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Preventable Death Rates Fell Where Communities Expanded Population Health Activities Through Multisector Networks

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ABSTRACT The US health system faces mounting pressure to improve population health. Research suggests a need for greater coordination and alignment across the sectors that deliver medical, public health, and social services. This study uses sixteen years of data from a large cohort of US communities to measure the extent and nature of multisector contributions to population health activities and how these contributions affect community mortality rates. The results show that deaths due to cardiovascular disease, diabetes, and influenza decline significantly over time among communities that expand multisector networks supporting population health activities. The findings imply that incentives and infrastructure supporting multisector population health activities may help close geographic and socioeconomic disparities in population health.

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The United States lags behind other high-income countries in measures of health status at nearly every stage of the life cycle, and this international disadvantage has become more pronounced in recent years.¹ Gaps in health insurance coverage and access to high-quality medical care are not the dominant reasons for the US disadvantage in health status, even though these gaps remain significant, particularly for low-income populations.^{2,3} Research points to social and economic determinants, mediated by behavior and geography, as major drivers of population health dynamics.^{4,5} Life expectancy varies by more than ten years between the wealthiest and poorest 1 percent of the US population, and income-related differences in longevity have grown larger in the opening decades of the twenty-first century.⁶ Racial and ethnic disparities in health status remain persistently high in the United States,⁷ and premature mortality rates have increased during the past fifteen years for white adults at midlife.⁸

A growing body of evidence suggests that im-

proving US population health requires strengthening the delivery of public health and social services that address behavioral, social, economic, and environmental determinants of health.^{9,10} Public health activities include a heterogeneous set of actions to assess population health status and needs, educate the public about health risks and prevention strategies, engage community stakeholders in planning and implementing health improvement strategies, and link individuals to available health and social services based on their needs.^{11–13} These activities also include protecting the quality and safety of water, food, air, housing, and the physical environment. Many public health programs target preventable risk factors including smoking, diet, physical activity, and misuse of alcohol and other drugs. Recent analyses suggest that lowering these risk factors to optimal levels among US residents could reduce by 69–80 percent the racial and geographic disparities observed in cardiovascular disease and diabetes mortality, and by 29–50 percent the disparities observed in cancer mortality.^{14,15} Similarly, a growing body of re-

search suggests that addressing unmet social needs such as housing, food security, employment and income security, education, and early childhood development can reduce the incidence and progression of preventable health conditions and thereby reduce racial and socioeconomic disparities in population health.¹⁶

While evidence about the health benefits of robust public health and social services continues to grow, the mechanisms for implementing these services on a broad, populationwide basis remain limited. The nation's public health infrastructure—including state and local public health agencies and the community organizations with which they work—is supported by a mix of public and private resources that vary widely across communities.^{17–20} Limited resources for health-related social services such as assistance with housing, food, transportation, education, and employment result in an anemic infrastructure for improving population health.^{1,9,13} Of particular concern, the delivery and financing systems for public health and social services are highly fragmented, reflecting a patchwork of federal, state, local, and private funding streams with distinct target populations, eligibility criteria, service providers, and implementation requirements.^{17,18} This fragmentation poses challenges for deploying limited public health and social service resources in the most coordinated and effective ways.

These findings suggest that mechanisms for coordinating the delivery and financing of public health, medical, and social services across the diverse sectors that implement these services may improve population health. A growing body of literature documents strategies for forming multisector partnerships to coordinate the delivery of health and social services.^{21,22} The Affordable Care Act (ACA) established new incentives for hospitals, health insurers, public health agencies, and employers to contribute to communitywide health improvement activities, potentially nudging these sectors toward greater coordination and collaboration.^{23,24} The ACA's enhanced community benefit requirements for not-for-profit hospitals and the Centers for Disease Control and Prevention (CDC) Partnerships to Improve Community Health funding initiative are two notable examples of such incentives.²⁵ Most recently, the Centers for Medicare and Medicaid Services (CMS) announced a five-year, \$157 million initiative to test Accountable Health Community models designed to identify health-related social needs of patients and to address these needs through coordinated relationships among medical care, public health, and social service providers.²⁶ While promising, these and other innovations have very little existing evi-

dence to draw upon regarding the impact of multisector efforts to improve population health.²⁷

