and Dolores Acevedo-Garcia, *Child Opportunity Index 2.0: Technical Documentation*, diversitydatakids.org, January 15, 2020.
Where to access data	diversitydatakids.org, Child Opportunity Index 2.0 database, 2022. As of May 2, 2022: https://data.diversitydatakids.org/dataset/coi20-child-opportunity-index-2-0-database

Composite Index of Socioeconomic Status

Table B.6. Composite Index of Socioeconomic Status

Description	The Composite Index of SES was developed by Yu and colleagues in 2013[1] to help researchers and other stakeholders study the relationship between SES and cancer outcomes in a way that minimizes the risk of disclosure of personally identifiable information. The index is made available to researchers upon request.
Components	*All variable descriptions are quoted from Yu et al., 2014, p. 83.*[1] **Occupation** 1. % working class **Unemployed** 2. % aged ≥ 16 years who are unemployed **Poverty** 3. % of persons below 150 % of poverty line 4. % of persons below poverty line **Income** 5. Median [household] income 6. % of total [household] income in the area derived from interest, dividends, and net rent **Education** 7. % aged ≥ 25 years and ≤ 12th grade of education 8. % aged ≥ 25 years and ≥ 4 years of education 9. Education index (weighted school years) **House** 10. % home worth ≥ $400 k 11. Median house value

	12. Median rent **Ownership** 13. % home ownership 14. % car ownership 15. % no telephone **Living crowdedness** 16. % of [households with] more than one person per room 17. % of [households with] only one room 18. % of {households without] kitchen 19. % of [households without] private plumbing
Level of disaggregation	Census tract
Data sources	2000 decennial census and ACS five-year estimates, 2005–2009
Most recent year and frequency of data update	2013. The developers did not release a data update, but they provide detailed methodology to recreate the index.
Data available for download?	No
How index is calculated	The developers performed a factor analysis on domains of SES that had previously been included in two composite census tract–based estimates of SES created by Kreiger et al. (2002) and Yost et al. (2001). All measures were normalized prior to the factor analysis. The developers "selected the first factor estimated from the factor analysis to be the SES index and estimated the SES score for each census tract" (p. 83).[1] The scores were then divided into equal tertiles and quintiles to facilitate class comparisons.
Changes to index over time	None identified
Considerations	• Index developed for a very specific use case and draws upon older data that would need updating. • Index scores are not readily available and would require programmer time and clarification of methods to update.
Citations	1. Mandi Yu, Zaria Tatalovich, James T. Gibson, and Kathleen A. Cronin, "Using a Composite Index of Socioeconomic Status to Investigate Health Disparities While Protecting the Confidentiality of Cancer Registry Data," *Cancer Causes & Control*, Vol. 25, No. 1, January 2014.
Where to access data	Not applicable

COVID-19 Vaccine Coverage Index

Table B.7. COVID-19 Vaccine Coverage Index

Description	The CVAC was developed by Surgo Ventures to identify communities where there are challenges with vaccine rollout and coverage.[1]
Components	All variable descriptions are quoted from Surgo Ventures, 2021, p. 4.[2] **Historic undervaccination** 1. Proportion of children age 35 months receiving ≥1 dose [of] MMR vaccine 2. Proportion of children age 35 months receiving ≥3 doses of polio vaccine 3. Proportion of children age 35 months receiving ≥4 doses [of] DTaP [diptheria, tetanus, pertussis] vaccine 4. Proportion of teens age 13–17 years up-to-date on HPV [human papillomavirus] vaccine 5. Proportion of adults receiving flu vaccine 6. Proportion of Medicare beneficiaries receiving pneumococcal vaccine 7. Nonmedical exemption rate from child school immunization

	Sociodemographic barriers 8. Proportion of racial and ethnic minority groups 9. Proportion of individuals without a bachelor's degree or higher 10. Median household income 11. Average unemployment rate March–October 2020 12. Proportion of individuals living below poverty level 13. Proportion of households without an internet connection 14. Proportion of individuals without a smartphone 15. Proportion of limited English-speaking households **Resource-constrained health system** 16. Vaccination provider workforce per capita 17. Infrastructure for vaccine administration per capita [e.g., medical facilities] 18. AHRQ Prevention quality indicator (PQI) overall composite 19. Health spending per capita 20. Total healthcare funding per capita **Health care accessibility barriers** 21. Proportion of individuals without health insurance coverage 22. Proportion of adults who reported that there was a time in the past 12 months when they needed to see a doctor but could not because of cost 23. Households without vehicle ownership 24. Transit Connectivity Index **Irregular care-seeking behavior** 25. Proportion of adults who reported that they did not have one or more individuals they thought of as a personal doctor or health care provider 26. Percent of children without a medical home 27. Proportion of individuals without visits to doctor for routine checkup 28. Percent of children (ages 0–17) who did not have both a medical and dental preventive care visit in the past 12 months
Level of disaggregation	County
Data sources	2016–2019 National Immunization Data, Behavioral Risk Factor Surveillance System, CMS Mapping Medicare Disparities Tool, ACS five-year estimates, U.S. Bureau of Labor Statistics Labor Force, HRSA, Area Health Resources File, U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages, U.S. Department of Homeland Security Homeland Infrastructure Foundation-Level Data, CDC Center for Preparedness and Response, Trust for America's Health, Kaiser Family Foundation, AllTransit, National Survey of Children's Health
Most recent year and frequency of data update	2021. The developers anticipated updating the index with the release of 2020 census data, although no date is provided for release.
Data available for download?	Yes
How index is calculated	The developers "used a stepwise percentile ranking process to generate a [composite] CVAC score and one score per theme . . . . First, indicator values were transformed into a percentile, a statistical measure ranking each data point in relation to other geographies (e.g. the 20th percentile represents the value below which 20% of the data points fall). Indicators ranks were then aggregated up to subthemes and ranked again across geographic regions. Subtheme ranks were aggregated into themes and then ranked to obtain the final theme scores. Finally, the theme scores were aggregated and ranked across geographies to create CVAC scores for each geographic unit (county and state). This methodology is similar to CDC's Social Vulnerability Index (SVI) and [the] US COVID-19 Community Vulnerability Index (CCVI). These stepwise aggregations of subcomponents were weighted equally across indicators, subthemes, and themes" (p. 9).
Changes to index over time	This is a new index. The developers note that updates are expected with additional validation work on the index and as more and more granular data are made available for use.
Considerations	• Newer index; more validation work is needed. • Index draws from numerous data sources, some of which are as old as 2014.

	• State-level data are used in some cases for all counties within a state, where county-level data are not available.
Citation(s)	Surgo Ventures, *The U.S. COVID-19 Vaccine Coverage Index (CVAC) Methodology*, version 1, updated March 4, 2021.
Where to access data	1. Surgo Ventures, "Precision for Covid: The U.S. COVID-19 Vaccine Coverage Index," webpage, undated. As of May 2, 2022: https://vaccine.precisionforcovid.org/ 2. Surgo Ventures, *The U.S. COVID-19 Vaccine Coverage Index (CVAC) Methodology*, version 1, updated March 4, 2021.

Distressed Communities Index

Table B.8. Distressed Communities Index

Description	The Distressed Communities Index was developed by the Economic Innovation Group[1] to provide a single, comparative measure of economic well-being across communities.
Components	*All variable descriptions are quoted from Economic Innovation Group, 2020, p. 5.*[1] 1. Percent of the 25-year-old+ population without a high school diploma or equivalent 2. Percent of habitable housing that is unoccupied, excluding properties that are for seasonal, recreational, or occasional use 3. Percent of the prime-age (25–54) population not currently employed 4. Percent of the population living under the poverty line 5. Median household income as a percent of metro area median household income (or state, for non-metro areas) 6. Percent change in the number of jobs from 2014 to 2018 7. Percent change in the number of business establishments from 2014 to 2018
Level of disaggregation	Zip code, for zip codes with 500 or more residents
Data sources	ACS five-year estimates, 2014–2018; Census Business Patterns data sets for the same years
Most recent year and frequency of data update	2020. The frequency of updates is not specified, but there have been four updates since 2015.
Data available for download?	Yes, but purchase of data license is required.
How index is calculated	"Each community's score on the index is equivalent to its percentile rank across all seven measures combined. To calculate the index, each community is ranked on each measure. Then each community's seven rankings are averaged, weighted equally, to create a preliminary score, which is in turn normalized into a final score that ranges from approaching 0 (most prosperous) to 100 (most distressed). Communities are then sorted into five even quintiles, or tiers, of economic well-being ranging from **prosperous** to **comfortable**, **mid-tier, at risk,** and **distressed**" (p. 6; emphasis in original).[1]
Changes to index over time	The 2000 Distressed Communities Index was calculated using data from the 2000 Decennial Census and Business Patterns data for 1996 and 2000. Zip code boundaries have shifted over time, and the number of zip codes included has also changed.
Considerations	• License to access the data costs $500, as of April 2022. • Published methods lack detail and full transparency, making it difficult to compare the index to others.

