

Research Article

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Examining individual- versus population-level social determinants of health in a cluster randomized trial of health coaches for patients with multiple chronic conditions

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Abstract

Introduction: Social determinants of health (SDOH) are an important contributor to health status and health outcomes. In this analysis, we compare SDOH measured both at the individual and population levels in patients with high comorbidity who receive primary care at Federally Qualified Health Centers in New York and Chicago and enrolled in the Tipping Points trial. **Methods:** We analyzed individual- and population-level measures of SDOH in 1,488 patients with high comorbidity (Charlson Comorbidity Index ≥ 4) enrolled in Tipping Points. At the individual level, we used a standardized patient-reported questionnaire. At the population level, we employed patient addresses to calculate the Social Deprivation Index (SDI) and Area Deprivation Index. Multivariable regressions were conducted in addition to qualitative feedback from stakeholders. **Results:** Individual-level SDOH are distinct from population-level measures. Significant component predictors of population SDI are being unhoused, unable to pay for utilities, and difficulty accessing medical transportation. Qualitative findings mirrored these results. High comorbidity patients report significant SDOH challenges at the individual level. Fitting a binomial generalized linear model, the comorbidity score is significantly predicted by the composite individual SDOH index ($p < 0.0001$) controlling for age and race/ethnicity. **Conclusions:** Individual- and population-level SDOH measures provide different risk assessments. The use of community-level SDI data is informative in the aggregate but should not be used to identify patients with individual unmet social needs. Health systems should implement a standardized individualized assessment of unmet SDOH needs and build strong, enduring partnerships with community-based organizations that can provide those services.

Introduction

Social determinants of health (SDOH) defined at the community level and at the individual level have recently received increased attention [1]. “Social determinants of health are the nonmedical factors that influence health outcomes. They are the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies, racism, climate change, and political systems” [2]. There are both individual determinants of risk – biology and behavior – and group-level determinants, such as neighborhood and community [3]. Both have salience for health risks, health status, and health outcomes [3]. Throughout all analyses of SDOH, racial and ethnic disparities have played a critical role [4]. Some have argued that community data can be used as a proxy for the time-consuming process of collecting individual-level data on SDOH [5,6]. However, the risk of assuming the community context determines individual risk (ecological fallacy) or that the individual determines community risk (atomistic fallacy) are both concerns; they may be correlated, but they are distinct [3].

In this paper, SDOH measured at an individual level will be compared to population-level findings in patients with multiple chronic diseases (MCDs) enrolled in the Tipping Points project, which is a cluster randomized controlled trial (cRCT, PCORI grant # IHS-2017C3-8923) examining clinical and patient-centered outcomes. Multiple chronic conditions are assessed from electronic health records (EHRs) using the enhanced CCI, a weighted measure of prognostically important chronic diseases. Patients with a CCI ≥ 4 are at high risk for destabilization leading to unplanned hospital admission and/or increased disability [7–9].

Patients for this cRCT were recruited from 16 Federally Qualified Health Centers (FQHCs) that are designated Patient-Centered Medical Homes (PCMHs) in four health systems in New York City and Chicago that are part of Clinical Directors Network's (CDN) or AllianceChicago's practice-based research networks (PBRNs). The patients who received care from PCMHs (usual care group) were compared to an intervention group that received care at PCMHs with health coaches added to help patients focus on setting life goals, learning self-management, using positive affect and self-affirmation, and overcoming obstacles and stresses.

The objective of this analysis is to compare SDOH measured at both the individual and population levels in patients with high comorbidity enrolled in this RCT who received their primary care at PCMH-designated FQHCs in New York City and Chicago.