Our study attempted to address this dearth of evidence by using data from a unique national survey offering new evidence about the implementation and impact of multisector approaches for population health improvement. The Robert Wood Johnson Foundation's National Longitudinal Survey of Public Health Systems follows a national cohort of US communities over time, measuring the scope of population health improvement activities implemented in each community and the range of sectors and organizations that contribute to these activities.^{18,20,28,29} Using sixteen years of data from this survey, combined with other data sources on community health resources and health outcomes, we analyzed the extent and nature of multisector contributions to population health activities and the extent to which these contributions are associated with improvements in community mortality rates. Our findings identify a range of health benefits that are plausibly attributable to multisector engagement in population health, and they indicate the structural forms of alignment associated with these effects.

Study Data And Methods

STUDY DESIGN AND SAMPLE Our retrospective cohort design followed a national sample of 360 US metropolitan communities over sixteen years using survey data collected initially in 1998 and again in 2006, 2012, and 2014.²⁸ This cohort of communities was selected in 1998 by identifying all local governmental public health agencies in the United States that serve jurisdictions containing at least 100,000 residents ($N = 397$). These jurisdictions, located predominantly (96 percent) in metropolitan areas, represent approximately 17 percent of all local public health jurisdictions in the United States, but they contain approximately 70 percent of the US population. The 2006, 2012, and 2014 waves resurveyed these same communities.^{17,18} Response rates for each wave of the survey ranged from 68 percent to 73 percent, with no indication of systematic differences between responding and nonresponding communities.

DATA AND MEASURES The National Longitudinal Survey of Public Health Systems uses a validated questionnaire administered to a designated respondent in each community to collect information about a set of twenty population health activities recommended by national guidelines and federal consensus panels for implementation in state and local practice settings.^{30–35} These activities derive from research-tested models that help communities design and

implement successful health interventions, such as the PRECEDE/PROCEED model used widely by the Centers for Disease Control and Prevention. Examples include periodic assessments of community health needs and risks; multisector priority setting and planning; community engagement in selecting and implementing health improvement strategies; resource allocation to support implementation of priority strategies; and monitoring and evaluation to track progress.^{11,31–35} The local public health official serves as the designated respondent for each community, who is asked to report information on all population health activities carried out in the community, regardless of which organizations perform them.³⁶

For each activity, the local public health official reports whether the activity is implemented in the community; and which organizations are involved in implementing the activity, including categories for governmental public health agencies, hospitals, primary care providers, health insurers, employers, schools, community- and faith-based organizations, and other governmental agencies.^{18,28} We used survey responses to classify each community into one of seven categories of multisector engagement in population health activities, using a previously developed typology of population health system capital.¹⁸ The seven categories in this typology were identified through a cluster analysis performed on three sets of measures from the survey: the scope of population health activities contributed by each type of organization; the density of connections that exist among the organizations that contribute to these activities; and the extent to which selected organizations play central coordinating roles within the network of contributing organizations. These latter two measures, which are measures of network density and degree centrality derived from the field of network analysis, indicate the extent to which organizations work together versus alone in implementing population health activities.³⁷ These two measures are calculated using survey data on the strength of ties between all possible pairs of organizations in the community, where tie strength is defined as the proportion of the twenty population health activities that are jointly contributed by each pair of organizations. The emerging literature on collective community capacity and collective impact suggests that both network density and degree centrality may contribute to the effectiveness of multiorganizational alliances.³⁸

Data from each survey wave were linked with county-level demographic, health, and economic characteristics obtained from contemporaneous editions of the Health Resources and Services

Administration's Area Health Resources File. Additionally, we linked survey data with county-level cause-specific mortality rates from the CDC's Compressed Mortality File, allowing a one-year lag between survey measures and mortality rates.³⁹

ANALYSIS Our analysis tested whether communities that engage a broad array of organizations and sectors in a wide array of population health activities experience superior health outcomes over time. Our primary explanatory variable was derived from the seven-category typology measure of population health system capital. Three of the seven categories of system capital are classified as *comprehensive system capital* because they reflect a broad scope of population health activities supported through densely connected networks of contributing organizations.¹⁸ We used this dichotomous measure, indicating the presence or absence of comprehensive system capital in the community, as our primary explanatory variable in multivariate analyses. The outcome variables used in this analysis included county-level measures of the all-cause mortality rate per 100,000 residents and cause-specific death rates from potentially preventable conditions including heart disease, diabetes, cancer, influenza, and infant mortality. Additionally, as a falsification test we used a measure of residual mortality due to other causes, assuming that these other causes of death would be less sensitive to population health activities.