	• If employment estimates from Business Patterns were suppressed to protect privacy, the Distressed Communities Index used the next-highest-level geography to produce a growth estimate for inclusion in the index.
Citation	1. August Benzow, Kenan Fikri, Daniel Newman, Kennedy O'Dell, and John Lettieri, *Distressed Communities Index: The Spaces Between Us: The Evolution of American Communities in the New Century*, 4th ed., Economic Innovation Group, 2020.
Where to access data	Economic Innovation Group, "Distressed Communities: Get the Data," webpage, undated. As of May 1, 2022 https://eig.org/distressed-communities/get-the-data/

Minority Health Social Vulnerability Index

Table B.9. Minority Health Social Vulnerability Index

Description	The Minority Health SVI was developed by the CDC/Agency for Toxic Substances and Disease Registry (ATSDR) as an extension to the SVI "to enhance existing resources to support the identification of racial and ethnic minority communities at greatest risk for disproportionate impact and adverse outcomes due to the COVID-19 pandemic"[1] (p. 1).
Components	All variable descriptions are quoted from the "About" tab of the CDC/ATSDR Minority Health Social Vulnerability Index Explorer.[2] **SES** 1. Persons below poverty 2. Persons unemployed 3. Per capita income 4. Persons age 25+ with no high school diploma **Household composition and disability** 5. Persons aged 65 and older 6. Persons aged 17 and younger 7. Civilian noninstitutionalized population with a disability 8. Single parent household with children under 18 **Minority status and language** 9. American Indian/Alaska Native, Asian, African American, Native Hawaiian/Pacific Islander, Hispanic or Latinx, some other race alone 10. Spanish speakers who speak English less than "very well" 11. Chinese speakers who speak English less than "very well" 12. Vietnamese speakers who speak English less than "very well" 13. Korean speakers who speak English less than "very well" 14. Russian speakers who speak English less than "very well" **Housing type and transportation** 15. Multi-unit housing structures 16. Mobile homes 17. Crowding 18. Households with no vehicle available 19. Persons in group quarters **Health care infrastructure and access** 20. Hospitals 21. Urgent care clinics 22. Pharmacies 23. Primary care physicians 24. Persons without health insurance 25. Persons without internet access **Medical vulnerability** 26. Cardiovascular disease mortality per 100,000

	27. Diagnosed diabetes rate per 100,000 28. Obesity rate per 100,000 29. Chronic respiratory disease mortality per 100,000
Level of disaggregation	County
Data sources	ACS five-year estimates, 2014–2018; U.S. Department of Homeland Security Homeland Infrastructure Foundation-Level Data; HRSA; American Community Survey; CDC Interactive Atlas of Heart Disease and Stroke; U.S. Diabetes Surveillance System, Institute for Health Metrics and Evaluation[2]
Most recent year and frequency of data update	2021. The frequency of data updates is unknown.
Data available for download?	Yes
How index is calculated	Website points to methods for SVI, which are summarized here. (The SVI is calculated at the census-tract level, while the minority health SVI is calculated at the county level, presumably because of availability of data for newly added measures or to mask small cell sizes, or both). Developers "ranked census tracts within each state and the District of Columbia…[Developers] also ranked tracts for the entire United States against one another, for mapping and analysis of relative vulnerability in multiple states, or across the U.S. as a whole. Tract ranking are based on percentiles. Percentile ranking values range from 0 to 1, with higher values indicating greater vulnerability. For each tract, [developers] generated its percentile rank among all tracts for 1) the fifteen individual variables, 2) the four themes, and 3) its overall position. For each of the themes, [developers] summed the percentiles for the variables comprising each theme. [Developers] ordered the summed percentiles for each theme to determine theme-specific percentile rankings… For the overall tract rankings, [developers] summed the sums for each theme, ordered the tracts, and then calculated overall percentile rankings."[3]
Changes to index over time	This index is an extension of the SVI. The Minority Health SVI includes measures on two additional themes: health care infrastructure and access and medical vulnerability. It also includes measures specific to race and ethnicity categories and languages.
Considerations	• County-level measure, with the potential for variability within the county. • Although new, the index is based on the commonly used SVI.
Citations	1. David Rickless, Minh Wendt, and Juliet Bui, "Minority Health Social Vulnerability Index Overview," Agency for Toxic Substances and Disease Registry, Centers for Disease Control and Prevention, and U.S. Department of Health and Human Services Office of Minority Health, 2021. As of April 29, 2022: https://www.minorityhealth.hhs.gov/minority-health-svi/assets/downloads/MH%20SVI%20Overview_11.19.2021.pdf 2. Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, and U.S. Department of Health and Human Services Office of Minority Health, Minority Health Social Vulnerability Index Explorer, undated. As of May 1, 2022: https://onemap.cdc.gov/Portal/apps/MapSeries/index.html?appid=3384875c46d649ee9b452913fd64e3c4 3. Centers for Disease Control and Prevention, "CDC SVI 2016 Documentation," February 13, 2020. As of September 16, 2022: https://svi.cdc.gov/Documents/Data/2016_SVI_Data/SVI2016Documentation.pdf
Where to access data	Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, and U.S. Department of Health and Human Services Office of Minority Health, Minority Health Social Vulnerability Index Explorer, undated. As of May 1, 2022: https://onemap.cdc.gov/Portal/apps/MapSeries/index.html?appid=3384875c46d649ee9b452913fd64e3c4

Multidimensional Deprivation Index

Table B.10. Multidimensional Deprivation Index

Description	The MDI was developed by the Census Bureau to quantify SDOH within small geographic areas to examine their relationships with premature mortality.[1]
Components	*All variable descriptions are quoted from Glassman, 2021, p. 4.*[1] **Standard of living** 1. In poverty according to the official poverty measure. **Education** 2. Aged 19 or older and without a high school diploma or GED; based on head of household educational attainment for those under the age of 19. **Health** 3. For people under age 65: Lacked health insurance. For people age 65 and under: Lacked health insurance or reported at least two disabilities. **Economic security** 4. For people under age 65: Aged 18 and older and unemployed at the time of the survey; OR lived in a household in which average household hours worked OR average household weeks worked for working-age adults (age 18 to 64, not in school) was less than 20 hours a week or less than 26 weeks a year, respectively. For people age 65 and over: Unemployed at the time of the survey; OR worked less than 20 hours a week OR less than 26 weeks a year AND had minimal retirement income. **Housing quality** 5. Lived in a housing unit with more than two people per bedroom or lived in a shelter **Neighborhood quality** 6. Lived in a deprived block group as measured by the Area Deprivation Index: all block groups with an ADI score greater than 90.
Level of disaggregation	Individual, then aggregated to state. Lower levels of geography seem feasible but would need to be calculated.
Data sources	ACS one-year sample; data at the block-group level from the ADI
Most recent year and frequency of data update	The 2021 report utilized 2019 data. The frequency of data updates is unclear. The 2021 report included data from 2018 and 2019 and updated prior years. Given the reliance on ACS one-year samples, this index could be updated annually.
Data available for download?	No
How index is calculated	"The MDI is constructed using the Alkire-Foster method,[2] a widely-used flexible methodology in which individual-level indicators of deprivation in multiple dimensions are used to identify who is deprived and to assess the intensity of their deprivation. Similar to the poverty estimates using official thresholds from the CPS [Current Population Survey] ASEC [Annual Social and Economic Supplement], SIPP [Survey of Income and Program Participation] and ACS, the MDI is limited to the poverty universe - all persons except unrelated individuals under age 15 and individuals residing in institutional group quarters. A person is defined as deprived according to the MDI if they are deprived in at least two dimensions"[1] (p. 3).
Changes to index over time	In the 2021 report, developers made several changes to the MDI based on emerging research. Changes included revised definitions of health, to include health insurance and disability, and revisions to how economic security is measured, with different criteria for people under age 65 and people age 65 and older.

Considerations	• Generates estimates at an individual level. The developers aggregated up to a state level for the purpose of the report, but it is likely that smaller geographic areas could be calculated. • Data are not readily available and would require programming to generate. • Reliance on one-year estimates might better reflect current population and social risk within an area. • Draws upon the ADI as a measure of neighborhood quality. • "The MDI should be viewed as a completely separate measure from the [official poverty measure] OPM or [supplemental poverty measure] SPM. The OPM and SPM measure income security, while the MDI evaluates deprivations in a number of different areas along with income"[1] (p. 1).
Citation	1. Brian Glassman, "The Census Multidimensional Deprivation Index: Revised and Updated," Washington, D.C., U.S. Census Bureau, Social, Economic, and Housing Statistics Division, Poverty Statistics Branch, SEHSD Working Paper 2021-03, January 15, 2021.
Where to access data	Not applicable

Multidimensional SDOH Index

Table B.11. Multidimensional SDOH Index

Description	The Multidimensional SDOH Index was developed by Kolak and colleagues to quantify SDOH within small geographic areas to examine their relationships with premature mortality.[1]
Components	*All variable descriptions are based on Kolak et al., 2020, p. 4.*[1] 1. Percent ethnic/racial minority, defined as persons of all race/ethnic ancestries with the exception of white, non-Hispanic ancestry 2. Percent aged ≥ 65 years 3. Percent aged ≤ 18 years 4. Percent with a disability, among civilian noninstitutionalized population 5. Percent without a high school diploma, among persons 25 years and older 6. Percent limited English proficiency, among persons 5 years and older 7. Percent single parent, among households with children under 18 8. Percent living in poverty 9. Per capita income 10. Percent unemployed, among civilians 16 years and older 11. Percent uninsured, in the total civilian noninstitutionalized population 12. Percent renting home 13. Percent of renters paying more than 30 percent of their household income for rent 14. Percent of occupied housing units consisting of more people than rooms. 15. Percent with no vehicle
Level of disaggregation	Census tract
Data source	ACS five-year estimates
Most recent year and frequency of data update	2014
Data available for download?	No
How index is calculated	The developers "implemented the principal component analysis using the singular-value decomposition method and initial variable standardization, and we used the Kaiser criterion ([i.e.], components with eigenvalues of less than 1.0 were excluded) to determine the final number of components to retain. In accordance

	with literature standards, we used 0.30 variable loading for the component as the cutoff for . . . determining the dominant variables within each principal component. Final components, which together accounted for most of the variance in all 15 SDOH variables, were visualized as SD [social determinant] maps. . . . Four principal components—the socioeconomic advantage index, the limited mobility index, the urban core opportunity index, and the mixed immigrant cohesion and accessibility index—met the Kaiser criterion for inclusion" (pp. 6–7).
Changes to index over time	The index was released in 2020, and there have been no changes to it over time.
Considerations	• Developed only with the continental states; generalizability to other parts of the United States is unclear. • Index validated with a subset of Chicago neighborhoods.
Citation	1. Marynia Kolak, Jay Bhatt, Yoon Hong Park, Norma A. Padrón, and Ayrin Molefe, "Quantification of Neighborhood-Level Social Determinants of Health in the Continental United States," *JAMA Network Open*, Vol. 3, No. 1, January 29, 2020.
Where to access data	Not applicable

