As public health and health care increase focus toward addressing social determinants of health (SDH), the growth of data and analytics affords new, impactful tools for data-informed community health improvement. Best practices should be established for responsible use, meaningful interpretation, and actionable implementation of SDH data for community health improvement.

In the public health and health care sectors, there is a growing focus toward addressing social determinants of health (SDH) to increase the cost efficiency and quality of care while improving population health outcomes [1]. While an argument can be made that SDH have long been a focus of community health improvement, the changing landscape of public health and health care has brought about substantial focus and investment into “moving upstream” to address SDH, as emphasized in emerging models such as Public Health 3.0. Public Health 3.0, described elsewhere in this issue of the *North Carolina Medical Journal* [2], is the third paradigm shift in public health, evolving from the advances in prevention, treatment, and understanding of disease in the early 20th century (Public Health 1.0), through the rise in public health core functions in the later 20th century (Public Health 2.0), to the current shift toward multi-sector, systems-level efforts to address the fundamental determinants of health and inequity [3].

Concurrent with the shift toward the Public Health 3.0 framework, the increasing availability and accessibility of data and analytics has brought about a wealth of tools and data to inform community health improvement. It is therefore no surprise that in the recommendations presented by DeSalvo and colleagues in *Public Health 3.0: A Call to Action for Public Health to Meet the Challenges of the 21st Century*, the authors call for “timely, reliable, granular-level (ie, sub-county), and actionable data” and “clear metrics” to monitor progress, impact, and equitable community health initiatives [4].

Beyond Public Health 3.0, recent policy initiatives have resulted in the health care sector moving toward playing a more substantial role in addressing SDH, including the Internal Revenue Service-mandated Community Health Needs Assessment for nonprofit hospitals, value-based payment models, and the Centers for Medicare & Medicaid Services’ (CMS) Accountable Health Communities Program, which explores the impact between social services and the health care sector [5, 6]. In North Carolina specifically, recent approval of the state’s Section 1115 waiver by CMS has permitted innovative approaches to measuring and addressing SDH needs of Medicaid enrollees through the Healthy Opportunities Pilots [7].

This fundamental shift toward community health improvement calls for the public health and health care sectors to coordinate, strategize, and engage within their communities to affect change. One of the key elements that unites all parties is data; data defines and informs the conditions, people, and systems within a community, and the impact of SDH interventions cannot be accurately measured without timely, reliable, and granular data.

Through prior and ongoing community collaborative projects, the North Carolina Institute for Public Health (NCIPH) at the University of North Carolina at Chapel Hill Gillings School of Global Public Health has worked with public health, health care, nonprofit, and philanthropic organizations to synthesize SDH data to inform and affect community health improvement. This work has shown that despite the wealth of available SDH data and tools, there is little guidance on the best practices for responsible use, meaningful interpretation, and actionable implementation of SDH data for community health improvement. What follows is a discussion of methods, relevant examples, and best practices for using community-level SDH data for affecting change.

**Measuring Social Determinants of Health**

SDH data can be collected through a variety of mechanisms, though they can operationally be distinguished as either collected for individual- or community-level purposes. In North Carolina, for example, the Department of
Health and Human Services (NC DHHS) recently developed a standardized SDH screening tool to assess unmet SDH needs of enrollees in the NC Medicaid prepaid health plans [8]. The purpose of this tool is to make individual-level SDH information available to care providers and managers for referral to address unmet needs, and was modeled after other similar screening tools in use in clinical settings [9-11]. Traditionally, community-level SDH information has been collected from national survey efforts such as the U.S. Census Bureau American Community Survey, the National Health and Nutrition Examination Survey (NHANES), and the Behavioral Risk Factors Surveillance System (BRFSS) from the US Centers for Disease Control and Prevention (CDC). While these surveys collect individual-level information, they are rigorously designed using sampling methodology to be representative and generalizable to a larger population and reported in aggregate within administrative boundaries such as state, county, municipality, or neighborhood. These community-level data have historically been used for assessing and identifying subpopulations and areas with SDH needs or inequities, and are referents for many Healthy North Carolina 2020 and CDC Healthy People 2020 objectives [12, 13].

The quality and availability of SDH data is highly dependent upon the mechanism by which the data were collected. While the preference for the most granular data might suggest that individual-level SDH data are most desirable, it is important to consider the context in which the data were collected. While individual-level SDH data are the most directly actionable in those with stated SDH needs can be identified and referred to necessary interventions, applications of these administratively-collected data to the wider community beyond their intended context are subject to various selection biases and may therefore not be generalizable. Additionally, if SDH data collection efforts vary across people or systems, there are further challenges in comparing these data across systems.

The preference for measuring and using SDH data for community health improvement is, absent a fully comprehensive population census, to use data collection and sampling strategies that are methodologically designed to be representative and generalizable to a larger population [14]. Survey sampling methodology is well documented and is the most efficient and effective mechanism to collect community-level data [15]. The results of these surveys, when generalized beyond those who complete the survey, are estimates that represent a given condition of SDH factors within a population. These sample estimates, by design, have a measure of uncertainty that represents the reliability of a given estimate, often expressed as a confidence interval or margin of error. It should be noted, however, that even the best community-level data is subject to ecologic bias where characteristics or needs of an individual may differ from those of a group [16]. Usage of any SDH data, therefore, requires an understanding of the methods of collection, intended use, and the limitations associated with each.