We used a quasi-experimental research design that took advantage of natural variation across communities in baseline levels of system capital in 1998 and in changes in system capital over the sixteen-year follow-up period. We used random effects regression models with instrumental variables estimation to determine the changes in mortality rates that are associated with changes in system capital, while controlling for a range of other factors that influence community health status. Our statistical models controlled for local population size and density, the racial and age composition of the population, household income and unemployment rates in the community, availability of hospitals and physicians, and the percentage of the population without health insurance coverage. Our models accounted for the temporal correlation that exists among observations taken on the same communities over time, and they controlled for the clustering of communities within states.

We used instrumental variables estimation to control for the possibility that communities with different levels of system capital have other, unmeasured characteristics that explain their differential mortality rates, allowing for a more rig-

orous assessment of whether system capital has causal (rather than spurious) relationships with community health status over time.⁴⁰ For example, economic recessions and residential mobility can cause area-level health status to change for reasons unrelated to population health activities and system capital.⁴¹ We used several measures of public health governance and decision-making structures as instrumental variables because they are expected to influence system capital but have no alternative pathway of impact on community mortality rates. These measures include the existence of a local board of health with authority to adopt health policies and regulations; the existence of a local government authority to establish dedicated fees and taxes to fund health programs; and the existence of a local government authority to approve public health agency budgets independently of state government. Much like randomization in a controlled trial, these instrumental variables assigned communities to different levels of system capital using a process that was unrelated to the outcome measures. Political theory and prior research support the hypothesis that local health governing boards and decentralized health policy making and fiscal authority generate enhanced community support for local health activities, thereby shaping system capital.^{19,42} Specification tests supported our use of these structural and legal characteristics as instrumental variables that were significantly predictive of system capital but not independently associated with community mortality rates, as discussed in the online Appendix.⁴³ Our sample included a total of 1,016 community-years, providing reasonable statistical power to detect differences in community mortality rates.

LIMITATIONS Several limitations should be kept in mind for this analysis. Our data on population health activities were reported by local public health officials in each community and might not capture all relevant activities and organizations accurately. By focusing only on activities that are known and reported by public health officials, this study may have understated the extensiveness of population health activities and their associations with health outcomes. Additionally, the quasi-experimental research design we used left open the possibility that unmeasured community characteristics and activities associated with system capital could explain some of the observed differences in outcomes, although our instrumental variables analysis made this possibility less likely. Because of data limitations, we only allowed for a one-year lag between population health activities and outcomes, which might not have captured the longer-term effects of these activities.³⁹ Finally, our

data were limited to US metropolitan communities and might not generalize to rural areas.

Study Results

IMPLEMENTATION OF POPULATION HEALTH ACTIVITIES The total proportion of the twenty surveyed population health activities implemented in US metropolitan communities increased from an average of 64 percent in 1998 to 70 percent by 2006, before declining to just under 67 percent during the post-recession year of 2012 and increasing slightly to almost 68 percent in 2014 (Exhibit 1). The proportion of communities implementing community health assessment and community health improvement planning activities (the first and twelfth of the twenty activities listed) increased significantly ($p < 0.05$) during the final two years of the study period ending in 2014, reaching 87 percent of communities and reflecting the new incentives created by ACA for tax-exempt hospitals and public health agencies to undertake these activities. The largest gains in implementation occurred for stakeholder-engaged health planning and resource allocation activities (activity number 11 of the twenty listed in Exhibit 1), with the proportion of communities implementing these activities increasing by more than 65 percent between 1998 and 2014. By contrast, the largest decline in implementation occurred for activities that link people to needed health and social services (activity 16), which declined by more than a third over the study period. Overall, assessment and planning activities experienced significantly larger gains in implementation than did assurance and evaluation activities ($p < 0.01$), but individual communities varied widely in the specific combinations of activities that were implemented.