Neighborhood Concentrated Disadvantage Index

Table B.12. Neighborhood Concentrated Disadvantage Index

Description	The Neighborhood Concentrated Disadvantage Index, included in the PhenX Toolkit Protocol,[1] was developed to assess the relationship between concentrated disadvantage, residential instability, and collective efficacy.[2]
Components	*All variable descriptions are quoted from PhenX Toolkit: Protocol-NCI: variables.*[1] 1. Percent of Individuals Below the Poverty Line 2. Percent of Households Receiving Public Assistance 3. Percent Female-Headed Families 4. Percent Unemployed 5. Percent Less Than Age 18 6. Percent Black
Level of disaggregation	Census tract
Data sources	Census Bureau decennial census; American FactFinder; ACS five-year estimates
Most recent year and frequency of data update	Documentation was published in 2016. Estimates are calculated by the user, using the most-recent data available.
Data available for download?	No
How index is calculated	"The Social Environments Working Group (WG) recommends that researchers follow Sampson et alia (1997) and conduct a factor analysis (e.g., a principal components analysis using varimax rotation methods or alpha-scoring factor analysis) . . . . The Social Environments WG recommends that investigators record and report the factor loading scores for each variable used in the factor analysis. These would vary across studies, but knowing how they vary (i.e., what other studies found) would allow for comparison between studies. Depending on the purpose of the study, investigators may want to remove the measure of Percent Black from the scale if the unique effects of racial concentration are a key research emphasis . . . .The calculation of concentrated disadvantage based on factor analysis generates a measure that is sample dependent (i.e., study specific). However, it is important to note that this is a well-established, robust, and highly cited measure across the social sciences and public health" (Protocol: specific instructions).[1] The website provides detailed information on how to obtain raw data

	counts needed to calculate the individual variables that create the index and the formula for calculating them.
Changes to index over time	The original paper was published in 1997 and used data from the 1990 census. Updates to variables have been made, and the toolkit specifies variable name, variable code, and how to calculate each measure using the most-recent census data.
Considerations	• Toolkit provides detailed methodology, but estimates would need to be calculated. • Included in PhenX Toolkit, commonly used in research studies.
Citation	1. PhenX Toolkit, "Protocol – Neighborhood Concentrated Disadvantage," August 18, 2022. As of September 20, 2022: https://www.phenxtoolkit.org/protocols/view/211302 2. Robert J. Sampson, Stephen W. Raudenbush, and Felton Earls, "Neighborhoods and Violent Crime: A Multilevel Study of Collective Efficacy," *Science*, Vol. 277, No. 5238, August 15, 1997.
Where to access data	Not applicable

Neighborhood Deprivation Index

Table B.13. Neighborhood Deprivation Index

Description	The Neighborhood Deprivation Index is recommended by the Accumulating Data to Optimally Predict Obesity Treatment (ADOPT) project to establish a standard set of core measures for use in obesity research[1] and is based on work by Diez Roux et al. (2010).[2]
Components	*All variable descriptions are quoted from Cancer.gov, Methods supplement (2020, p. 1).*[3] **Wealth and income** 1. Median household income (dollars) 2. Percent of households receiving dividends, interest, or rental income 3. Percent of households receiving public assistance 4. Median home value (dollars) 5. Percent of families with incomes below the poverty level **Education** 6. Percent with a high school degree or higher 7. Percent with a college degree or higher **Occupation** 8. Percent in a management, business, science, or arts occupation 9. Percent unemployed **Housing conditions** 10. Percent of households that are female headed with any children under 18
Level of disaggregation	Census tract
Data source	ACS five-year estimates
Most recent year and frequency of data update	The available data use ACS five-year estimates from 2013–2017. The frequency of data updates is unknown.
Data available for download?	Yes
How index is calculated	"Factor analysis was . . . used to generate the NDI. This involved the following steps: • Log transform median household income and median home value

	• Reverse code percentages so that higher values represent more deprivation. For example, the percent of housing units that are owner occupied was converted to the percent of housing units that are not owner occupied. • Z-standardize the percentages . . . Run a factor analysis using Promax (oblique) rotation and a minimum Eigenvalue of 1 • Calculate the factors using only variables with a loading score > 0.4 for the first factor (this removed three variables: the percent of housing units that are owner occupied, the percent of households without a telephone, and the percent of households without complete plumbing facilities) • Calculate Cronbach's alpha correlation coefficient among the factors and verify values are above 0.7. • Use the resulting calculation of the first factor as the Neighborhood Deprivation Index (NDI)"[3] (p. 1).
Changes to index over time	None identified
Considerations	• Data are available for download but are dated. Use of this index might require updating with more-recent data. • One of a standard five core measures recommended for cancer research.
Citation(s)	1. National Cancer Institute, GIS Portal for Cancer Research, "Accumulating Data to Optimally Predict Obesity Treatment (ADOPT) Core Measures: Environmental Domain," webpage, last updated August 18, 2022b. As of September 20, 2022: https://gis.cancer.gov/research/adopt.html 2. Ana V. Diez Roux and Christina Mair, "Neighborhoods and Health," *Annals of the New York Academy of Sciences*, Vol. 1186, No. 1, February 2010. 3. National Cancer Institute, GIS Portal for Cancer Research, "Methods—Neighborhood Deprivation Index Data," August 8, 2022a. As of September 20, 2022: https://gis.cancer.gov/research/NeighDeprvIndex_Methods.pdf
Where to access data	National Cancer Institute, GIS Portal for Cancer Research, "GIS Search Results," search results for "ndi," webpage, last updated June 26, 2020. As of May 2, 2022: https://gis.cancer.gov/search?q=NDI

Neighborhood Socioeconomic Status

Table B.14. Neighborhood Socioeconomic Status

Description	The NSES was developed by Miles and colleagues[1] to create a way to measure neighborhood-level SES that would be stable over time, facilitating longitudinal research.
Components	1. Median household income 2. Percent of households with income below the Federal Poverty Line 3. The educational attainment of adults (age 25+) 4. Unemployment rate 5. Percent of households with children under the age of 18 that are "female-headed" (no male present)
Level of disaggregation	Census tract
Data source	ACS five-year estimates
Most recent year and frequency of data update	2011–2015. Data have not been updated.
Data available for download?	Yes
How index is calculated	"The formula is:

	NSES = log(median household income) + (-1.129 * (log(percent of female-headed households))) + (-1.104 * (log(unemployment rate))) + (-1.974 * (log(percent below poverty))) + .451*((high school grads)+(2*(bachelor's degree holders)))"[2]
Changes to index over time	None identified
Considerations	• Data are available for download but dated. Use would likely require programming to update with more-recent data. • Included as a layer within ArcGIS.
Citation	1. Jeremy N. Miles, Margaret M. Weden, Diana Lavery, José J. Escarce, Kathleen A. Cagney, and Regina A. Shih, "Constructing a Time-Invariant Measure of the Socio-Economic Status of U.S. Census Tracts," *Journal of Urban Health*, Vol. 93, No.1, February 2016, pp. 213–232.
Where to access data	ArcGIS, "Socioeconomic Status (NSES Index) by Census Tract, 2011-2015," webpage, July 20, 2017, last updated October 14, 2021. As of May 1, 2022: https://www.arcgis.com/home/item.html?id=2a98d90305364e71866443af2c9b5d06#overview

Neighborhood Stress Score

Table B.15. Neighborhood Stress Score

Description	The NSS7 was developed by Ash and Mick[1,2] to support risk adjustment for MassHealth payment models by incorporating SDOH.
Components	*All variable descriptions are quoted from FAQs for MassHealth's 2017 Payment Model, p. 2.*[2] 1. Percent of families with incomes < 100% of the FPL 2. Percent of families with incomes < 200% of the FPL 3. Percent of adults who are unemployed 4. Percent of households receiving public assistance 5. Percent of households with no car 6. Percent of households with children and a single parent 7. Percent of people age 25 or older who have no [high school] degree
Level of disaggregation	Census block group
Data source	Massachusetts Medicaid data
Most recent year and frequency of data update	Developed using data from 2013 for use in MassHealth's 2017 payment model. The data are not available for download but could be calculated using recent data.
Data available for download?	No
How index is calculated	Developers "first geocoded each member's current address to the census block group level and included the value of each of the above census variables (v1, v2, …, v7) to a file with one line per member. Next, [they] standardized each variable, letting z1 = (v1 – mean (v1))/SD(v1), etc., and added them to get S = z1 + z2 + …+ z7. Then [they] defined NSS7 = (S – mean(S))/SD(S). Finally, for the ~5 percent of members whose addresses could not be assigned to a census block group, [they] set NSS7 = 0. By construction, NSS7 has mean = 0 and [standard deviation] a little less than 1 (because of the extra 0s due to non-geocodable addresses), but its distribution is not necessarily normally distributed. In [the developers'] data, its values ranged from a little more than –2 to a little more than +3. The coefficient of NSS7 in a regression model is the increment to expected cost associated with approximately a 1 standard deviation (SD) increase in NSS7. Note that in [their] original report [they] used weights from [their] principal components analysis, but

	for simplicity—and given that these weights varied little across the 7 variables—[they] now calculate it using the unweighted sum, as just described" (p. 2).[2]
Changes to index over time	• Originally, the developers weighted the data elements based on weights from principal components analysis, but they now calculate it using an unweighted sum.
Considerations	• The NSS7 was developed using data from Massachusetts for use in Massachusetts. Generalizability to other states would need to be examined. • Data are not readily available, so NSS7 scores would need to be calculated.
Citation	1. Arlene S. Ash and Eric Mick, *UMass Risk Adjustment Project for MassHealth Payment and Care Delivery Reform: Describing the 2017 Payment Model*, University of Massachusetts Medical School, Center for Health Policy and Research, 2016. 2. Arlene S. Ash, Eric O. Mick, Randall P. Ellis, Catarina I. Kiefe, Jeroan J. Allison, and Melissa A. Clark, "Social Determinants of Health in Managed Care Payment Formulas," *JAMA Internal Medicine*, Vol. 177, No. 10, October 2017.
Where to access data	Not applicable