Materials and methods

Site and patient recruitment

Patients with multiple chronic conditions defined by having a Charlson Comorbidity Index ≥ 4 were cluster randomized from 16 FQHCs (8 in Chicago and 8 in New York) from four FQHC networks that were invited and agreed to participate in the trial. These FQHCs are all accredited Patient-Centered Medical Homes (PCMHs), which serve mostly low-income Black and Latino patients. In PCMHs, staff work to make sure patients receive the right care at the right time. The PCMH provides individualized care with multidisciplinary care teams [10,11]. The current analysis includes 1488 participants from four health systems: Health System 1 ($n = 374$), Health System 2 ($n = 330$), Health System 3 ($n = 395$), and Health System 4 ($n = 389$). This trial was reviewed and approved by Institutional Review Boards (IRBs) including BRANY, Clinical Directors Network (CDN), Weill Cornell, and Chicago Area IRB (CHAIRb) and registered with ClinicalTrials.gov (ID NCT04176510) [12].

Assessment of comorbidity

Cited in more than 43,000 publications, the CCI, the most extensively validated measure of the prognostic impact of multiple chronic illnesses, is a weighted measure of the burden of chronic disease that predicts long-term prognosis [8]. Different weights are assigned for specific conditions and summed to find the score [8]. It has been adapted to predict future cost [9,7], and a partial index that is adjusted for the exclusions in the Tipping Points RCT was used. The CCI can be assessed prospectively by a 5–10 minute interview, as well as through claims data or EHR. Thus, the CCI-based method to identify patients with MCDs can be embedded within any EHR system (see Appendix 1 – partial adjusted CCI score).

All established patients of the participating FQHCs with a CCI ≥ 4 were evaluated for eligibility. The CCI was calculated from EHR data and then verified by patients prior to enrollment. Health coaches asked participants questions pertaining to eligibility and exclusion criteria. Consent was obtained in writing when health coaches were in-person at the FQHCs and orally when patients were consented remotely. Documentation of consent was recorded in the study database management system.

Assessment of SDOH

SDOH data for Tipping Points patients are collected from several sources: individual-level data from baseline questionnaires from

consented patients, FQHC EHR systems, and neighborhood-level data from publicly available neighborhood-level information linked to the patient's current home address and zip code.

Individual-level SDOH assessment

Individual determinants are collected from patients through baseline questionnaires as well as directly from EHRs. At baseline, all participants complete a standardized questionnaire related to unmet SDOH needs based on the National Association of Community Health Center's "Protocol for Responding to and Assessing Patients' Assets, Risks, and Experiences" (PRAPARE), which is available in English and Spanish [13–15]. Patient's insurance, education, housing, transportation, food insecurity, repeated and utility needs are recorded. SDOH information is also extracted from patients' EHRs and then verified by the patients, including race and ethnicity. Only insurance data were primarily extracted from the EHR. All the other data, including race, ethnicity, education, marital status, living situation, employment, and specific challenges such as food, housing, and transportation, were obtained from the patient interview at baseline.

While some health systems have dedicated sections on their EHR for assessing SDOH, the four health systems each use different EHR platforms. Further, only some of the health systems specifically ask questions about SDOH needs, such as food insecurity or housing instability. There was no universal SDOH screening used across all four health systems.

Population-level SDOH assessment

Neighborhood-level determinants were assessed using patients' home addresses geocoded and linked to publicly available data. The Area Deprivation Index (ADI) and the Social Deprivation Index (SDI) are composite neighborhood-level measures used to assess socioeconomic disadvantage or deprivation, but they differ in focus, methodology, and application. The ADI is designed to assess deprivation in geographic areas using a single number, whereas the SDI can be separated into its individual components.

Computation of ADI and SDI

We downloaded the lists of consented participants and removed identifiers other than addresses. We used the Decentralized Geomarker Assessment for Multi-Site Studies (DeGAUSS), which is a "decentralized method for geocoding and deriving community and individual-level environmental characteristics while maintaining the privacy of protected health information" [16,17] to match each home address to a census tract and census block. We then matched the geocodes with two datasets to determine SDI and ADI. SDI was determined by matching the patient's census tract with raw measures and scores in the SDI [18]. SDI includes seven community characteristics from census tracts about poverty, education, housing, single parents, employment, and car ownership and is one of the most commonly employed measures of population-level social risk with individually identifiable components [18]. (See Appendix B) ADI was ascertained by matching the patient's census block with ADI National and State ranks [19]. ADI uses 17 indicators from the census: 8 focused on poverty, 5 on housing, and 4 on employment [19]. (See Appendix C) The 2020 year data were used; there was no difference between different years for enrolled patients.