Among all types of organizations, governmental public health agencies contributed to the largest scope of population health activities (see Appendix Exhibit A1).⁴³ However, hospitals, community health centers, nonprofit community organizations, and other local government agencies also contributed to a third or more of these activities by 2014.⁴⁴ The largest increases in contributions to population health activities occurred among community health centers and colleges and universities, reflecting steady growth in the numbers of federally funded centers and academic public health programs in the United States since 1998. Contributions by hospitals and health insurers also increased markedly over the sixteen-year period, while contributions by state agencies, schools, employers, and physician practices declined over time.

COLLECTIVE ACTION AND SYSTEM CAPITAL Communities varied widely in the extent to

EXHIBIT 1
Recommended population health activities implemented in US metropolitan communities, selected years 1998–2014

Activity no.	Description	Percent of organizations implementing				Percent change, 1998–2014
		1998	2006	2012	2014	
ASSESSMENT						
1	Conduct periodic assessment of community health status and needs	71.5%	77.5%	72.6%	87.1%	21.8%
2	Survey community for behavioral risk factors	45.8	70.2	73.9	71.1	55.2
3	Investigate adverse health events, outbreaks, and hazards	98.6	97.9	99.6	100.0	1.4
4	Conduct laboratory testing to identify health hazards and risks	96.3	97.0	99.2	96.1	-0.2
5	Analyze data on community health status and health determinants	61.3	73.2	63.5	72.7	18.6
6	Analyze data on preventive services use	28.4	26.1	33.2	39.0	37.3
1–6	Average percentage of assessment activities implemented ^a	67.0	73.7	73.7	77.7	15.9
POLICY AND PLANNING						
7	Routinely provide community health information to elected officials	80.9	90.1	87.1	84.0	3.8
8	Routinely provide community health information to the public	75.4	88.8	80.9	82.3	9.1
9	Routinely provide community health information to the media	75.2	88.4	87.1	89.0	18.3
10	Prioritize community health needs	66.1	71.7	66.8	83.6	26.5
11	Engage community stakeholders in health improvement planning	41.5	50.6	49.8	68.8	65.7
12	Develop a communitywide health improvement plan	81.9	86.7	69.7	87.9	7.3
13	Identify and allocate resources based on community health plan	26.2	37.3	27.8	41.9	59.9
14	Develop policies to address priorities in community health plan	48.6	51.9	49.0	56.8	16.9
15	Maintain a communication network among health-related organizations	78.8	87.2	89.6	85.3	8.2
7–15	Average percentage of policy and planning activities implemented ^a	63.9	72.5	67.5	75.5	18.3
ASSURANCE AND EVALUATION						
16	Link people to needed health and social services	75.6	68.7	60.6	50.0	-33.8
17	Implement legally mandated public health activities	91.4	92.3	89.2	92.4	1.1
18	Evaluate health programs and services in the community	34.7	37.5	33.2	37.9	9.4
19	Evaluate local public health agency capacity and performance	56.3	56.2	55.2	56.1	-0.3
20	Monitor and improve implementation of health programs and policies	47.3	50.4	42.7	46.4	-1.9
16–20	Average percentage of assurance and evaluation activities implemented ^a	61.1	61.0	56.2	56.6	-7.3
ALL ACTIVITIES						
1–20	Average percentage of all activities implemented	63.8	70.2	66.9	67.6	6.0

SOURCE Authors' analysis of data from the National Longitudinal Survey of Public Health Systems. ^aPercentage of organizations implementing each type of activity.

which organizations work together versus separately to implement population health activities. Network density ranged from a low of 0 percent to a high of 73 percent across communities (data not shown), reflecting the degree to which multiple organizations jointly produce these activities. The scope of population health activities implemented within a community was strongly and positively related to the density of contributing organizations (Exhibit 2), with a distributional shift toward higher-scope, higher-density communities between 1998 and 2014. Variation in network density also increased with the scope of activities. For example, among communities that implemented more than 90 percent of the recommended population health activities, network density ranged from less than 10 percent to just under 70 percent, reflecting heterogeneity in how much of the work is implemented through individual versus collective actions of organizations and sectors.

