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Evidence Links Increases In Public Health Spending To Declines In Preventable Deaths

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Abstract

Public health encompasses a broad array of programs designed to prevent the occurrence of disease and injury within communities. But policy makers have little evidence to draw on when determining the value of investments in these program activities, which currently account for less than 5 percent of US health spending. We examine whether changes in spending by local public health agencies over a thirteen-year period contributed to changes in rates of community mortality from preventable causes of death, including infant mortality and deaths due to cardiovascular disease, diabetes, and cancer. We found that mortality rates fell between 1.1 percent and 6.9 percent for each 10 percent increase in local public health spending. These results suggest that increased public health investments can produce measurable improvements in health, especially in low-resource communities. However, more money by itself is unlikely to generate significant and sustainable health gains; improvements in public health practices are needed as well.

Despite devoting far more resources to health than any other country in the world, the United States continues to lag behind many other industrialized nations in health outcomes, including morbidity and mortality.¹ Although there are many factors that contribute to this gap between resources and outcomes, one possible contributor is the relatively limited investment in public health activities that are designed to promote health and prevent disease and disability.^{2–5} These activities include efforts to monitor community health status; investigate and control disease outbreaks; educate the public about health risks and prevention strategies; enforce public health laws and regulations such as those concerning tobacco use; and inspect and ensure the safety and quality of water, food, air, and other resources necessary for health.⁶

Although national data on public health spending are scarce and imperfect, estimates consistently indicate that less than 5 percent of national health spending is devoted to public health activities.^{7–9} In fact, the United States spends more on administrative overhead for medical care and health insurance than it does on public health activities.¹⁰

The resources invested in public health strategies within the United States vary widely across states and communities, yet the effects of this variation on population health remain

poorly understood. Consequently, public health officials and policy makers face considerable uncertainty regarding the appropriate levels and targets of investing in public health activities.

The Affordable Care Act of 2010 authorized the largest expansion in federal public health spending in decades—a projected \$15 billion in new spending over ten years—with the goals of improving population health, reducing health disparities, and helping to “bend the cost curve” by moderating growth in medical care spending. However, uncertainties regarding the expected effect and value of these public health investments have contributed to the political controversy surrounding the Affordable Care Act.^{11,12} Meanwhile, a persistent economic downturn has precipitated large cuts in state and local government support for public health activities, which has raised concerns about future adverse consequences for population health.

To shed light on these uncertainties, this study uses measures of public health spending from local public health agencies over a thirteen-year period to estimate the effects of this spending on preventable mortality rates.

Background

Public health activities in the United States are supported through a patchwork of funding sources and financing arrangements that vary widely across states and communities and that are relatively unstable over time.^{13,14} These arrangements result in large geographic differences in spending for public health activities, even among communities with relatively similar population characteristics and health needs.¹⁵

At the state level, per capita public health spending varied by a factor of more than thirty in 2010, ranging from a low of less than \$4 in Nevada to a high of more than \$171 in Hawaii.⁹ Local variation in public health spending was even larger, ranging from less than \$1 per capita to more than \$200 per capita in 2008; among local public health agencies the median spent was about \$36 per person.¹⁶ Many communities depend heavily on local tax bases to support public health programs, making it difficult for economically disadvantaged communities to support a comprehensive array of activities.¹⁷ Because only 16 percent of funding for public health activities is derived from the federal government,⁷ federal spending is insufficient to equalize large differences in funding—from taxes—of public health programs across localities.¹⁸

The amount of resources expended on public health activities in a given community is determined through a complex interaction of economic conditions and fiscal capacities, community health needs, policy priorities, and delivery system characteristics.¹⁵ Community-level variation in public health spending may result from differences in the mix of activities produced; differences in the volume, intensity, and quality of activities produced; and differences in the production and delivery costs incurred.

Higher levels of spending may contribute to improved population health if resources are allocated to activities that are effective in reducing health risks, and if these activities are targeted successfully to population groups at risk. However, communities may vary

considerably in how effectively and efficiently resources are used to address community health needs, thereby weakening the effect of spending on population health. Research has documented such disconnects between spending and outcomes in local medical care delivery.¹⁹

On balance, there is very little empirical evidence about the extent to which differences in public health spending levels contribute to differences in population health.²⁰ Several cross-national studies have found weak and conflicting associations between spending and health outcomes at a national level.^{21–23} In the United States, several time-series studies have examined associations between spending levels and health outcomes for specific types of programs such as those targeting HIV prevention, sexually transmitted disease prevention, and tobacco control, finding that disease incidence and/or harmful behaviors declined as expected in response to funding increases.^{24–28}

However, very little attention has been paid to the value of investments in the public health system as a whole, leading to persistent questions about whether the nation's current spending levels are worth the opportunity costs. Better evidence about the consequences of these spending patterns is likely to help policy makers at all levels of government make informed decisions about how to allocate scarce health resources.