### Using Social Determinants of Health Data

Examples of SDH data and analytics are numerous throughout the published literature, and their dissemination extends into comprehensive and interactive SDH tools for visualization, program implementation, and policy action. Despite the wide variety of tools and resources developed that may look and function differently, all generally adhere to an underlying framework of selecting SDH metrics, conducting analysis and visualization that is appropriate for the intended audience, and building a supportive infrastructure for meaningful use. The following example describes prior work by NCIPH to develop an impactful SDH mapping tool in collaboration with Atrium Health, formerly Carolinas HealthCare System. Through this work and subsequent projects that followed, NCIPH has identified best practices for using SDH data for community health improvement.

In 2016, Atrium Health initiated a community health improvement plan to 1) understand the neighborhood- and community-level social and economic factors that influence health throughout a 10-county service region and 2) inform the work of its community benefit and outreach initiatives [17]. Over a period of several months, the NCIPH conducted an evaluation of potential SDH measures used in other similar initiatives, including the County Health Rankings and Roadmaps, California Healthy Places Index, and those identified through SDH literature review [18, 19]. Following consultation with subject matter experts and Atrium Health partners, 12 SDH indicators at the census tract level were selected and grouped into three substantive domains: social resources, housing and transportation, and economic factors (see Figure 1).

All SDH indicators were sourced from the most recent American Community Survey 5-year estimates at the time (2010-2014) [20], with the exception of low access to food sources, which was available from the US Department of Agriculture (2010) [21]. These indicators were chosen due to their 1) substantive merit; 2) availability across the entire service area at the census tract level; 3) published (and acceptable) reliability; 4) temporal relevance (timely and up to date); and 5) ease of interpretation and communication.

For each indicator, a descriptive analysis was conducted and data were mapped by census tract using ESRI® Geographic Information System (GIS) Story Map software. An index of all 12 indicators was created by standardizing and averaging each indicator using SAS 9.4 analytic software within each of the three domains to create an overall z-score. The SDH index, therefore, is a relative metric of the degree to which the 12 SDH indicators are above or below the 10-county regional average [data not shown]. This methodologic approach was adapted from the California Healthy Places Index [19] and general theory of standardization and
scaling, and the purpose of this approach was to establish a preponderance of evidence identifying areas in need of SDH intervention.

The results of the SDH mapping provided impactful quantitative data and visualization for the disparities throughout Atrium Health’s urban and rural service areas (see Figure 2). Findings from the SDH mapping initiative were used to identify Atrium Health strategic focus areas for 2017-2019 and to identify areas of alignment in the following system program and initiatives: faith community health ministry, community health, sponsorships and partnerships, community service projects, and grants and research. Though local public health and health care partners know their communities and may have a general understanding of themes and disparate areas, the SDH mapping helped to validate Atrium’s knowledge with data and became a powerful tool to begin conversations about community health improvement and investment with other peripheral partners within the region such as Novant Health. This “unexpected partnership” between Atrium Health and Novant Health was detailed by Cole in the North Carolina Medical Journal in 2017 [17]. Further, the selected indicators and methods were replicated in the statewide SDH maps produced by NC DHHS in the spring of 2018 [22].

Other powerful SDH tools and resources exist at various levels, and the rapid evolution of visualizations, tools, and resources is inspiring. Many tools are now going beyond visualization and synthesis of data and are linking evidence-based interventions and policies to address identified needs. Notably, the County Health Rankings and Roadmaps, developed by the University of Wisconsin Population Health Institute, and the California Healthy Places Index, developed by the Public Health Alliance of Southern California, have incredibly impactful tools and resources associated with a wealth of SDH data and metrics [18, 19]. The ongoing work of the North Carolina Institute of Medicine through Healthy North Carolina 2030 and NC DHHS through the Healthy Opportunities Initiative will also yield powerful and impactful SDH work in the years to come.

**Best Practices for Using Social Determinants of Health Data**

With the growing focus on SDH data and the increase in powerful visualization tools and resources available, a set of best practices for using SDH data is emerging:

1) **Understand how the data were collected and be aware of the potential limitations.** Data are only as powerful as the methods driving the data collection. High-quality data are the result of rigorous data collection strategies, particularly as data are narrowed to specific subpopulations or small geographic units.

2) **Follow an objective, methodologic approach to selecting and using SDH metrics.** There is no prescriptive set of indicators—rather, the selection of indicators requires careful consideration of factors to identify timely, reliable, relevant, and actionable community health data. If the intent is to compare across areas, these metrics and analytics should be scaled such that comparisons across areas or groups are meaningful to the intended audience.

3) **Choose a visualization and dissemination strategy that is appropriate for the intended audience.** Communication and visualization of SDH analytics should be impactful and easily understood by the intended audience. Avoid overwhelming the viewer with extraneous and unnecessary data. The ability to overlay data and descriptive text can be an effective mechanism for communication.

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**FIGURE 1.**
SDH Domains and Indicators Selected for Atrium Health Community Health Improvement Mapping

| Social Resources        | Economic                        |
|-------------------------|---------------------------------|
| - Individuals with < HS education |
| - Households with no/limited English |
| - Single parent households |
| - Low access to food sources |
| - Median household income |
| - Individuals living below federal poverty level |
| - Unemployed individuals |
| - Uninsured individuals |

**Housing & Transportation**
- Households living in rental housing
- Households paying >30% of income on rent
- Households without transportation
- Crowded households (>1 person/room)

Source: NCIPH.
4) **Build a supportive infrastructure for meaningful use of the developed resource(s).** Tools and resources that are presented without explanation or strategies for use and implementation are of limited value to intended audiences.

SDH data and metrics will continue to be important decision-making tools that enable decision-makers to address health equity and further inform and refine community health initiatives. Data mapping has a long history in public health and the tools for data integration and spatial visualization are rapidly improving. The continued development and adoption of best practices for incorporating SDH metrics, analysis, and visualization will further strengthen the impact and success of future initiatives. **NCMJ**

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