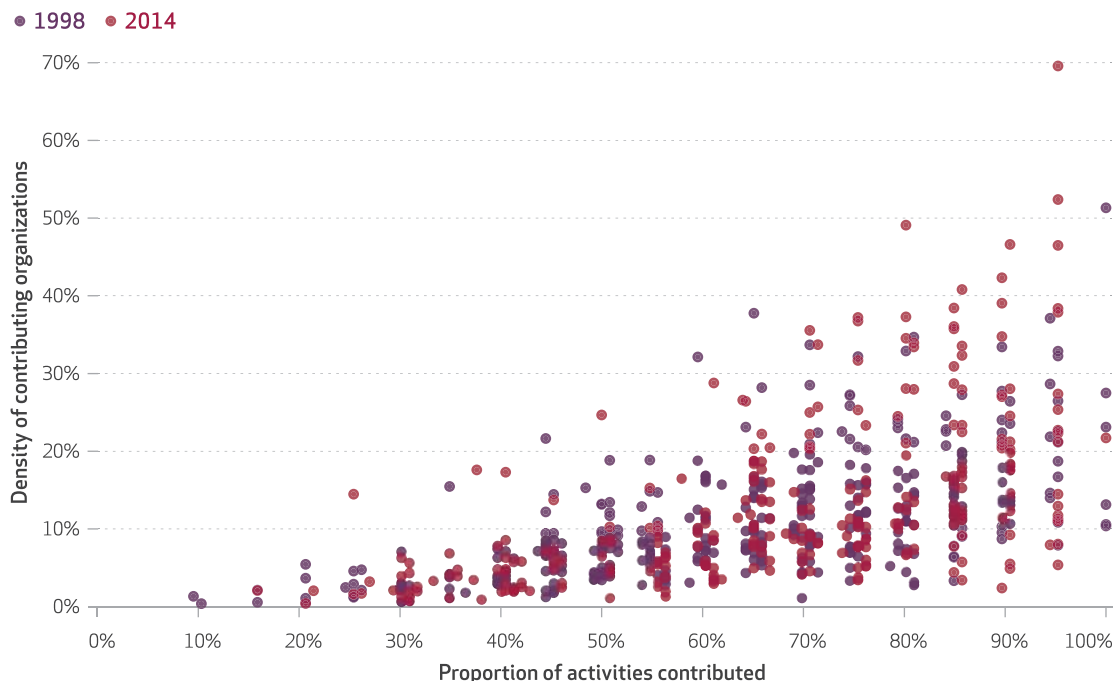
The proportion of communities classified as having comprehensive system capital—both a

broad scope of population health activities and a dense network of contributing organizations—increased from over 24 percent in 1998 to almost 40 percent by 2014, interrupted by a period of decline coinciding with the economic recession (Exhibit 3). Increases in network density were responsible for nearly 60 percent of the growth in system capital over time (data not shown). Correspondingly, the prevalence of conventional system capital fell from 50 percent to 40 percent over the sixteen-year period, while communities with limited system capital fell from almost 26 percent to slightly over 20 percent (Exhibit 3).

IMPACT ON COMMUNITY MORTALITY Multivariate results indicate that communities achieving comprehensive system capital over the sixteen-year study period experienced significantly lower death rates from potentially preventable conditions compared to communities without this capital (Exhibit 4). Regression-adjusted death rates in 2014 show that the largest differences in mortality rates occurred for deaths due to influenza, heart disease, and diabetes, as well

EXHIBIT 2

Density of relationships among organizations contributing to population health activities



SOURCE Authors' analysis of data from the National Longitudinal Survey of Public Health Systems. **NOTE** Each plotted point represents a community in 1998 or 2014, indicating the proportion of population health activities that are implemented in each community (x axis) and the density of relationships between organizations that contribute to population health activities in each community (y axis).