The ADI measure is constructed by ranking the ADI score from low to high for the USA by each 1 percent range of the ADI score. For both SDI and national ADI, scores range from 1–100, with 1,

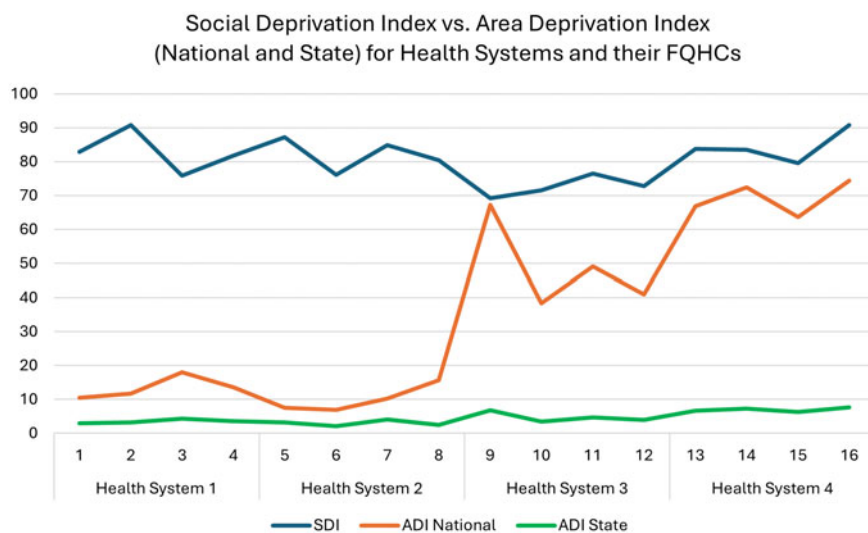


Figure 1. Social and Area Deprivation Index values for the Tipping Points health systems and Federally Qualified Health Centers (FQHCs). ADI = Area Deprivation Index; SDI = Social Deprivation Index.

least disadvantaged, to 100, most disadvantaged in the U.S. [19]. State ADI ranks in deciles from a scale of 1, least disadvantaged, to 10, most disadvantaged in that state [20].

Statistical methods

The present analyses evaluate and compare aspects of individual and population-level SDOH. We employed the following statistical tests and techniques while accounting for potential site-level dependence, where applicable. The chi-square test was employed to assess the association between categorical variables. Kruskal–Wallis tests, a nonparametric method, were applied to compare the distribution of continuous variables across the levels of a categorical variable. Multiple regression analysis was conducted to explore the relationship between various predictor variables and the population-level SDOH index. Regression models with CCI as a dependent variable use a negative binomial generalized linear model with a lower tail truncation at 3 to account for CCI's count nature and threshold within the sample. Since the data exhibited site-level dependence or clustering, we employed robust standard errors. These cluster-robust standard errors corrected the correlation between observations within the same FQHC, providing accurate standard errors and confidence intervals for the regression coefficients. Maximum likelihood factor analysis was applied in order to uncover an underlying single latent factor that explains the correlations among observed SDOH variables. A significance level (two-tailed alpha) of 0.05 was selected for all statistical tests. We conducted all statistical analyses using the software package Stata 17 with the appropriate libraries and functions for each test.

Results

Population-level social determinants of health

Figure 1 shows the 4 health systems and their participating 16 FQHCs according to both ADI and SDI. Since the ADI is heterogeneous between the Chicago and New York FQHCs and it consists of a single number that cannot be split into interpretable components, subsequent analysis will focus on the SDI, which is homogeneous across the health systems.

Individual-level SDOH measures

Table 1 presents patient characteristics by SDI tertiles. Patients were an average age of 59 years old; 73% were female, 42% were Latino or Hispanic, and 44% were Black/ African American. 41% had an education < 12 years and 67% were unemployed. All had a comorbidity score ≥ 4 (eligibility criteria): 49% had a score of 4–5, 35% had a score of 6–8, and 16% had a score of 9 or more. Overall, 22% of patients had moderate to severe depression. Those living in the highest SDI areas had lower education, more with comorbidity > 9 and were less likely to be Latino or white.