To this end, we assembled a unique longitudinal database that included local government public health spending, population characteristics, and community mortality rates, in order to estimate how changes in public health spending influence population health. We used the considerable natural variation in public health spending levels across communities, and the considerable change in these levels over time, to estimate health effects.

This study focuses on spending and health at the local level because local public health agencies—rather than their state and federal counterparts—assume primary responsibility for directly implementing public health activities in most communities.²⁹ Most federal and state funding—and large amounts of private philanthropic funding—for public health activities is channeled through local public health agencies. The local agencies also mobilize and coordinate the public health activities of hospitals, health plans, and community-based organizations.³⁰ Thus, these agencies provide valuable settings in which to study the health consequences of public health spending in the United States.

Study Data And Methods

We analyzed changes in spending patterns and mortality rates within the service areas of the nation's nearly three thousand local public health agencies over a thirteen-year period. The study population included all organizations that met the National Association of County and City Health Officials' definition of a local health department: a unit of a local or state government that has responsibility for performing public health functions for a geopolitical jurisdiction smaller than a state.¹⁶ In 2005 approximately 73 percent of these agencies served county jurisdictions or combined city and county jurisdictions, and the remaining agencies served city or township jurisdictions (16 percent), or multi-county or regional jurisdictions (11 percent).

Data Sources And Measures

The National Association of County and City Health Officials collected spending data along with organizational and operational characteristics of local public health agencies through census surveys conducted in 1993, 1997, and 2005. Key variables reflecting annual agency spending, service offerings, and staffing levels were collected in each year of the survey. We linked the survey data with contemporaneous county-level data on population characteristics and health resources from the Health Resources and Services Administration's Area Resource File (a national county-level health resource information database), federal and state spending estimates from the Census Bureau's *Consolidated Federal Funds Report* and Census of Governments, and cause-specific mortality rates from the Centers for Disease Control and Prevention's Compressed Mortality File.

As outcome measures, we used mortality rates that were expected to be sensitive to public health interventions over the thirteen-year period of study,^{31,32} including the age-adjusted all-cause mortality rate, the infant mortality rate, and the age-adjusted mortality rates for heart disease, cancer, diabetes, and influenza. Two additional mortality measures were selected as control conditions based on the expectation that they would not be influenced by public health resources and interventions during the study period. These measures included mortality from Alzheimer's disease and a measure of residual mortality indicating deaths not attributable to heart disease, cancer, diabetes, chronic obstructive pulmonary disease, influenza, cerebrovascular diseases, or unintentional injuries.

The primary independent variable of interest in this analysis is the measure of per capita local public health spending, defined as the total annual spending of the local public health agency, divided by the total population residing within the jurisdiction of the agency. We also constructed measures of direct state and federal public health spending that were not passed through to local public health agencies. Other measures reflecting community demographic and socioeconomic characteristics and area health resources are used as control variables in the analysis (Exhibit 1).

Analytic Methods

Multivariate regression models for panel data were used to estimate the effect of local public health spending on each mortality measure while controlling for the effects of other community characteristics that influence population health. Time-trend variables were used in the models to account for general downward trends in mortality that occurred independently of spending.

An important methodological complication arises in this analysis because local public health spending levels may be influenced by unobserved community characteristics that simultaneously influence mortality. For example, deteriorating local economic conditions may cause public health spending to decline and mortality risks to rise, resulting in incorrect inferences about how spending influences mortality.