Opportunity Index

Table B.16. Opportunity Index

Description	The Opportunity Index was developed by Child Trends, Opportunity Nation, and the Forum for Youth Investment to create an index of opportunity in the United States.[1]
Components	*All variable descriptions are quoted from Child Trends et al., 2019, pp. 2–3.*[1] **Economy** 1. Unemployment rate (percentage of the population ages 16 and older who are not working but available for and seeking work) 2. Median household income (in 2010 dollars) 3. Percentage of the population below the federal poverty level 4. 80/20 ratio (ratio of household income at the 80th percentile to that at the 20th percentile) 5. Number of banking institutions . . . per 10,000 residents 6. Percentage of households spending less than 30 percent of their income on housing-related costs 7. Percentage of households with subscriptions to broadband internet service **Education** 8. Percentage of 3- and 4-year-olds attending preschool 9. On-time high school graduation rate 10. Percentage of adults ages 25 and older with an associate's degree or higher **Health** 11. Percentage of infants born weighing less than 5.5 pounds 12. Percentage of the population (under age 65) without health insurance coverage 13. Deaths attributed to alcohol or drug poisoning, or suicide **Community** 14. Percentage of adults (ages 18 and older) who reported they volunteered during the previous year (national and state-level only) 15. Percentage of adults ages 18 and older who are registered to vote (national and state-level only) 16. Percentage of youth (ages 16–24) not in school and not working

	17. Incidents of violent crime reported to law enforcement agencies (per 100,000 population) 18. Number of primary care physicians (per 100,000 population) 19. Number of grocery stores and produce vendors (per 10,000 population) 20. Number of people incarcerated in jail or prison (per 100,000 population 18 and older; national and state-level only)
Level of disaggregation	County
Data sources	Bureau of Labor Statistics; ACS one-year estimates and Public Use Microdata Sample; Census Bureau: County Business Patterns and Population Estimates Program, Current Population Survey, Volunteering, and Voting and Registration Supplement; EDFacts Adjusted Cohort Graduation Rate; Robert Wood Johnson Foundation County Health Rankings; CDC Wonder; U.S. Department of Justice, Federal Bureau of Investigation Criminal Justice Information Services; Bureau of Health Workforce, Area Health Resource Files; Bureau of Justice Statistics.
Most recent year and frequency of data update	2019. The frequency of updates is unclear, but documentation suggests roughly an annual update.
Data available for download?	Yes, data are available upon request.
How index is calculated	"Calculating Opportunity Scores for states and grades for counties entails three steps: 1) Rescaling indicators, 2) Calculating dimension scores, and 3) Calculating Opportunity Scores and grades. Rescaling Indicators The diverse indicators that comprise the Opportunity Index include percentages, rates, and dollar values. To include them in a composite measure such as the Opportunity Index, [developers] transform each of these statistics to enable comparisons on a common scale. The Opportunity Index uses a simple rescaling procedure based on the minimum and maximum values obtained for each indicator. Each state or county's performance on an indicator is compared with the highest and lowest scores obtained on that indicator, excluding outliers (extreme values)…. In each dimension, the rescaled values for indicators are averaged to create dimension-level Opportunity Scores, also ranging from 1 to 100. Because data for some indicators are not available at the county level, the county Opportunity Index is made up of 17 indicators. As with states, indicators in each dimension are averaged to create dimension-level Opportunity Scores ranging from 0 to 100…. Each state also has an overall Opportunity Score that summarizes performance across the four Index dimensions. To calculate these, [developers] averaged each state's four dimension scores with equal weighting. Final opportunity scores are represented as values from 0 to 100; [developers] use these values to rank the 50 states and the District of Columbia on the Opportunity Index. To create county opportunity scores, [developers] averaged the four dimension scores with equal weighting. Counties are also assigned Opportunity Grades that correspond to their scores, ranging from A+ to F."
Changes to index over time	In 2017, dimensions and indicators that made up the Opportunity Index were revised and updated. As a result, the developers created new cutoff points for assigning grades.
Considerations	• Index uses a number of data sources, with variable data lag. • Calculated at a state and county level. For county-level estimates, those variables only available at a state level are excluded. • Given change in methodology in 2017, county grades using the original index (before 2016) should not be compared with more-recent grades.
Citations	1. Child Trends, Opportunity Nation, and Forum for Youth Investment, *The 2019 Opportunity Index*, 2020. As of April 29, 2022: http://opportunityindex.org/wp-content/uploads/2020/08/2019-Opportunity-Index-Briefing-Book.pdf 2. Opportunity Index, "Data & Scoring," webpage, undated a. As of September 19, 2022: https://opportunityindex.org/methods-sources/
Where to access data	Opportunity Index, "Request Data," web form, undated b. As of May 1, 2022: https://opportunityindex.org/request-data/

Social Capital Index

Table B.17. Social Capital Index

Description	The Social Capital Index was developed by the Social Capital Project, a project of the Joint Economic Committee, to encourage more research on social capital and to support policy solutions.[1]
Components	*All variable descriptions are quoted from Social Capital Project, 2018, p. 16.*[1] **Family Unity Subindex** 1. Share of births in past year to women who were unmarried 2. Share of women ages 35–44 who are currently married (and not separated) 3. Share of own children living in a single-parent family **Community Health Subindex** 4. Registered non-religious non-profits per 1,000 5. Religious congregations per 1,000 6. Informal Civil Society Sub-Index [taken from state-level resources and combines domains like volunteering, attending meetings, working with neighbors, served on a committee, took part in demonstration] **Institutional Health Subindex** 7. Average (over 2012 and 2016) of votes in the presidential election per citizen age 18+ 8. Mail-back response rates for 2010 census 9. Confidence in Institutions Sub-Index: [combination of] some confidence in corporations, in the media, and in public schools **Collective Efficacy** 10. Violent crimes per 100,000
Level of disaggregation	County
Data sources	ACS five-year estimates; *U.S. Religion Census: Religious Congregations and Membership Study*; County Business Patterns; Internal Revenue Service, Business Master File; ACS Election Administration and Voting Survey; Census Bureau; Behavioral Risk Factor Surveillance System. Additional data sources were used for state-level estimates (not listed).
Most recent year and frequency of data update	2018. Updates are not clear, as the index uses data from a variety of sources.
Data available for download?	Yes
How index is calculated	"We standardized all variables and reversed the polarity (multiplying by –1) for 21 of them so that higher standard scores always indicated more "social capital." We started with some initial analyses estimating Cronbach's alpha and using principal components analysis, using both county- and state-level analyses. These gave us a general sense of the domains of social capital that appeared using inductive methods. We then attempted to determine how to best measure the underlying concept reflected in these domains"[1] (p. 41). The report describes how the developers added and dropped various measures to reach a higher Cronbach's alpha for various subindices. We refer the interested reader to the report for additional detail on the approach.
Changes to index over time	None identified
Considerations	• Report led by Republican Joint Economic Committee—not clear to what extent it has bipartisan support. • Data generated at state and county levels; lower levels of geography might not be possible given the source for some data inputs. • State-level index includes seven dimensions of social capital; county-level index includes three subindices and one stand-alone indicator. Information on

	state-level index not included in table but can be accessed on pp. 11–15 of the report.
Citation	1. Social Capital Project, *The Geography of Social Capital in America*, Washington, D.C., SCP Report No. 1-18, 2018.
Where to access data	Social Capital Project, *The Geography of Social Capital in America*, Washington, D.C., SCP Report No. 1-18, 2018.

Social Deprivation Index

Table B.18. Social Deprivation Index

Description	The SDI was originally developed by Butler and colleagues to examine relationships between levels of social disadvantage and health and health care.[1]
Components	*All variable descriptions are quoted from the Robert Graham Center: SDI, Table 1.*[2] 1. Percent population [with income] less than 100% [of the] FPL 2. Percent population 25 years or more with less than 12 years of education 3. Percent non-employed . . . for the population 16–64 years 4. Percent population living in renter-occupied housing units 5. Percent population living in crowded housing units 6. Percent single-parent households with dependents < 18 years 7. Percent population with no car
Level of disaggregation	Census tract, Zip Code Tabulation Area; Primary Care Service Areas
Data source	ACS five-year estimates
Most recent year and frequency of data update	2019. The SDI is updated annually.[2]
Data available for download?	Yes
How index is calculated	"Based on similar international and national indices, [the developers] started with a larger list of 14 candidate measures available in the ACS. [They] converted each of these measures into centiles to create a common scale for easy interpretation of results. [They] used factor analysis methods to create the Social Deprivation Index. Factor analysis is a statistical technique used to investigate the relationship between a group of observed variables and an unobserved (or "latent") variable underlying a concept. . . . The output from the factor analysis model is a factor loading for each variable. The factor loading represents the strength of correlation between the variables that comprise the factor and the factor itself. The factor loadings can be interpreted as though they are regression coefficients; the higher the factor loading score, the greater the variation that is explained by that variable. To simplify the model, [developers] . . . include 7 measures with factor loadings greater than 0.60 . . . . [The developers] constructed a final SDI measure based on weighted factor loading scores for each measure" (see the "Methodology" section of the webpage).[2]
Changes to index over time	None identified
Considerations	The SDI website states that the index is updated annually with the most recent ACS five-year estimates. However, only 2015 SDI scores are available for download from the website. Users might need to contact the Robert Graham Center for information on how to access the more recent data.
Citations	1. Danielle C. Butler, Stephen Petterson, Robert L. Phillips, and Andrew W. Bazemore, "Measures of Social Deprivation That Predict Health Care Access

	and Need Within a Rational Area of Primary Care Service Delivery," *Health Services Research*, Vol. 48, No. 2, Part I, April 2013. 2. Robert Graham Center, "Social Deprivation Index (SDI)," webpage, undated. As of May 1, 2022: https://www.graham-center.org/maps-data-tools/social-deprivation-index.html
Where to access data	Robert Graham Center, "Social Deprivation Index (SDI)," webpage, undated. As of May 1, 2022: https://www.graham-center.org/maps-data-tools/social-deprivation-index.html