Table 2 describes individual-level social determinants evaluated among these 1488 patients. While only 5% reported not having housing, almost 26% were worried about losing their housing. About 10% experienced issues with obtaining food and with paying for their utilities. Additionally, 14% needed help with getting transportation to medical appointments. Patients with higher SDI had more difficulty getting utilities ($p = 0.03$) and medical transportation ($p = 0.04$). A Kruskal–Wallis test for heterogeneity shows the above variables had differences by health system and FQHC site, except for worries about losing housing ($p < 0.05$).

Comparing individual- and population-level SDOH measures

Assessments of individual- versus population-level SDOH measures from the SDI were then compared. Table 3 shows the measures covering certain domains which are quite different.

Table 4 compares the domain measures of individual- versus population-level SDOH, and while the components are generally related, most do differ. The only exception is education of less than 12 years which is employed in both assessments. Of note, with an identical measure, 42% of individuals had an education < 12 years, but only 21% of those in the participants' community had an education of less than 12 years, a significant difference ($p < 0.001$). Transportation also differs: 15% on the individual level have an issue with medical transportation, and 40% in communities do not have vehicles. While the numbers differ, the assessments are also qualitatively different. Housing does not differ, but the assessments, unhoused versus crowding differ qualitatively, as does the proxy measure of income – inability to get food versus poverty. Population- or area-level SDOH correlate with overall health in a

Table 1. Patient baseline measurements: mean (SD) and percentages by Social Deprivation Index (SDI) tertiles

	SDI<76	SDI 76-93	SDI>93	All	P-value
Age	58.9 (11.4)	59.1(11.2)	58.4 (11.5)	58.8 (11.4)	0.495
Female	72%	71%	77%	73%	0.034
Hispanic/Latino	48%	43%	34%	42%	0.0005
Black	38%	50%	43%	44%	0.003
White	28%	17%	10%	18%	0.0001
Asian	3%	3%	2%	3%	0.332
<12 years high school	42%	46%	35%	41%	0.002
Unemployed	66%	72%	64%	67%	0.015
Comorbidity 4-5	53%	50%	44%	49%	0.009
Comorbidity 6-8	36%	38%	32%	35%	0.097
Comorbidity >9	10%	13%	24%	16%	0.0001
Perceived stress score	14.3 (7.1)	14.8 (7.4)	15.4 (7.5)	14.8 (7.3)	0.071
Depressed*	2.3 (0.9)	3.4 (0.9)	2.5 (0.9)	2.7 (0.9)	0.011

Table 2. Individual-level social determinants of health measures by Social Deprivation Index (SDI) tertiles

	SDI < 76	SDI 76–93	SDI > 93	All	P-value
Housing					
Unhoused	3.4%	5.3%	6.0%	4.9%	0.14
Worry about losing housing	26.2%	25.9%	24.9%	25.6%	0.88
Unable to get					
Food	10.4%	11.0%	8.1%	9.7%	0.26
Utilities	12.8%	10.6%	7.7%	10.4%	0.03
Phone	7.9%	7.8%	6.3%	7.3%	0.54
Clothing	6.5%	7.0%	6.1%	6.5%	0.85
Child care	3.2%	2.8%	2.4%	2.8%	0.74
Elder care	2.0%	2.3%	1.8%	2.0%	0.82
Medicine or any health care	9.1%	9.8%	8.1%	8.9%	0.64
Medical transportation	11.1%	13.1%	16.5%	13.6%	0.04
Lack of nonmedical transportation	6.1%	8.9%	9.2%	8.1%	0.14

community but do not reliably predict individual patient health outcomes. Thus, larger differences between the individual- and population-level measures of SDOH are largely related to education and transportation issues, but the qualitative differences in transportation are substantial.

