Institutional and Economic Determinants of Public Health System Performance

Glen P. Mays, PhD, MPH, Megan C. McHugh, MPA, Kyumin Shim, PhD, Natalie Perry, DrPH, MPH, Dennis Lenaway, PhD, MPH, Paul K. Halverson, DrPH, MHSA, and Ramal Moonesinghe, PhD

Objectives. Although a growing body of evidence demonstrates that availability and quality of essential public health services vary widely across communities, relatively little is known about the factors that give rise to these variations. We examined the association of institutional, financial, and community characteristics of local public health delivery systems and the performance of essential services.

Methods. Performance measures were collected from local public health systems in 7 states and combined with secondary data sources. Multivariate, linear, and nonlinear regression models were used to estimate associations between system characteristics and the performance of essential services.

Results. Performance varied significantly with the size, financial resources, and organizational structure of local public health systems, with some public health services appearing more sensitive to these characteristics than others. Staffing levels and community characteristics also appeared to be related to the performance of selected services.

Conclusions. Reconfiguring the organization and financing of public health systems in some communities—such as through consolidation and enhanced intergovernmental coordination—may hold promise for improving the performance of essential services. (*Am J Public Health.* 2006;96:523–531. doi:10.2105/AJPH.2005.064253)

A growing body of evidence demonstrates that the availability and quality of essential public health services vary widely across communities.[1–7] These services include population-based efforts to investigate community health threats, promote healthy lifestyles, prevent disease and injury, and ensure the quality of water, food, air, and other resources necessary for good health.[8] Unfortunately, relatively little is known about the factors that give rise to variation in local public health services delivery, and many existing studies are quite dated and do not reflect contemporary public health issues ranging from obesity to bioterrorism.[9,10]

In many communities, public health services are produced through the collective actions of numerous governmental agencies and private organizations that vary widely in their resources, missions, and operations.[11–13] As such, public health delivery systems exist as complex and adaptive systems that operate through the interactions of multiple heterogeneous actors,[14] including local and state public health agencies, law enforcement and public safety agencies, community-based organizations, health care providers and insurers, businesses, educational institutions, and many other types of organizations.[15] A better understanding of how attributes of the local public health system influence the availability and effectiveness of public health services is a critical first step in elucidating pathways for improving public health service delivery.

Theories of organizational sociology and industrial organization suggest that the activities performed by a public health system are likely to be shaped by the resources available to the system, the ways in which the resources are organized, and the characteristics of the community or market served by the system.[16–18] The most basic resources available to local public health systems include funds and personnel. Funding often determines the amount of human, technological, and other resources that can be engaged to perform public health activities. Many local public health systems depend heavily on local governments and their ability and willingness to draw on local tax bases and other revenue sources to support public health activities.[19] Nationally, local governmental public health agencies obtain an average of 44% of their funding from local governmental appropriations, with the remainder derived from state government (30%), fee-based revenue (19%), and direct federal appropriations (3%).[20]

Although funding is often a major determinant of staffing levels, even well-funded public health systems experience difficulties in recruiting and retaining a sufficient volume and mix of staff in view of persistent shortages in key health professions and competition with other employment settings including medical care provision and health insurance. Previous studies have documented wide variations in both funding and staffing levels across local public health systems,[21,22] suggesting that disparities in these 2 types of resources may account for much of the variation in public health system performance observed across communities.

The activities performed by a public health system also may be shaped by the structure of the system itself and the ways in which resources are organized. One potentially important structural characteristic is the size of the public health system as reflected by the number of people served by the system. Large public health systems may be able to realize economies of scale in performing activities such as disease surveillance and health education by spreading the fixed costs of public health infrastructure over larger populations of beneficiaries and taxpayers. Large public health systems may also benefit from larger pools of organizations in the community that may be enlisted to participate in public health activities, including medical care providers, community organizations, educational

institutions, local media, businesses, and government agencies.[11,13,23] Several previous studies have found evidence that larger public health systems perform better than their counterparts in carrying out activities considered to be important elements of public health practice.[1,3,5]

Another organizational characteristic that may influence public health system performance is the type of government authority and control within the system. In some states and communities, local governmental public health agencies operate as centralized administrative units of a state health agency, whereas in other communities these agencies operate as decentralized, autonomous units of local government.[24] In still other communities, public health agencies operate under the shared authority of both state and local governments. One theory of political economy suggests that decentralized governmental authority and decisionmaking may yield superior public services because local governments, as opposed to state administrative units, may be more informed of and responsive to local community needs.[25–27] Alternative theories suggest that centralized provision of services may be more effective and efficient because central governments can coordinate resources and activities across local jurisdictions, thereby addressing any spillover effects and correcting inequities in resources across communities.[28] The empirical evidence on this issue, however, is limited and mixed.[1,3]