Social Vulnerability to Environmental Hazards Index

Table B.19. Social Vulnerability to Environmental Hazards Index

Description	The SoVI was created by Cutter and colleagues to show geographic variation in social vulnerability to, and recovery from, environmental hazards.[1]
Components	*All variable descriptions are quoted from the SoVI Frequently Asked Questions page.*[2] **Wealth** 1. Median housing value 2. Percent households earning over $200,000 annually 3. Median gross rent 4. Per capita income 5. Percent Asian **Race (Black) and social status** 6. Percent Black 7. Percent female headed households 8. Percent poverty 9. Percent civilian unemployment 10. Percent with less than 12th grade education 11. Percent of housing units with no car 12. Percent children living in 2-parent families **Age (elderly)** 13. Median age 14. Percent households receiving Social Security benefits 15. Percent population under 5 years or 65 and over 16. Percent unoccupied housing units 17. Percent renters **Ethnicity (Hispanic) and lack of health insurance** 18. Percent Hispanic 19. Percent speaking English as a second language with limited English proficiency 20. Percent of population without health insurance (county level only) **Special needs populations** 21. Nursing home residents per capita 22. Hospitals per capita (county level only) 23. People per housing unit **Service sector employment** 24. Percent employment in service industry 25. Percent female participation in labor force 26. Percent employment in extractive industries **Race (Native American)** 27. Percent Native American **Gender (female)** 28. Percent female

Level of disaggregation	Census tract
Data source	ACS five-year estimates
Most recent year and frequency of data update	The most-recent SoVI scores available for download use 2010–2014 data. The frequency of data updates moving forward is unknown.
Data available for download?	Yes
How index is calculated	The SoVI can be calculated via the following steps: "1. Collect the input variables. 2. Normalize all variables as either percentages, per capita values, or density functions (i.e. 'per square mile'). 3. Verify accuracy of the dataset using descriptive statistics… Census units with population values of zero should be omitted. 4. Standardize the input variables using z-score standardization... This generates variables with a mean of 0 and a standard deviation of 1. 5. Perform the principal components analysis (PCA) using a varimax rotation (100 iterations) and Kaiser criterion (100 iterations) for component selection. 6. Examine the resulting factors…. 7. Factors are named via the choosing of variables with significant factor loadings (or correlation coefficients)--usually greater than .700 or less that -.700…Next, a directional adjustment (or cardinality) is applied to an entire factor to ensure that the signs of the subsequent defining variables are appropriately describing the tendency of the phenomena to increase or decrease vulnerability…8. Save the component scores as a separate file. 9. Calculate a new variable named "SoVI" by placing all the components with their directional (+,-) adjustments into an additive model to generate the overall SoVI® score for the place. SoVI® Score= (-Factor 1:wealth) + Factor 2:race and social status + Factor 3:age + Factor 4:ethnicity and lack of health insurance + Factor 5: special needs populations + Factor 6:service sector employment + Factor 7:race + Factor 8:gender."[3]
Changes to index over time	There was a change in the SoVI 2010–2014 to include new constructs emerging as important to vulnerability, including family structure, language barriers, vehicle availability, medical disabilities, and health care access.
Considerations	• Index calculates data at the county level. It is not clear whether the index could be calculated at smaller levels of disaggregation. • County maps and index values on the SoVI website use ACS data from 2010–2014. It is not known whether the SoVI values and maps are available using more-recent data.
Citations	1. Susan L. Cutter, Bryan J. Boruff, and W. Lynn Shirley, "Social Vulnerability to Environmental Hazards," *Social Science Quarterly*, Vol. 84, No. 2, June 2003. 2. University of South Carolina College of Arts and Sciences, "FAQ," webpage, undated b. As of May 1, 2022: https://www.sc.edu/study/colleges_schools/artsandsciences/centers_and_institutes/hvri/data_and_resources/sovi/faqs/index.php 3. University of South Carolina College of Arts and Sciences, "The SoVI Recipe," September 2016. As of September 19, 2022: https://www.sc.edu/study/colleges_schools/artsandsciences/centers_and_institutes/hvri/documents/sovi/sovi_recipe_2016.pdf
Where to access data	University of South Carolina College of Arts and Sciences, "SoVI Data," webpage, undated c. As of May 1, 2022: https://www.sc.edu/study/colleges_schools/artsandsciences/centers_and_institutes/hvri/data_and_resources/sovi/sovi_data/index.php

Social Vulnerability Index

Table B.20. Social Vulnerability Index

Description	The SVI was developed by the CDC/ATSDR to support the identification of communities and geographic areas most likely to need support over the course of a disaster.[1]
Components	*All variable descriptions are quoted from CDC SVI 2018 documentation, 2022, pp. 7–12.*[2] **SES** 1. Persons below poverty 2. Persons unemployed 3. Per capita income 4. Persons age 25+ with no high school diploma **Household composition and disability** 5. Persons aged 65 and older 6. Persons aged 17 and younger 7. Noninstitutionalized persons older than age 5 with a disability 8. Single parent households with children under 18 **Minority status and language** 9. American Indian/Alaska Native, Asian, African American, Native Hawaiian/Pacific Islander, Hispanic or Latinx, some other race alone 10. Persons age 5 or older who speak English "less than well" **Housing type and transportation** 11. Multi-unit housing structures 12. Mobile homes 13. Crowding 14. Households with no vehicle available 15. Person in group quarters
Level of disaggregation	Census tract
Data source	ACS five-year estimates
Most recent year and frequency of data update	2020. The SVI is updated regularly, with prior versions being released in 2018, 2016, 2014, and 2010.
Data available for download?	Yes
How index is calculated	The developers "ranked census tracts within each state and the District of Columbia…[The developers] also ranked tracts for the entire United States against one another, for mapping and analysis of relative vulnerability in multiple states, or across the U.S. as a whole. Tract ranking are based on percentiles. Percentile ranking values range from 0 to 1, with higher values indicating greater vulnerability. For each tract, [the developers] generated its percentile rank among all tracts for 1) the fifteen individual variables, 2) the four themes, and 3) its overall position. For each of the themes, [the developers] summed the percentiles for the variables comprising each theme. [The developers] ordered the summed percentiles for each theme to determine theme-specific percentile rankings… For the overall tract rankings, [the developers] summed the sums for each theme, ordered the tracts, and then calculated overall percentile rankings."[1]
Changes to index over time	• In 2014, the SVI added a database of tribal census tracts, but these are not ranked. • Some updates to variable names across update years; the developers provide a crosswalk. • In 2021, an extension of the SVI was released: the Minority Health SVI.

Considerations	• Developed with SQL programming language, which might result in slightly different estimates from those produced with Microsoft Excel, given different levels of precision across software. • Widely used, with estimates available at the census-tract and county levels.
Citations)	1. Chaitra H. Nagaraja, *Deprivation Indices for Census Tracts in Bronx and New York Counties*, New York: Fordham Global Healthcare Innovation Management Center, EmblemHealth Value Initiative, March 2015. 2. Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, "CDC SVI 2018 Documentation," January 19, 2022. As of September 19, 2022: https://www.atsdr.cdc.gov/placeandhealth/svi/documentation/pdf/SVI2018Documentation_01192022_1.pdf
Where to access data	Agency for Toxic Substances and Disease Registry, "CDC/ATSDR SVI Data and Documentation Download," page last reviewed August 27, 2021. As of May 1, 2022: https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html

Townsend Index (adapted for the United States)

Table B.21. Townsend Index (adapted for the United States)

Description	The Townsend Material Deprivation Index was created by Townsend and colleagues in 1987[1] to measure material deprivation in England in relation to poor health outcomes. In 2015, Nagaraja presented an adaptation of the index for use in the United States.[2]
Components	*All variable descriptions are quoted from Nagaraja, 2015, p. 7.*[2] 1. Percent of households with no vehicle 2. Percent of households with more than one occupant per room 3. Percent of dwelling renter-occupied 4. Percent of people above 16 years who are unemployed
Level of disaggregation	Census tract
Data source	ACS five-year estimates
Most recent year and frequency of data update	A working paper to develop a U.S. adaptation used ACS data from 2008 to 2012. No data updates are planned, but the methodology could be used to generate scores with updated data.
Data available for download?	No
How index is calculated	To compute the index, the authors first ensured that all variables were in percentage form rather than decimal form. The variables were then transformed to reduce skewness and to stabilize the variance. Variable means and standard deviations were computed, which were used to standardize the values for each region and variable. The variables were then summed to create the index. The authors note, "the index values themselves are not interpretable, only the sign of the score and the relative rankings are important. A negative Townsend value indicates a less deprived region, whereas a positive score signifies a more deprived region. A score of 0 corresponds to roughly the average level of deprivation across the regions in the geographic area. Using the Townsend scores, we can rank the census tracts from least to most deprived"[2] (p. 9).
Changes to index over time	None identified, beyond adaptation to the United States using ACS data

Considerations	The index has been adapted for use within Bronx County and New York County, both in the state of New York; generalizability to other states and counties is unknown.
Citations	1. Peter Townsend, "Deprivation," *Journal of Social Policy*, Vol. 16, No. 2, April 1987. 2. Chaitra H. Nagaraja, *Deprivation Indices for Census Tracts in Bronx and New York Counties*, New York: Fordham Global Healthcare Innovation Management Center, EmblemHealth Value Initiative, March 2015.
Where to access data	Not applicable