EXHIBIT 3

Prevalence of seven types of population health systems in US metropolitan communities, by amount of system capital, selected years 1998-2014

Type of system	Prevalence			
	1998	2006	2012	2014
COMPREHENSIVE SYSTEM CAPITAL				
A broad scope of recommended population health activities (>75%) supported through dense networks of contributing organizations and sectors.	24.2%	36.9%	31.1%	39.5
Centralized: wide range of organizations contribute to activities, with local public health agency playing a central role.	12.5	21.5	12.0	19.9
Distributed: wide range of organizations contribute to activities, with local public health agency playing a less central role.	5.1	3.9	6.2	10.0
Compact: narrower range of organizations contribute to activities, with local public health agency playing a central role.	6.6	11.6	12.9	9.6
CONVENTIONAL SYSTEM CAPITAL				
A moderate scope of recommended population health activities (>50%) implemented through lower-density networks of contributing organizations and sectors.	50.1	33.9	49.0	40.2
Centralized: local public health agency plays central role in performing activities.	3.4	3.0	3.7	4.3
Distributed: local public health agency plays a less central role in performing activities.	46.7	30.9	45.2	35.9
LIMITED SYSTEM CAPITAL				
A narrow scope of recommended public health activities (<50%) implemented through lower-density networks of contributing organizations and sectors.	25.6	29.2	19.9	20.3
Centralized: local public health agency plays central role in performing activities.	12.3	18.0	11.6	8.5
Distributed: local public health agency plays a more peripheral role in performing activities.	13.4	11.2	8.3	11.7

SOURCE Authors' analysis of data from the National Longitudinal Survey of Public Health Systems. **NOTES** System typology is based on cluster analysis methodology described in Mays GP et al., Understanding the organization of public health delivery systems: an empirical typology (Note 17 in text). Prevalence refers to the percentage of organizations fitting each of the seven system types.

as infant mortality (the latter of which is not considered here), which were more than 20 percent lower in communities with comprehensive system capital compared to other communities (see Appendix Exhibit A3 for infant mortality results).⁴³ Smaller differences of 14 percent and 7 percent were estimated for cancer deaths and all-cause mortality, which approached but did not reach statistical significance at conventional thresholds ($p = 0.07$ and $p = 0.08$, respectively). The residual mortality rate was not significantly associated with system capital after other factors were controlled for.

Discussion

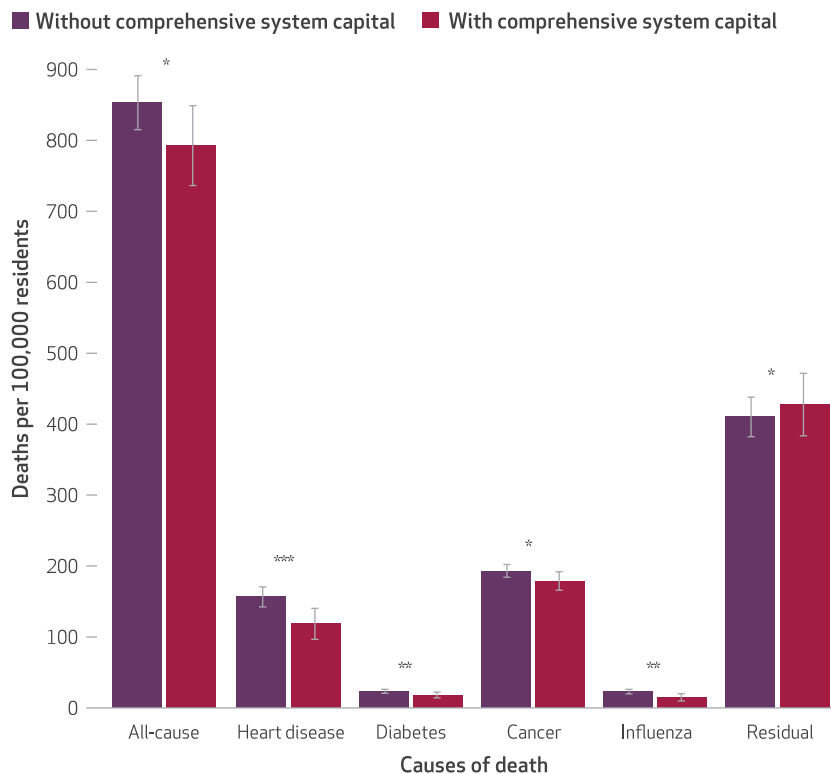
Our results indicate that sizable gains in health status accrue over time to communities that achieve comprehensive system capital through dense multisector networks supporting population health activities. The largest health improvements associated with system capital were observed for deaths from causes that are largely preventable, including cardiovascular disease, diabetes, and influenza. System capital also may have contributed to a drop in the overall mortality rate, although these results approached but did not reach statistical significance. To our knowledge, this is first US study to document community-level health improvements associated with multisector health planning and implementation activities using nationally representative data.