Other aspects of government authority and control may influence public health system performance, including the types of governmental jurisdictions and governance structures that exist within the systems. As with decentralization, it is difficult to know *a priori* the net effects of various approaches to organizing governmental public health responsibilities. Some local public health agencies serve the jurisdiction of a single city or county and therefore act as the public health arm of a single local government.[12,20] Other agencies, however, serve consolidated city–county or multicounty jurisdictions and operate as agents for multiple local governments. Consolidated jurisdictions may achieve a level of intergovernmental coordination that enhances the delivery of public health services; alternatively, these jurisdictions may face complexities in authority and reporting relationships that pose barriers to effective public health action. Governance structures also vary across local public health agencies, with some agencies reporting directly to elected local legislative bodies such as county commissions or city councils and others reporting to boards of health that are appointed or elected specifically to provide strategic direction for public health agencies. Where they exist, local boards of health may improve public health performance by enhancing public oversight, engagement, and accountability, or they may inhibit performance by making policy and administrative decisionmaking more cumbersome and time consuming. Evidence from prior studies is lacking in these areas.

Finally, the activities performed by a local public health system are likely to reflect the health resources and needs within the community that it serves. In communities that are underserved by medical care resources such as physicians and hospitals, public health systems may devote larger a share of their resources to ensuring that people receive access to needed medical care, thereby leaving fewer resources available for other important public health responsibilities.[8] Similarly, public health systems serving impoverished communities with low rates of insurance coverage and high rates of social and behavioral health risks may devote more of their resources to health promotion and health care initiatives—all at the expense of other activities. These communities also are likely to have limited tax bases and many competing human services needs, leaving fewer resources available to invest in public health activities of any type. Rural systems may experience unique challenges in performing core public health activities if geographic barriers make activities such as health risk investigation and regulatory enforcement more difficult and costly.[29] Collectively, community characteristics may give rise to substantial differences in the scope and intensity of activities performed by local public health systems across the nation.

Recognizing that many different factors potentially play a role in determining local public health practice, this study provides an exploratory analysis of the institutional, financial, and community characteristics most strongly associated with public health system performance.

METHODS

Study Population

We used data from 315 local public health systems located in the 7 states that participated in pilot tests of the National Public Health Performance Standards Program between 1999 and 2001. Under this program, the Centers for Disease Control and Prevention (CDC) and 6 national public health organizations developed a consensus set of performance standards for local public health systems along with a validated instrument for measuring the degree to which the standards are achieved.[30–32] The performance standards and associated instrument were based on the 10 essential services of public health as identified by the Public Health Functions Working Group (Table 1).[33] The local public health systems volunteered to participate in the pilot tests and do not constitute a representative sample of all US systems, but they do exhibit considerable variation in geographic region, population size, urbanization, and public health agency organizational structure (see Table 2). In total, 60% of the local public health systems located in the 7 states participated in the pilot tests. These systems serve approximately 11% of the total US population. The states represented were Florida, Hawaii, Minnesota, Missouri, Mississippi, New York, and Ohio.

Data

The Performance Standards Program collects information on local public health system performance through a self-administered survey instrument designed to be completed by administrators of local public health organizations. The instrument asks respondents to assess the extent to which a range of public health services and activities is performed within their community regardless of whether the local public health agency performs the activities directly. Hence, the instrument is designed to assess the performance of the local public health system as a whole rather than the performance of an individual public health organization. The instrument is designed to be completed by a group of public

TABLE 1—Essential Public Health Services and Performance Indicators Included in the Analysis