Appendix C. Supplemental Information on Administrative Measures of Social Risk

Table C.1. Data Sources in the Shortage Designation Management System

Content Area	Data Source
Provider information	National Provider Identifier
Geographic information for mapping	Environmental System Research Institute
Demographic data	Census Bureau
Health data	CDC National Vital Statistics
Information on FQHCs and look-alikes	HRSA's Uniform Data System

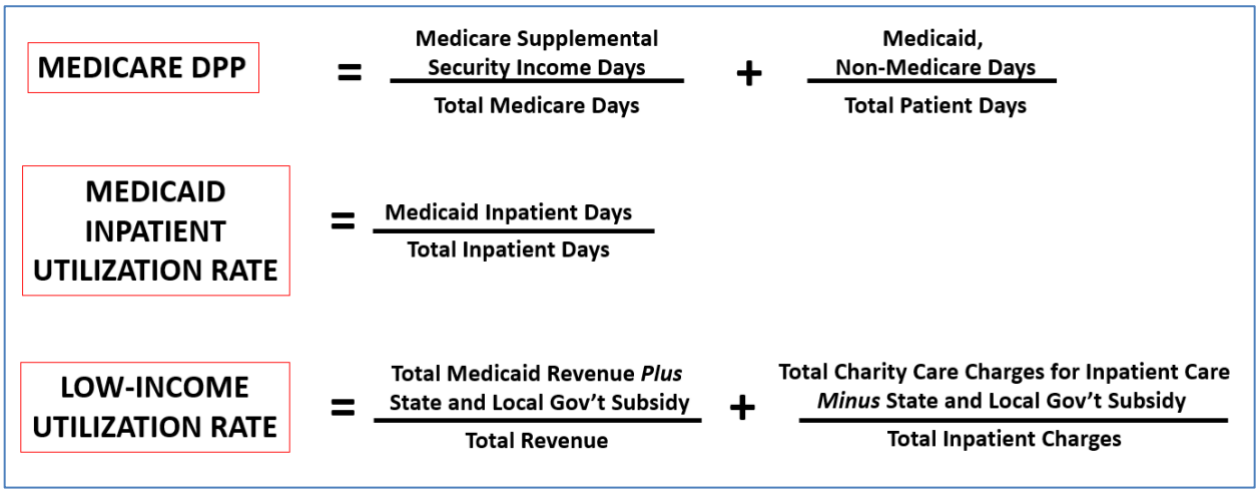
SOURCE: HRSA, 2021.

Table C.2. Income and Asset Limits for Low-Income Subsidy and Partial Dual Eligibility for Medicare Savings Programs (2021)

Program	Income Limits (per month)	Asset Limits
Qualified Medicare Beneficiary Program	Individual: $1,094; couple: $1,472	Individual: $7,970; couple: $11,960
Specified Low-Income Medicare Beneficiary Program	Individual: $1,308; couple: $1,762	Individual: $7,970; couple: $11,960
Qualifying Individual Program	Individual: $1,469; couple: $1,980	Individual: $7,970; couple: $11,960
Qualified Disabled Working Individual Program	Individual: $4,339; couple: $5,833	Individual: $4,000; couple: $6,000

SOURCE: CMS, undated.

Figure C.1. Formulas Used to Calculate Measures Used in Medicare and Medicaid Disproportionate Share Hospital Payment Programs



Appendix D. Detailed Summaries of Payment Models That Incorporate Social Risk Factors

Payments to Health Plans

Table D.1. MassHealth Payments to Managed Care Organizations

Model category	Payments to health plans
Description	The Massachusetts Medicaid Agency, MassHealth, adjusts capitation payments to MCOs to incorporate three enrollee-level social risk factors and two area-level measures of social risk. The agency uses a statistical model to measure the relationship between each risk factor and annual spending per enrollee and derives a relative risk score for each enrollee that is used to adjust the capitation payment.
Social risk/need measures and data sources	1. **Housing problems:** Includes housing instability or homelessness based on either an ICD-10 Z-code (Z59.0) reported on a claim or documentation of three or more different addresses for the enrollee within a single calendar year.[1] 2. **Disability:** Measured using enrollment data from the state's Department of Mental Health, Department of Developmental Services, or MassHealth eligibility data.[1] 3. **Behavioral health conditions:** Indicators for SMI, OUD, or both are included in the adjustment model. Each condition is measured using diagnosis codes reported on claims.[1] 4. **NSS:** Seven-item, normalized composite measure calculated for each enrollee at the census block-group level. The seven items are (1) percentage of families with incomes < 100 percent of the FPL, (2) percentage of families with incomes < 200 percent of the FPL, (3) percentage of adults who are unemployed, (4) percentage of households receiving public assistance, (5) percentage of households without a car, (6) percentage of households with children and a single parent, and (7) percentage of people age 25 or older who lack a high school degree.[1,2] The NSS is transformed to have a minimum value of zero,[3] which implies that this indicator will not lower predicted spending (and, thus, payments) for enrollees who live in neighborhoods with NSS scores less than zero (i.e., below the mean NSS). 5. **Rural:** Not defined but likely based on the state's Office of Rural Health definition, which takes into account designations used by the U.S. Census Bureau.[4,5]
Algorithm or statistical model for determining magnitude of adjustment	MassHealth uses weighted least squares regression to predict annual spending per enrollee (excluding long-term services and supports) as a function of the social risk factors described above, pairwise combinations of ten age categories and two sex categories, and two risk scores. The risk scores represent measures of comorbidity and are used to predict an enrollee's expected prescription drug spending and medical spending separately. The model also includes interactions between medical and social risk factors (including both pairwise and three-way interactions) to incorporate relationships between combinations of risk factors that may be multiplicative rather than additive. The most recent model, which was used in payment year 2020, was derived using data from 2017. The current model, which is based on concurrent measurement of medical and social risk factors and spending explains 60.3 percent of the variation in annual spending using the R-squared statistic.[3] After the model is fit to data from the most recent calendar year, the model predictions are bottom coded at $15 and top coded at $250,000, rescaled so that the sum of the model predictions is equal to the total expenditures in the calendar year.[6] Enrollee-level model predictions are then divided by the mean prediction, and the resulting relative risk scores are used to adjust capitation payments to each MCO in the next payment year.

Magnitude of payment adjustment	Although the magnitude of payment adjustments cannot be quantified directly, the coefficients for the social risk factors from the risk adjustment model are as follows: • Disabled, Client of Department of Mental Health: $12,604 higher annual spending • Disabled, Client of Department of Developmental Services (and not Department of Mental Health): $4,251 higher annual spending • Disabled, all other enrollees: $2,200 higher annual spending • SMI and no OUD: $1,707 higher annual spending • OUD and no SMI: $3,753 higher annual spending • Both SMI and OUD: $5,594 higher annual spending • Rural residence: $171 higher annual spending • DxCG risk score: $3,406 higher annual spending for each one-unit increase in DxCG risk score • DxCG*NSS: $26 additional spending for each 1–standard deviation increase in NSS • DxCG*Housing Problems*Any Behavioral health conditions: $592 additional spending for enrollees with both housing problems and behavioral health conditions.
Year of first implementation	2016
Citations	1. Colin Planalp, *Risk Adjustment Based on Social Factors: State Approaches to Filling Data Gaps*, issue brief, State Health and Value Strategies, 2020. 2. Arlene Ash, "FAQs for MassHealth's 2017 Payment Model," undated. As of [date]: https://www.mass.gov/doc/social-determinants-of-health-sdh-faq-1/download 3. M. Alcusky, E. Mick, F. Eanet, and A. S. Ash, "Seeking Equitable Reimbursement for Medicaid Members with Complex Medical and Social Needs," poster presentation, AcademyHealth Annual Research Meeting, 2020. 4. Massachusetts State Office of Rural Health, "Rural Definition," fact sheet, undated. As of [date]: https://www.mass.gov/doc/rural-definition-detail-0/download#:~:text=A%20municipality%20in%20Massachusetts%20is,below%20500%20people%20per%20square 5. Massachusetts State Office of Rural Health, "Massachusetts Rural Definition," list of rural towns, version 3.2017, 2017. As of September 2, 2022: https://www.mass.gov/doc/massachusetts-rural-towns-list/download 6. Arlene S. Ash and Eric Mick, *UMass Risk Adjustment Project for MassHealth Payment and Care Delivery Reform: Describing the 2017 Payment Model*, University of Massachusetts Medical School, Center for Health Policy and Research, 2016.

Table D.2. AHCCCS Complete Care Payments to Managed Care Organizations

Model category	Payments to health plans
Description	Arizona's Medicaid Agency, AHCCCS, adjusts capitation payments to MCOs participating in the AHCCCS Complete Care program. The adjustment incorporates four enrollee-level social risk factors and one area-level measure.
Social risk/need measures and data sources	1. **Housing problems**: Measured using ICD-10 diagnosis code Z59 **on medical claims**[1] 2. **Child/parent problems:** Measured using ICD-10 diagnosis code Z62 on medical claims[1] 3. **Family problems:** Measured using ICD-10 diagnosis code Z63 on medical claims[1] 4. **Criminal problems:** Measured using ICD-10 diagnosis code Z65 on medical claims[1] 5. **SVI:** Defined as a binary indicator of an enrollee's residence in one of 44 zip codes associated with the highest values of the SVI in the state. In deriving this indicator, the state assigned census tracts to zip codes and then aggregated the census tract–level SVI to the zip code level. Detailed methods are not available.[1]
Algorithm or statistical model for determining magnitude of adjustment	AHCCCS's actuary, Wakely, developed the state's adjustment model, which is based on the Chronic Illness and Disability Payment System with Medicaid Rx (CDPS+Rx) risk adjuster version 6.4 (developed by the University of California, San Diego) to include the five variables described above. The updated risk scores were used to adjust capitation rates that varied

	across three geographic service areas and seven risk groups, such as newborns, dual eligible, and expansion adults. The inclusion of social risk variables led to a slight increase in the R-squared statistic, indicating more-accurate predictions of spending per enrollee. Ratios of predicted spending to actual spending for individuals with each of the social risk factors indicate that inclusion of each of the social risk variables in the adjustment model improves payment accuracy.
Magnitude of payment adjustment	The average costs for Medicaid enrollees with social risk factors were found to be 1.2 to 3.4 times higher than the cost for an average enrollee (excluding members without encounters). Incorporation of social risk factors in the risk-adjustment model resulted in incremental transfer payments ranging from –$2.1 million to $1.7 million across the seven MCOs in the state. Expressed as a percentage of the total transfer payment, social risk adjustment decreased transfer payments by as much as –83 percent for one MCO and increased transfer payments by as much as 6.2 percent for one MCO.
Year of first implementation	Prior to March 2021; specific date unknown
Citations	1. Karan Rustagi, Ksenia Whittal, Danielle Bivins, Windy Marks, and Amy Filler, “Social Determinants of Health (SDOH) and Risk Adjustment: Arizona Medicaid Innovations,” Wakely and Arizona Health Care Cost Containment System, 2021.