To address this possible source of bias, we used instrumental variables methods to distinguish the effects of spending on mortality from the effects of unmeasured characteristics that simultaneously influence spending and mortality.^{33,34} This methodology

requires the identification of variables that influence local public health spending but have no direct effects on community mortality rates. We used measures of local public health decision-making structures for this purpose, including whether the agency is governed by a local board of health with policy making authority, and whether the agency operates under the centralized administrative control of state government. Theory and previous studies indicate that these characteristics influence the ability and inclination of local public health agencies to secure external funding sources for their work.^{15,35–37}

Specification tests³⁸ confirm that the structural characteristics meet the requirements for instrumental variables (see the Appendix).³⁹ Using a two-step process, we first estimated the effect of the instrumental variables on spending levels, and then used the natural variation in spending produced by these variables to estimate how spending affects mortality.

Limitations

Several limitations of this analysis are worthy of emphasis. Although we used strong statistical controls to address possible sources of bias,^{34,35} it remains possible that factors distinct from, but closely correlated with, public health spending may explain some of the observed associations between spending and mortality. In addition, our analysis focused on selected mortality rates as measures of population health, not on other indicators of disease burden or quality of life.

Local public health activities may have important and perhaps more immediate effects on these other indicators of health. Moreover, the thirteen-year time period used in this study is insufficient for observing the complete, long-term effects of public health interventions on chronic disease mortality rates. Consequently, this analysis may underestimate the health consequences of changes in local public health spending.

Study Results

Variation In Spending And Mortality

A general secular trend of growth in public health spending and reductions in selected mortality rates during the 1993–2005 period masked significant community-level differences. Local public health spending in the average community reached \$40.84 per capita in 2005, up from \$34.68 per capita in 1993 (Exhibit 1). However, only 65 percent of agencies experienced positive growth in per capita public health spending during the 1993–2005 period, while 35 percent of agencies experienced spending reductions.

The degree of change in per capita spending varied widely across communities. The top 20 percent of agencies experienced growth of nearly 150 percent, while the bottom 20 percent of agencies experienced reductions of nearly 45 percent during the study period. Meanwhile, infant mortality and heart disease mortality rates declined moderately during the same period, continuing a longer-term secular trend downward, while cancer and diabetes mortality rose slightly (Exhibit 1).

The rates of change in these outcomes varied widely among communities. For example, the top 20 percent of communities experienced a reduction in age-adjusted heart disease

mortality of 104 deaths per 100,000 people, while the bottom 20 percent of communities saw mortality increase by forty-three deaths per 100,000 people. Overall, population size, educational attainment, physician availability, and number of people above the federal poverty level increased in the average community during this period.

Determinants Of Public Health Spending

Local decision-making structures influenced public health spending levels considerably. Per capita spending was more than 17 percent higher in communities governed by a local board of health, compared to communities without such boards ($p < 0.001$) (Exhibit 2). Moreover, spending was 24 percent lower among agencies that operated under the centralized administrative control of state agencies, as compared to independent local agencies.

Public health spending increased with social indicators of community health need, including the unemployment rate, the uninsured rate, and the nonwhite racial composition of the community, whereas spending decreased with the availability of selected medical resources in the community (Exhibit 2).

Effects Of Spending On Mortality

Increases in public health spending were associated with statistically significant reductions in mortality for four of the six mortality rates we examined (Exhibit 3). The strongest effects were found for infant mortality and cardiovascular disease mortality, indicating that mortality rates fell by 6.9 percent and 3.2 percent for each 10 percent increase in spending ($p < 0.05$). Diabetes mortality fell by 1.4 percent and cancer mortality fell by 1.1 percent for each 10 percent increase in spending ($p < 0.05$).

Influenza mortality and total mortality changed in the expected direction, but did not reach statistical significance. Public health spending showed no association with the two control conditions, Alzheimer's mortality and residual mortality, helping us to rule out the possibility of spurious associations between spending and mortality.

Overall, public health spending emerged as one of the most consistent determinants of community-level preventable mortality. Most of the other variables that were consistently associated with reductions in mortality reflected social determinants of health, including educational attainment, percentage of the population above the federal poverty level, and percentage of the population that was white (see the Appendix).³⁹ Medical resource variables were not consistently associated with mortality after controlling for the effects of other variables in the analysis.

Discussion

Communities with larger increases in public health spending experienced larger reductions in mortality from leading preventable causes of death over a thirteen-year period. This relationship was consistent across several different mortality measures, and it persisted after accounting for differences in demographic and socioeconomic characteristics, medical resources, and unobserved community characteristics that jointly influence spending and health. These findings are consistent with recent time-series studies estimating that,

nationally, as much as 50 percent of the gains in life expectancy experienced in the United States since 1950 are attributable to public health attention to diet, tobacco exposure, and other measures.^{40–44}

Although our study does not establish a definitive causal link between spending and mortality because of the observational research design we used, it nevertheless provides compelling evidence that differences in public health investments may contribute to differences in community health outcomes. Consequently, efforts to improve community health and reduce geographic disparities in mortality are likely to require attention not only to local medical resources and interventions, but also to the resources invested in local public health activities.