Individual SDOH measures as predictors of population SDOH

Table 5 presents multiple regression analyses that explore the relationship between the individual measures and the population-level SDOH. Since our data exhibited site-level dependence or clustering, we employed robust standard errors for our regression coefficients to obtain accurate standard errors. Table 5 Column (1)

examines the significance of the individual SDOH measures from Table 2 in predicting the population SDI. Significant predictors of the population SDI from individual determinants of health are being unhoused, unable to get utilities, and lacking medical transportation. Table 5 Column (2) examines the significance of the individual significant SDOH measures from Column (1). Each of these individual SDOH measures also predicts population SDI individually.

To construct a univariate (latent) composite individual SDOH index, we developed a maximum likelihood one-factor model for the predictor variables in Table 5. A single factor that explains over 90% of the variability among the individual SDOH measures is a composite measure of “worry about losing housing,” “inability to get utilities and clothing,” and “lack of medical transportation.”

Table 3. Comparison between individual- and population-level social determinants of health domains (SDOH) in the Tipping Points project

Social determinants of health		
	Individual SDOH	Population SDI
<i>Education</i>		
<12 years	X	X
Single parent		X
Unemployed	X	
<i>Housing</i>		
Unstable/none	X	
Crowding		X
Rented housing		X
Household size		X
<i>Unable to get</i>		
Food	X	
Utilities	X	
Phone	X	X
Clothing	X	
Childcare	X	
Health care	X	
Poverty rate		X
<i>Transportation issues</i>		
Medical appointments	X	
No vehicle		X

SDI = Social Deprivation Index.

However, from Column (3) of Table 5, this composite individual SDOH index is not significant as a single predictor of the population-level SDI. Thus, the analysis confirms that individual-level SDOH are quite distinct from population-level measures.

While high comorbidity patients have significant individual-level SDOH challenges, individual SDOH does not relate significantly to comorbidity scores. On the other hand, fitting a truncated negative binomial generalized linear model with the composite, CCI score is predicted substantially by the constructed composite individual SDOH index as a dependent variable ($p < 0.0001$) controlling for age and race (Hispanic/Latino, Black). Similarly, the CCI score is significantly predicted by the state-level ADI index ($p < 0.0001$).

Qualitative analysis

Unmet SDOH needs were discussed at our Community and Patient Stakeholder Advisory Committee (CPSAC) meetings in June 2023 and January 2024. Committee members include FQHC clinicians, staff, patients, and community members. In addition to the quantitative analysis, the CPSAC reviewed the data, shared their experiences and noted that a key issue with housing is the failure of landlords to make repairs. The CPSAC members identified the connections between the housing environment and mental health, highlighting the challenges associated with having landlords complete needed repairs.

As described in Figure 2, Advisory committee (CPSAC) members also stressed that medical transportation is an ongoing

major problem. In addition to using mass transit, patients often book transportation through insurance or the Department of Transportation as part of Medicaid's nonemergency medical transportation [21,22]. While patients can arrange low-cost or free medical transportation to take them to their medical appointments, the services are often unreliable, arriving late or not at all. Transportation appointments need to be scheduled at least 24 hours in advance, and often patients cannot reach the driver directly for updates. One stakeholder shared, "When they schedule an appointment and schedule the transportation for that appointment, the driver never arrives on time, and these clients are waiting for hours and hours." When medical transportation delivers patients more than 15 minutes late to their appointments, the medical facilities often cancel the appointment as a policy. Patients are sent home to re-book their appointment, sometimes weeks later, and need to start the process again, thus delaying their access to care, and generating ongoing frustration: "... sometimes the doctor doesn't know that they don't come, they just put "no show" and they don't come to the appointment because they had this problem with transportation ... to schedule or reschedule an appointment again is a problem too because it takes 3 months or 6 months for a general doctor or for a specialist up to a year."

Discussion

Socioeconomic status has always had salience for its explanatory power in health, but there is a contrast between individual-level and group-level determinants. Among these patients with high comorbidity enrolled in this cRCT conducted with 16 FQHCs in New York City and Chicago, the individual-level SDOH had minimal overlap with community-level SDOH.

The National Academy of Medicine [23,24] and the Centers for Medicare and Medicaid Services [25] have each recommended elements of SDOH to assess as part of care.