Table D.3. Washington State and Hawaii Medicaid Agency Payments to Managed Care Organizations

Model category	Payments to providers
Description	The Washington State Health Care Authority and Hawaii’s Medicaid agency make higher capitation payments to MCOs for Medicaid enrollees who are homeless. Both states use a methodology that was developed by their actuary, Milliman.
Social risk/need measures and data sources	**Homelessness:** Measured using ICD-10 diagnosis code Z59.0 on medical claims[1]
Algorithm or statistical model for determining magnitude of adjustment	Both states adjust MCO payments for enrollees who are homeless through additive adjustments to enrollee risk scores. We describe Washington’s methodology, but we anticipate that the process is similar in Hawaii. Washington derives enrollee-level risk scores using the CDPS+Rx algorithm in conjunction with age, gender, and condition-specific risk weights that were developed by the University of California, San Diego, using national Medicaid data. The state then calculates (1) the average risk score for homeless and non-homeless enrollees and (2) the average per-member, per-month costs for homeless and non-homeless enrollees. These calculations are performed within distinct enrollee eligibility categories. For enrollees in each eligibility category, an additive adjustment to enrollee risk scores is calculated so that the ratio of the average risk score to the average cost for homeless enrollees equals the ratio for non-homeless enrollees.
Magnitude of payment adjustment	Unable to determine
Year of first implementation	2020 (Washington); unable to determine (Hawaii)
Citations	1. Justin Birrell and Shelly Brandel, “Enabling Sustainable Investments in Social Interventions: A Review of Medicaid Managed Care Rate-Setting Tools,” presentation slides, Milliman, 2020. As of [date]: https://cdn.ymaws.com/www.tahp.org/resource/resmgr/conference/tahp_2020/speaker_documents/Milliman.pdf

Payments to Providers

Table D.4. MassHealth Payments to Accountable Care Organizations

Model category	Payments to providers
Description	The Massachusetts Medicaid Agency, MassHealth, adjusts payments to ACOs to incorporate three enrollee-level social risk factors and two area-level measures of social risk. The agency uses a statistical model to measure the relationship between each risk factor and annual spending per enrollee and derives a relative risk score for each enrollee that is used to adjust payments. The nature of the payment adjustment varies across the three types of ACO models available in MassHealth[1]: • **Accountable Care Partnership Plan**: Adjusted capitation payments are made to each partnership involving a provider-led ACO and a single MCO (13 ACOs in 2018). • **Primary Care ACO**: Fee-for-service payments are made from MassHealth to ACO providers, and savings or losses are determined by comparison with an adjusted total-cost-of-care target (three ACOs in 2018). • **MCO-Administered ACO**: Adjusted capitation payments are made to MCO (or MCOs), and MCOs pay the ACO according to a state-approved payment arrangement (one ACO in 2018).
Social risk/need measures and data sources	*The information in this section is identical to the information presented in Table D.1.* 1. **Housing problems:** Includes housing instability or homelessness based on either an ICD-10 Z-code (Z59.0) reported on a claim or documentation of three or more different addresses for the enrollee within a single calendar year.[2] 2. **Disability:** Measured using enrollment data from the state's Department of Mental Health, Department of Developmental Services, or MassHealth eligibility data.[2] 3. **Behavioral health conditions:** Indicators for SMI, OUD, or both are included in the adjustment model. Each condition is measured using diagnosis codes reported on claims.[2] 4. **NSS**: Seven-item, normalized composite measure calculated for each enrollee at the census block-group level. The seven items are (1) percentage of families with incomes < 100 percent of the FPL, (2) percentage of families with incomes < 200 percent of the FPL, (3) percentage of adults who are unemployed, (4) percentage of households receiving public assistance, (5) percentage of households without a car, (6) percentage of households with children and a single parent, and (7) percentage of people age 25 or older who lack a high school degree.[2,3] The NSS is transformed to have a minimum value of zero,[4] which implies that this indicator will not lower predicted spending (and, thus, payments) for enrollees who live in neighborhoods with NSS scores less than zero (i.e., below the mean NSS). 5. **Rural:** Not defined but likely based on the state's Office of Rural Health definition, which takes into account designations used by the U.S. Census Bureau, Office of Management and Budget, rural-urban commuting areas, population size and density, and the presence of small rural hospitals and critical access hospitals.[5,6]
Algorithm or statistical model for determining magnitude of adjustment	*The information in this section is identical to the information presented Table D.1.* MassHealth uses weighted least squares regression to predict annual spending per enrollee (excluding long-term services and supports) as a function of the social risk factors described above, pairwise combinations of ten age categories and two sex categories, and two risk scores. The risk scores represent measures of comorbidity and are used to predict an enrollee's expected prescription drug spending and medical spending separately. The model also includes interactions between medical and social risk factors (including both pairwise and three-way interactions) to incorporate relationships between combinations of risk factors that might be multiplicative rather than additive. The most recent model, which was used in payment year 2020, was derived using data from 2017. The current model, which is based on

	concurrent measurement of medical and social risk factors and spending, explains 60.3 percent of the variation in annual spending, based on the R-squared statistic.[3] After the model is fit to data from the most recent calendar year, the model predictions are bottom coded at $15 and top coded at $250,000 and rescaled so that the sum of the model predictions is equal to the total expenditures in the calendar year.[7] Enrollee-level model predictions are then divided by the mean prediction, and the resulting relative risk scores are used to adjust capitation payments to each MCO in the next payment year.
Magnitude of payment adjustment	*The information in this section is identical to the information presented in Table D.1.* Although the magnitude of payment adjustments cannot be quantified directly, the coefficients for the social risk factors from the risk adjustment model are as follows: • Disabled, Client of Department of Mental Health: $12,604 higher annual spending • Disabled, Client of Department of Developmental Services (and not Department of Mental Health): $4,251 higher annual spending • Disabled, all other enrollees: $2,200 higher annual spending • SMI and no OUD: $1,707 higher annual spending • OUD and no SMI: $3,753 higher annual spending • Both SMI and OUD: $5,594 higher annual spending • Rural residence: $171 higher annual spending • DxCG: $3,406 higher annual spending for each one-unit increase in DxCG risk score • DxCG*NSS: $26 higher annual spending for each 1–standard deviation increase in NSS • DxCG*Housing Problems*Any Behavioral health conditions: $592 higher annual spending for enrollees with both housing problems and behavioral health conditions.
Year of first implementation	2018
Citations	1. Robert W. Seifert and Kelly Anthoula Love, *What to Know About ACOs: An Introduction to MassHealth Accountable Care Organizations*, Boston, Mass.: Massachusetts Medicaid Policy Institute, Blue Cross Blue Shield of Massachusetts Foundation, and University of Massachusetts Center for Health Law and Economics, 2018. 2. Colin Planalp, *Risk Adjustment Based on Social Factors: State Approaches to Filling Data Gaps*, issue brief, State Health and Value Strategies, 2020. 3. Arlene Ash, "FAQs for MassHealth's 2017 Payment Model," undated. As of [date]: https://www.mass.gov/doc/social-determinants-of-health-sdh-faq-1/download 4. Massachusetts State Office of Rural Health, "Rural Definition," fact sheet, undated. As of [date]: https://www.mass.gov/doc/rural-definition-detail-0/download#:~:text=A%20municipality%20in%20Massachusetts%20is,below%20500%20people%20per%20square 5. ———, "Massachusetts Rural Definition," list of rural towns, version 3.2017, 2017. As of [date]: https://www.mass.gov/doc/massachusetts-rural-towns-list/download 6. M. Alcusky, E. Mick, F. Eanet, and A. S. Ash, "Seeking Equitable Reimbursement for Medicaid Members with Complex Medical and Social Needs," poster presentation, AcademyHealth Annual Research Meeting, 2020. 7. Arlene S. Ash and Eric Mick, *UMass Risk Adjustment Project for MassHealth Payment and Care Delivery Reform: Describing the 2017 Payment Model*, University of Massachusetts Medical School, Center for Health Policy and Research, 2016.