The findings imply that the mortality reductions attributable to increases in public health spending are sizable, and may exceed the reductions achievable through similar expansions in local medical care resources. For example, our estimates suggest that a 10 percent increase in public health spending could achieve a 3.2 percent reduction in cardiovascular mortality. This spending increase would require an additional \$312,274 in annual funding in the average metropolitan community included in our analysis.

Achieving this same mortality reduction by increasing the number of primary care physicians would require an additional twenty-seven physicians in the average metropolitan community, based on a recent analysis of physician supply.⁴⁵ Increasing the physician supply by this amount would probably require new spending considerably in excess of the amount needed to achieve the mortality reduction through public health spending. The potential for substitution and synergy between public health and medical care resources is an important area for further study.

The strongest associations between spending and mortality were observed for infant mortality, cardiovascular disease, diabetes, and cancer—four of the preventable health conditions most commonly targeted by public health agencies. In 2005, 73 percent of the nation's local health departments maintained screening and/or risk-reduction programs for cardiovascular disease or high blood pressure, 74 percent delivered maternal and infant health programs involving nutrition and/or prenatal care, and 69 percent performed activities to reduce tobacco exposure—a risk factor for all four causes of death.¹⁶

Evidence-based public health interventions are known to address risk factors for these causes of death.^{46–48} The observed associations between spending and mortality are consistent with the expectation that higher levels of spending allow public health agencies to implement these types of risk-reduction activities more effectively within their communities.

Influenza mortality and total mortality did not appear sensitive to public health spending in our analysis. A combination of factors may explain the influenza result, including the dearth of effective community-based interventions for achieving high vaccination rates, random variation in influenza lethality, and inconsistencies in how deaths are attributed to influenza.⁴⁹ For total mortality, the lack of a significant spending effect probably stems from the heterogeneous disease processes reflected in this broad mortality measure and the many factors beyond public health interventions that influence these processes.

Our results suggest that additional spending, such as the \$15 billion in new federal funds authorized under the Affordable Care Act's Prevention and Public Health Fund, would be expected to generate substantial improvements in population health over time. At the same time, our results suggest that the recent recession-driven reductions in state and local support for public health activities are likely to have adverse health consequences over time unless they are offset with new spending. Additional research is urgently needed to track the downstream effects of these ongoing, unprecedented spending shocks in public health. Our study provides a foundation for these future investigations.

The mortality reductions attributable to public health spending in this study represent average effects across all US local public health agencies and across all categories of local governmental public health spending. Unfortunately, because our analysis of spending was carried out at an aggregate level, our results do not suggest how future funding increases and reductions should be allocated among the many programs and services maintained at the local level.

The aggregate nature of our analysis may also explain the relatively modest mortality effects we observed. By measuring spending levels in specific programmatic areas such as tobacco control, nutrition, and physical activity, it may be possible to identify more precise relationships between investments and health outcomes and to examine the comparative effectiveness of each type of spending. Such targeted studies will require much more detailed spending data than are currently available for local public health agencies nationwide, which calls attention to the need for improved data systems to track public health spending.

Our analysis supports the contention that spending on local public health activities is a wise health investment. Increasing such investments in communities with historically low levels of spending may provide an effective way of reducing geographic disparities in population health. However, more money by itself is unlikely to generate significant and sustainable health gains.