The American College of Physicians developed a comprehensive policy paper focused on addressing social determinants to improve patient care and health equity [26]. It also stressed the importance of documenting individual-level impacts of SDOH [26]. It emphasized the importance of expanding policy programs to reduce the socioeconomic inequalities with a negative impact on health and for investments in programs to reduce the disparities [26].

Individual measures

The Institute of Medicine (IOM) also urged the incorporation of individual patient data on SDOH in EHRs [27]. The IOM defined SDOH as race, ethnicity, education, financial resources strain, connections and social isolation, and exposure to violence, as well as stress, depression, physical activity, tobacco, and alcohol use [27]. The 22 questions to assess these social and behavioral domains are clear and straightforward [23]. While the completion time is only 5 minutes, the questions have not been generally added to the EHR except for the Patient Health Questionnaire (PHQ-2) measure of depression [28]. As noted previously, one standardized instrument adopted by many FQHCs is the PRAPARE, a 21-item survey that measures food insecurity, housing instability, financial resources strain, relationship safety, inadequate physical activity, social connection/isolation, and stress [14,29]. Some health systems have developed a modified version of PRAPARE to streamline the assessment of social needs [13]. A recent analysis of SDOH data collection in PCORnet Clinical Research Networks

Table 4. Side-by-side comparison of the common individual and population social determinants of health (SDOH) measures (adjusted for site-level dependence)

Social determinants of health			
	Individual SDOH	Population SDI	P- value
Education <12 years	42%	21%	$p = 0.001$
Housing	6% (unhoused)	7% (crowding)	$p = 0.407$
Unable to get food	9%	22% (poverty)	$p = 0.408$
Transportation	15% (medical transportation)	40% (no vehicle)	$p = 0.027$

SDI = Social Deprivation Index.

Table 5. Regression model with population SDI as the dependent variable

Individual SDOH	(1)	(2)	(3)
	Pop SDI	Pop SDI	Pop SDI
Education <12 years	0.481 (1.611)		
Unhoused	5.948** (2.689)	5.606** (2.549)	
Worry about losing housing	-1.725 (1.185)		
Unable to get food	0.911 (2.188)		
Unable to get utilities	-8.032** (3.084)	-5.988** (2.790)	
Unable to get phone	0.905 (2.353)		
Unable to get clothing	0.130 (2.798)		
Unable to get childcare	2.467 (5.940)		
Unable to get eldercare	-2.982 (4.660)		
Unable to get medicine or health care	3.409* (1.876)		
Lack of medical transportation	3.349** (1.528)	3.577** (1.451)	
CCI score	-0.413 (0.320)	-0.416 (0.331)	-0.450 (0.317)
Composite individual SDI			-0.671 (0.869)
Observations	1485	1485	1485
R-squared	0.020	0.017	0.01

Controls for age, race (Hispanic/Latino, Black), and CCI score. Robust standard errors adjusted for site-level dependence in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. CCI = Enhanced Charlson Comorbidity Index; SDI = Social Deprivation Index; SDOH = social determinants of health.

found that most health systems do not use a framework or standard terminologies for SDOH data [30]. Moreover, 40% of health systems report a low percentage of patients with SDOH data [30]. The PCORnet sites did agree on SDOH priority domains such as housing instability, food insecurity, transportation access, financial hardship, employment status, social isolation, intimate partner violence, and veteran status [30]. One national study that examined 2333 physician practices and 757 hospitals reported that nearly 40% of physician practices and almost 80% of hospitals reported that they assessed transportation needs [31]. A more recent report examined 2749 hospital systems' assessment of and intervention on unmet SDOH needs, including food insecurity, housing instability, utility needs, interpersonal violence, and transportation needs, and reported that transportation needs were the most commonly identified and intervened issue, in 77% of hospitals [32].