The pathways through which system capital leads to health improvements cannot be determined definitively through this study; however, these pathways appear to extend beyond the medical care system. For example, communities that gained comprehensive system capital during the study period were significantly more likely than their counterparts to adopt comprehensive smoking bans, and they achieved lower rates of smoking, obesity, and physical inactivity among low-income residents (see Appendix Exhibit A4).⁴³ These results are consistent with the view that higher levels of system capital may help communities achieve changes in policy and in social and environmental conditions—such as access to recreation opportunities, healthy food, and community exercise groups—that improve health for at-risk populations.

Prior studies have found that population health status varies significantly with the resources devoted to public health and other social services. Our findings indicate that the strong associations between system capital and community mortality persist across a wide range of community resource levels. J. Mac McCullough and Jonathan Lieder found that counties that in-

EXHIBIT 4

Differences in county mortality rates associated with comprehensive population health system capital, 2014



SOURCE Authors' analysis of data from the National Longitudinal Survey of Public Health Systems. **NOTES** Regression-adjusted death rates are estimated for the 2014 calendar year. Estimates indicate regression-adjusted differences in death rates after controlling for population size, population density, age distribution, racial composition, household income per capita, unemployment rate, hospital and physician availability, uninsurance rate, and year fixed effects. Instrumental variables are used to adjust for unmeasured differences between counties. Vertical lines ("whiskers" indicate 95% confidence intervals. p values indicate the statistical significance of the difference in each pair of death rates. The residual death rate includes deaths from all causes except heart disease, diabetes, cancer, and influenza, and infant mortality.

vested more dollars into public health and other resources such as parks and libraries had better health outcomes than those that did not.⁴⁴ Elizabeth Bradley and colleagues found a similar pattern at the state level.⁹ At the same time, we also found that better-resourced communities are more likely to achieve comprehensive system capital (see Appendix Exhibit A4).⁴³ Taken together, these findings suggest that while funding is not the only pathway to strong system capital, it clearly helps. These findings underscore the need for adequate and sustainable financing mechanisms for multisector work in population health.

As of 2014, almost 40 percent of US metropolitan communities had attained levels of system capital that are associated with the reductions in mortality shown in Exhibit 4, up from 24 percent in 1998. Less than half of the US population currently resides in a community with compre-

hensive system capital. These results imply significant unrealized potential for improving health through focused efforts to build multisector system capital, and doing so may help the United States improve its health standing relative to other developed countries. Even more important, efforts to build system capital may help close geographic and socioeconomic disparities in health within the United States. Although not included in this study, rural communities have significantly lower levels of system capital compared to their urban counterparts, and recent data show that only one-quarter of US communities with fewer than 100,000 residents met the criteria for comprehensive system capital in 2014.⁴⁵ Communities with lower household incomes and higher proportions of racial and ethnic minority residents are also less likely than their counterparts to achieve comprehensive levels of system capital.^{17,18} Consequently, efforts to build system capital in low-income, minority, and rural communities may go a long way toward reducing inequities in population health.

From a policy perspective, our findings suggest that multisector engagement in health plan-

ning, implementation, and evaluation activities can produce sizable communitywide benefits. Building strong and durable capabilities for carrying out these foundational activities may be at least as important to population health as are the downstream choices made by communities about which specific interventions and target populations to pursue at a given point in time. These results underscore the importance of building strong incentives and sustainable infrastructure at the community level to support multisector work in population health. Considerable additional resources will be needed to finance the development of this infrastructure, given our finding that two-thirds of US communities currently lack strong system capital. Many communities will need to draw upon a combination of financing sources to build this capital, such as hospital community benefit spending, shared-savings arrangements with health care delivery systems, allocations from the ACA's Prevention and Public Health Fund, and investments from community development institutions.⁴⁶ New structures such as local health outcome trusts may help communities pool resources for building the necessary system capital.⁴⁷ ■

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