A growing body of evidence suggests that the quality and efficiency of public health practice within the United States have considerable room for improvement, and progress in these areas could greatly increase the value of additional public health spending.^{35,50–54} Better systems for tracking data on trends in public health spending and the use of funds at local, state, and national levels are needed to ensure that resources are allocated wisely. Moreover, the resulting estimates of spending and their health consequences must be accessible to public health officials, policy makers, and the public at large to support informed decision making about societal investments in public health activities.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Exhibit 1

Characteristics Of The Study Communities, 1993 And 2005

Variable	1993 mean	1993 SD	2005 mean	2005 SD
Public health agency characteristics				
Per capita public health spending	\$34.68	\$33.08	\$40.84	\$42.52
Agency governed by local board of health	64.41%		57.42%	
Agency operates as centralized unit of state agency	10.27%		7.83%	
Community characteristics				
Population size (1,000s)	108.63	340.60	131.44	426.42
Population per square mile (1,000s)	475.08	1,841.46	484.04	1,842.57
Community located within a metropolitan area	51.05%		50.48%	
Percent of:				
Population nonwhite	14.33	17.93	19.27	17.36
Population 65 or older	14.39	3.91	14.07	4.00
Population with college degree	15.85	8.25	19.59	9.53
Population unemployed	6.21	2.42	5.64	2.26
Population below federal poverty level	15.65	7.04	11.92	4.79
Population non-English speaking	1.07	1.77	1.73	2.32
Population uninsured	13.66	4.65	13.52	4.50
Medical care resources				
Active physicians per 100,000 population	138.04	133.83	169.24	159.23
Hospital beds per 100,000 population	384.16	320.51	320.60	372.81
Federally qualified health center serves community	48.33%		46.57%	
Health outcomes				
Infant deaths per 1,000 live births	8.76	3.50	7.03	3.22
Deaths per 100,000 population from:				
Influenza	36.11	17.66	27.28	15.52
Cancer	215.46	56.16	219.49	57.99
Heart disease	225.02	78.87	194.09	76.95
Diabetes	23.47	10.58	28.67	14.41
Total deaths per 100,000 population	1,020.97	256.59	980.62	270.68
Number of observations	2,026		2,300	

SOURCE Authors' analysis of linked data from the National Association of County and City Health Officials' National Profile of Local Health Departments, the Census Bureau's Census of Governments and *Consolidated Federal Funds Report*, the Health Resources and Services Administration's Area Resource File, and the Centers for Disease Control and Prevention's Compressed Mortality File. **NOTE** SD is standard deviation.

Exhibit 2**Influence Of Selected Characteristics On Local Public Health Spending**

Characteristic	Percent change in spending
Public health agency characteristics	
Agency governed by local board of health	0.169***
Agency operates as centralized unit of state agency	-0.240***
Community characteristics	
Population per square mile (1,000s)	0.001
Community lies within a metropolitan area	-0.388***
Percent of population nonwhite	0.008***
Percent of population 65 or older	0.010
Percent of population with college degree	-0.011***
Unemployment rate	0.013**
Percent of population below federal poverty level	0.005
Percent of population non-English speaking	-0.068***
Percent of population uninsured	0.037***
Medical care resources	
Active physicians per 100,000 population	0.002
Hospital beds per 100,000 population	-0.002***
Federally qualified health center serves community	-0.174***

SOURCE Authors' analysis of linked data from the National Association of County and City Health Officials' National Profile of Local Health Departments, the Census Bureau's Census of Governments and *Consolidated Federal Funds Report*, the Health Resources and Services Administration's Area Resource File, and the Centers for Disease Control and Prevention's Compressed Mortality File. **NOTE** This table shows coefficient estimates from a semilogarithmic regression model that controls for demographic, socioeconomic, and health resources characteristics and community-specific random effects.

**
 $p < 0.05$

 $p < 0.01$

Exhibit 3

Effects Of Local Public Health Spending On Community Mortality Rates

Mortality rate	Percent change per 10% increase in spending
Infant deaths per 1,000 live births	-6.85***
Heart disease deaths per 100,000 population	-3.22**
Diabetes deaths per 100,000 population	-1.44**
Cancer deaths per 100,000 population	-1.13**
Influenza deaths per 100,000 population	-0.25
All-cause deaths per 100,000 population	-0.29
Alzheimer's deaths per 100,000 population	0.25
Residual deaths per 100,000 population	0.18

SOURCE Authors' analysis of linked data from the National Association of County and City Health Officials' National Profile of Local Health Departments, the Census Bureau's Census of Governments and *Consolidated Federal Funds Report*, the Health Resources and Services Administration's Area Resource File, and the Centers for Disease Control and Prevention's Compressed Mortality File. **NOTE** This table shows coefficient estimates obtained from instrumental variables estimation of semilogarithmic regression models for panel data that control for demographic, socioeconomic, and health resources characteristics and community-specific random effects.

**
 $p < 0.05$

 $p < 0.01$