Community measures

The importance of area-level measures has been reinforced by recent analyses of county level cause-specific mortality rates from 1980 to 2014, which shows geographic disparities in life expectancy and rates of cause-specific deaths [33,34]. The geographic disparities were driven by race/ethnicity, socioeconomic status, and healthcare factors [34]. Between the most advantaged and disadvantaged, there is a 15-year difference in life expectancy [35]. Community-level social risks have been defined by a number of methods [36]. A comprehensive analyses of socioeconomic gradients in health and area-based socioeconomic measures focused on geocoded data from two states [37]. Evaluating census tracts with 4000, block groups with 1000, and zip codes with 30,000 people, they found that census tract analysis was the optimal strategy for geocoding for health [37]. Evaluating mortality, low birth rate, cancer, and tuberculosis among other conditions, they found that the percentage below poverty was the most sensitive marker of socioeconomic gradients in health [37]. Area-level measures have been increasingly seen as a method of accounting for social risk in healthcare payments.

There are many different area-level deprivation measures that are used [38]; two of the most commonly referenced are the SDI and the ADI. The SDI includes seven community characteristics from census tracts about the percentage living in poverty, less than high school education, rental housing, overcrowded (people vs. rooms) housing, single parents, unemployment, and having a car and is one of the most commonly employed measures of population-level social risk with individually identifiable components [18]. It was

Transportation Delays, Late Arrivals & Rescheduling
"Transportation is the main issue. The health center gives you a 15-minute window for your appointment. If you miss your appointment, it can be difficult to get another one soon, you could be put on a waiting list." – Chicago Patient
"We don't have specific policies for people taking public transportation. We had a grant to provide patients with Ubers. But it ran out in the middle of the year because patients needed it so much that the second half of the year we didn't have that service for patients." – FQHC Staff Member, Chicago
"It's always been my experience that the reception people are usually not willing to or don't want to help at all, which is unfortunate, especially in some of these situations where people are coming from long distances or run into transportation problems ." – NYC Patient
"It's ultimately the provider's decision, but it's a team effort and if one person in the team recognizes this...it's a good thing to communicate. – NYC Clinician
"It's a lot more complex than the patient not arriving and the provider not seeing the patient. The provider has to almost make a judgement call." – Chicago Clinician
"Part of the issue is once we figure out what their barriers are, what do you do with them? I know that a majority of my patients are facing housing instabilities, at the verge of becoming homeless. We do not have wrap around services to address this information that we're gleaned from the patient." – Chicago Clinician
"When I finally get an appointment I try not to be late, but we don't really know what any given day will anticipate for us...but just [for the doctors] to know that this person has had some challenges prior to the appointment and just to know that they are in the building there is a strong possibility maybe that the doctor could and can fit them in." – Chicago Patient
"It's based on our availability. Providers, if they if they have the availability, we definitely try to accommodate. But if not, we would try to either get you with another provider within our practice who has the availability." – NYC FQHC staff member

Figure 2. Quotes from Community and Patient Stakeholder Advisory Committee members. FQHC = Federally Qualified Health Center; NYC = New York City.

validated in relation to a measure of poverty [39]. Correlations between SDI and health outcomes (such as mortality, infant mortality, low birth rate, and diabetes) were lower because the units of geography differed for SDI (primary care service area) and health outcome (county) [39]. The goal is to use higher ADI levels to identify high-risk patients for care management interventions [19]. One analysis that focused on an area of relatively high poverty suggested that 30-day readmission was higher in higher ADI neighborhoods [40].

Individual versus population measures

A few years ago, the concept of hot spotting (focusing on the "super-utilizer" patients who were repeatedly in the ER and the hospital) was popularized by Gawande [41]. This is still widely believed, although a RCT based on the Camden model found no difference in readmission after an intensive intervention with high utilizers [42]. Population segmentation is a misleading term, not related to a population, per se, but often referring to the use of prior utilization to stratify patients into tiers of utilization – which are not stable over time [43].

However, the "hot spotting" of individuals led to the conceptualization of "cold spots" in communities where there are issues with housing, education, health, and broadly deficiencies in SDOH. In its most extreme construct, the focus should be on eliminating cold spots because they were responsible in large measure for patients' healthcare problems and costs [44]. While most analyses do not use that expansive a framework, communities as defined by census tracts have been characterized as "cold spots" – that is, those communities with worse incomes, education, and social deprivation [5]. One study assessed 12 practices in one area and their census tracts according to the percentage of residents earning less than 200% of the poverty level, without high school diplomas, and according to the SDI [5]. However, the differences in health measures such as cancer

screening between whether patients live in a cold spot or not were modest except for differences in obesity [5].