Table D.5. Minnesota Integrated Health Partnership Quarterly Population-Based Payments

Model category	Payments to providers
Description	Minnesota's Medicaid agency adjusts quarterly population-based care-coordination payments to IHPs—organizations that are accountable for the costs and quality of care for their Medicaid

	enrollees. The PBPs incorporate measures of social risk for each IHP's enrollees and are included in the total-cost-of-care calculation that determines each IHP's share of savings or losses at the end of each year.[1]
Social risk/need measures and data sources	1. **Deep poverty:** defined as income below 50 percent of the FPL.[2] 2. **Homelessness**: identified in any of three ways: (1) self-reported by enrollees at the time of enrollment, (2) an address determined to be a homeless shelter, or (3) a nonresidential address, such as a nonprofit.[2] **3. Past incarceration**: based on data from the state's department of corrections.[1] 4. **SMI, severe and persistent mental illness (SPMI), or SUD:** SMI includes schizophrenia, borderline personality disorder, bipolar disorder, and major depressive disorder. Enrollees with SPMI are defined as enrollees with SMI who are receiving services billed to the following codes: presence of psychiatric service (90804–90857, 90882), behavioral health treatment in either a residential treatment center or outpatient setting (740–760), or behavioral health treatment in either a residential treatment center or outpatient setting (H0018, H0019, H0031, H0034, H0035, H0040, H2011, H2012, H2017, or S9484). SUD includes substance abuse, substance dependence, or a substance-induced disorder.[2]
Algorithm or statistical model for determining magnitude of adjustment	Minnesota adjusts the PBP according to both medical and social risk factors. Medical risk is measured using a risk score based on the Johns Hopkins Adjusted Clinical Group System. The baseline PBP is $1.00 for enrollees up to the 6th percentile of medical risk and $2.00 for enrollees from the 6th to 30th percentiles. Between the 30th and 65th percentiles, PBPs begin at $2.30 and increase linearly as a function of the enrollee's medical risk score. Between the 65th and 100th percentiles, PBPs begin at $6.00 and increase according to a logarithmic function of the enrollee's medical risk score. The state then makes an additional payment for adult beneficiaries depending on their social risk factors: • beneficiaries who have both SMI and SUD • beneficiaries who have either (1) SUD or SMI (but not both), (2) homelessness, or (3) past incarceration.
Magnitude of payment adjustment	Unable to determine the magnitude of the payment adjustment for social risk factors or the extent to which the magnitude of the adjustment depends on the level of the enrollee's medical risk score
Year of first implementation	2018
Citations	1. Colin Planalp, *Risk Adjustment Based on Social Factors: State Approaches to Filling Data Gaps*, issue brief, State Health and Value Strategies, 2020. 2. Minnesota Department of Human Services, "Integrated Health Partnerships (IHP) Request for Proposals and Contracts," webpage, last updated August 10, 2022. As of September 2, 2022: https://mn.gov/dhs/assets/ihp-sample-contract-template_tcm1053-327867.pdf

Table D.6. New York Health Homes Serving Adults

Model category	Payments to providers
Description	New York's Health Homes program, authorized through Section 2703 of the Affordable Care Act (Pub. L. 111-148, 2010), allows for the reimbursement of selected high-value services, such as outreach and care management, for eligible Medicaid enrollees. For New York's Health Home Serving Adults program, providers receive higher payments for care-management services for enrollees who are identified as high risk.
Social risk/need measures and data sources	Social risk/need measures are collected every six months through the Medicaid Analytics Performance Portal Health Home Tracking System Clinical and Functional Questionnaire to support the Health Homes program's billing structure. The questionnaire was later renamed the *HML assessment*, as it serves to classify enrollees according to their risk level (i.e., high, medium, or low risk).[1] Although New York previously used a three-tier rating structure for adults, it now uses two tiers (*high-risk* and *non-high risk*). For children, the three-tier system

	remains in place. If an enrollee's status changes, providers can update the HML assessment, qualify for the higher payment rates, and begin a new six-month period during which the same payment rate applies. **Literally homeless (Housing and Urban Development Category 1) or imminent risk of homelessness (Housing and Urban Development Category 2):** *Literally homeless* implies any one of the following: "(1) has a primary nighttime residence that is a public or private place not meant for human habitation; or (2) is living in a publicly or privately operated shelter designated to provide temporary living arrangements (including congregate shelters, transitional housing, and hotels and motels paid for by charitable organizations or by federal, state and local government programs); or (3) is exiting an institution where (s)he has resided for 90 days or less and who resided in an emergency shelter or place not meant for human habitation immediately before entering that institution." *Imminent risk of homelessness* means that (1) the individual's "residence will be lost within 14 days of the date of application for homeless assistance; (2) no subsequent residence has been identified; *and* (3) the individual or family lacks the resources or support networks needed to obtain other permanent housing" (emphasis in original).[2] **Criminal justice involvement:** May include any of the following: "released from state prison or county jail after sentence is served," "on probation or parole," "detention or arrest for charges not adjudicated or sentenced," "violations of probation/parole," "released on bail awaiting arraignment," "other criminal justice [involvement] requiring care management intervention."[1] Other factors aside from social risk factors make enrollees eligible for the higher rate, including preexisting medical conditions, HIV T-cell counts, HIV viral load, and mental health utilization. The criteria for measuring high risk have evolved over time. For example, in 2016, homelessness, incarceration in the past year, domestic violence exposure, and child welfare incidents were included.
Algorithm or statistical model for determining magnitude of adjustment	Method for setting rates for high-risk and non-high-risk adults is unclear
Magnitude of payment adjustment	Care-management payments for high-risk adults are 1.8 times higher than the payments for adults who are not high risk. This amounts to a $160 higher payment per service for enrollees in upstate New York counties and a $170 higher payment per service for enrollees in downstate New York counties.[3]
Year of first implementation	2016
Citations	1. New York State Department of Health, "Billing and Documentation Guidance for Health Home Adult Rates with Clinical and Functional Adjustments," webpage, last revised August 2021. As of [date]: https://www.health.ny.gov/health_care/medicaid/program/medicaid_health_homes/billing/billing_guidance_hh_adult_rates_revised_march_2019.htm 2. U.S. Department of Housing and Urban Development, "Four Categories of the Homeless Definition," webpage, undated. As of [date]: https://www.hudexchange.info/homelessness-assistance/coc-esg-virtual-binders/coc-esg-homeless-eligibility/four-categories/ 3. New York State Medicaid Redesign Team, "Health Home Rate Codes in Effect for Health Home Services on/After July 2020," table, 2022. As of [date]: https://www.health.ny.gov/health_care/medicaid/program/medicaid_health_homes/billing/docs/current_hh_rates.pdf

Table D.7. MaineCare Permanent Supportive Housing Community Care Teams

Model category	Payments to providers
Description	MaineCare provides permanent supportive housing support via Community Care Teams, a specialized set of providers that support members with eligible chronic conditions in accessing and sustaining housing and meeting other needs through whole-person care coordination and health promotion. Permanent supportive housing Community Care Teams are paid on a per-member, per-month basis that varies across three service tiers (intensive, stabilization, and maintenance).
Social risk/need measures and data sources	1. **Homelessness:** Indicators of "homeless currently," "housed," and "long-term homelessness" are used to categorize individuals into the three tiers (as indicated below).[1] 2. **Experience of abuse or trauma:** Measured by the SPDAT. Includes abuse or trauma resulting in homelessness or from other causes and level of impact on daily functioning.[1,2] 3. **Legal issues:** Measured by the SPDAT. Includes outstanding legal issues likely to result in fines or incarceration.[1,2] **4. Social relationships and networks:** Measured by the SPDAT. Includes leaving an exploitive, abusive, or dependent relationship; ability to follow social norms; and difficulty following reconnection with previous family or friends.[1,2] All beneficiaries eligible for the permanent supportive housing Community Care Teams program must (1) be diagnosed with two or more chronic conditions or (2) be diagnosed with one chronic condition and be at risk for another chronic condition. These individuals are then assigned to one of three tiers: • Intensive: Currently homeless and has long-term homelessness • Stabilization: Currently housed and has SPDAT or Youth-SPDAT score of 20 to 60 • Maintenance: Currently housed and has SPDAT or Youth-SPDAT score of 4 to 19.[2]
Algorithm or statistical model for determining magnitude of adjustment	Method for setting rates for each tier is unclear
Magnitude of payment adjustment	Per-member, per-month payments per tier are not available.
Year of first implementation	Has not been implemented
Citations	1. Maine Department of Health and Human Services, "MaineCare Community Care Teams (CCT)," presentation slides, May 21, 2021. As of [date]: https://www.maine.gov/dhhs/sites/maine.gov.dhhs/files/inline-files/HH-CCT-Slides-Public-Presentation-04.29.2021.pdf 2. OrgCode Consulting Inc., *Service Prioritization Decision Assistance Tool (SPDAT): Assessment Tool for Single Adults*, version 4.01, 2015.

Abbreviations

ACO	accountable care organization
ADI	Area Deprivation Index
AHC	Accountable Health Communities
AHCCCS	Arizona Health Care Cost Containment System
AHRQ	Agency for Healthcare Research and Quality
ASPE	Assistant Secretary for Planning and Evaluation
ATSDR	Agency for Toxic Substances and Disease Registry
BRIC	Baseline Resilience Indicators for Communities
CBSA	core-based statistical area
CDC	Centers for Disease Control and Prevention
CDPS+Rx	Chronic Illness and Disability Payment System with Medicaid Rx
CMS	Centers for Medicare & Medicaid Services
COI	Child Opportunity Index
COVID-19	coronavirus disease 2019
CVAC	COVID-19 Vaccine Coverage Index
DPP	disproportionate patient percentage
DSH	disproportionate share hospital
DSRIP	Delivery System Reform Incentive Payment
FPL	federal poverty level
FQHC	Federally Qualified Health Center
HHS	U.S. Department of Health and Human Services
HPSA	Health Provider Shortage Area
HRSA	Health Resources & Services Administration
HRSN	health-related social needs
ICD-10	*International Classification of Diseases*, tenth revision
IHP	Integrated Health Partnerships
IMU	Index of Medical Underservice
MCO	managed care organization
MDI	Multidimensional Deprivation Index
MUA	medically underserved area
MUA/P	medically underserved area or population
MUP	medically underserved population
NASEM	National Academies of Sciences, Engineering and Medicine
NSES	Neighborhood Socioeconomic Status
NSS	Neighborhood Stress Score

OUD	opioid use disorder
PBP	population-based payment
SDI	Social Deprivation Index
SDOH	social determinants of health
SES	socioeconomic status
SMI	serious mental illness
SoVI	Social Vulnerability to Environmental Hazards Index
SPDAT	Service Prioritization Decision Assistance Tool
SUD	substance use disorder
SVI	Social Vulnerability Index

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