Yet the emphasis on community-level characteristics as defining individually relevant SDOH has persisted – in part because assessing communities from census tract or zip code is easier than collecting individual-level data. Several recent analyses contrasting individual- and community-level SDOH are comprehensive and persuasive about the distinctions between the two.

An important cross-sectional study of 36,578 patients at community health centers compared patient-level social risk data to community-level data through SDI [45]. Patient-level risks were assessed in those who completed at least one of three questions about financial strain, housing stability, and food insecurity, and the percentage of those who had one or more social risk factors was analyzed [45]. The individual risks were compared to quartiles of SDI, and social risks in the "coldest quartile" occurred in 30% of patients, similar to the second and third quartiles – 29% in each, while in the best off quartile, a total of 23% had social risks [45]. Thus overall, 30% of cold spot patients had social risks, and 28% of non-cold spot patients had social risks. Conversely, 69% of cold spot patients had no social risk, and 72% of non-cold spot patients had social risks [45].

Another analysis by the Society of Actuaries contrasted census tract data with SDOH data from 231,989 Medicaid patients [46]. Individual data was either from PRAPARE or from the assessment by the Accountable Health Communities Model [46,47]. Both surveys document education, housing, food insecurity, safety, transportation, income, and utilities. The analysis found that census-derived neighborhood social determinants were not significant predictors of individual SDOH for either adults or children [46]. The analysis then focused on both individual and neighborhood SDOH as predictors of utilization and cost and found that they differed in terms of who was predicted as high risk. They also found that individual and neighborhood SDOH were not

always associated with inpatient cost, utilization, and high risk, and adding them to predictive models did not improve performance [46].

Limitations

The four health systems and 16 FQHC sites did not use a uniform method for assessing SDOH as part of their routine workflow. Additionally, the health systems used different EHR platforms. A final limitation is the reliability of address data as patients may have moved during the study. Patients provided their addresses at baseline and did not always update us if they moved.

Conclusion

In summary, patient- and community-level measures of SDOH provide different risk assessments. The use of community-level SDI data, while informative in the aggregate, when used to identify patients with individual unmet social needs, may be imprecise and could result in an ecologic fallacy [45]. The PCORnet Common Data Model contains the building blocks to calculate the comorbidity index, as well as various other indices including the ADI and SDI. ADI and SDI are calculated from raw zip codes and address data. The comorbidity index can be calculated from the ICD-10 codes in the PCORnet Common Data Model.

It is critical for health systems and practices to implement a standardized assessment of unmet SDOH needs that can be embedded within the EHR and workflow at entry into the practice and repeated at fixed intervals. This routine SDOH assessment needs to be combined with appropriate referrals within the practice and to external community-based partners that provide access to specific services. This study identified challenges at both the population and individual levels faced by patients with multiple chronic conditions that are associated with barriers to accessing primary care through medical transportation programs in two large urban settings. This systems-level barrier requires attention by health systems that are committed to improving access to care.

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Competing interests. MEC at Cornell University has filed a patent application on methods and systems implementing the enhanced CCI in the management of healthcare resources. Cornell owns the copyright on the index, and MEC receives a portion of license revenue from Cornell University under Cornell's Inventions and Related Property Rights Policy. The enhanced CCI has been disclosed to, and is managed by, the Center for Technology Licensing at Cornell University (CTL), the technology transfer arm of Cornell University. CTL has filed for patent protection on methods and systems implementing the CCI and also owns and administers the copyright. The CCI is available for licensing through CTL. To date, the CCI has been made widely available and licensed to many other academic institutions and noncommercial entities on a nonexclusive and royalty-free basis for research purposes only and typically in the context of a collaboration. Licenses to commercial entities are also available and are subject to negotiation with CTL.

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