Essential Service	Performance Indicators
1. Monitor health status to identify community problems	Development of a population-based community health profile
2. Diagnose and investigate health problems and health hazards in the community	Identification and surveillance of health threats
	Plan for public health emergencies
	Investigate and respond to public health emergencies
	Laboratory support for investigation of health threats
3. Inform, educate, and empower people about health issues	Health education to facilitate informed decisionmaking on health issues at individual and community levels
4. Mobilize community partnerships to identify and solve health problems	Constituency development to establish productive relationships with entities that influence health issues
	Community partnerships to facilitate cooperation and collective action on health issues
5. Develop policies and plans that support individual and community health efforts	Governmental public health presence at the local level
	Public health policy development
	Process for community health improvement
	Strategic planning and alignment with community health improvement processes
6. Enforce laws and regulations that protect health and ensure safety	Review and evaluate public health laws, regulations, and ordinances
	Involvement in the improvement of public health laws, regulations, and ordinances
	Enforce public health laws, regulations, and ordinances
7. Link people to needed personal health services and ensure provision of care	Identification of populations facing barriers to needed personal health care
	Ensuring the linkage of people to needed personal health care
8. Ensure a competent public and personal health care workforce	Assessment of health workforce supply, distribution, competencies, skills, and training needs
	Maintenance of workforce standards/qualifications for individuals who deliver or contribute to public health services
	Continuing education, training, and mentoring for the public health workforce
	Leadership development for the public health workforce
9. Evaluate the effectiveness, accessibility, and quality of personal and population-based health care	Evaluation of the accessibility, quality, and effectiveness of population-based health services
	Evaluation of the accessibility, quality, and effectiveness of personal health services
	Evaluation of the performance of the local public health system
10. Research for new insights and innovative solutions to health problems	Fostering innovation in public health practice through research and field-based efforts
	Linkage and consultation with institutions of higher learning and research
	Capacity to initiate or participate in epidemiological, health policy, and health systems research

Source. Data are from the National Public Health Performance Standards Program, 1999–2002.[32]
Note. Only indicators used on all 3 versions of the local instrument were included in this analysis.

health professionals who are knowledgeable about local public health activities underway within the community, assembled by the local public health agency director in each community. Through this process, group participants are asked to reach consensus about the extent to which specific public health activities are performed within the community, and report their consensus response to each question on the instrument. The community is defined as the geopolitical jurisdiction served by the local public health agency—typically a county, city, township, or multicounty region.

Measures of Public Health System Performance

The survey instrument contains questions that correspond to each of the 10 essential services of public health,[32] such as monitoring health status in the community, diagnosing and investigating health hazards and threats, and informing and educating the public about health issues. Each *essential service* is linked to 1 or more *performance indicators* (see Table 1). For each indicator, CDC developed a *performance standard* that provides a qualitative description of the activities that a public health system would need to undertake in order to achieve an optimal level of performance on the indicator. For example, the performance standard for the first indicator listed in Table 1, "Development of a population-based community health profile," indicates that the public health system should compile and maintain current, population-based data on the incidence and prevalence of diseases and injuries, risk factors, mortality, and the delivery of recommended preventive and screening services. The CDC and its partner organizations developed the indicators and performance standards through an extensive expert panel process.[31]

The survey instrument contains several different types of questions based on the performance indicators and standards. For each performance indicator shown in Table 1, the instrument contains a summary question that asks respondents to rate the overall degree to which the local public health system meets the performance standard associated with the indicator. These questions, which we call *summary performance measures*, use an ordinal Likert response scale. The instrument also

TABLE 2—Definitions and Descriptive Statistics for Variables Used in the Analysis

Variable and Definition	Mean	SD	Min	Max
Independent Variables				
Population size (1000s)	154.417	502.017	4	7332.564
Local health agency spending per capita, $	47.513	73.152	0	1204.819
Direct federal health spending per capita, $	24.232	130.522	0	1646.822
Local health agency FTE staff per 100 000 population	86.255	56.949	0	500.176
State–local administrative relationship (0,1)				
Centralized	0.494	0.501	0	1
Decentralized	0.158	0.366	0	1
Shared or mixed (omitted category)	0.348	0.477	0	1
Type of local governmental jurisdiction (0,1)				
City or township	0.017	0.130	0	1
County (omitted category)	0.866	0.342	0	1
Combined city and county	0.072	0.260	0	1
Multicounty or other district	0.045	0.207	0	1
Local board of health exists with policymaking authority (0,1)	0.293	0.456	0	1
Partnerships between local health agency and community organizations, % of 14 possible partnerships	0.640	0.296	0	1
Community is located in metropolitan area (0,1)	0.347	0.477	0	1
Percent of population below federal poverty level, %	15.026	7.072	2.900	41.100
Physicians per 100 000 population	153.591	307.831	0	4388.506
Dependent Variables				
Model standard performance score, % of maximum				
Service 1: Monitor health status	0.360	0.258	0	1
Service 2: Diagnose/investigate health problems	0.674	0.231	0	1
Service 3: Inform and educate the public on health issues	0.613	0.255	0	1
Service 4: Mobilize communities to identify health issues	0.474	0.291	0	1
Service 5: Develop policies/plans to address health issues	0.381	0.264	0	1
Service 6: Enforce health laws and regulations	0.585	0.291	0	1
Service 7: Link people to needed health services	0.542	0.242	0	1
Service 8: Ensure a competent health workforce	0.456	0.231	0	1
Service 9: Evaluate the effectiveness of health services	0.336	0.246	0	1
Service 10: Conduct research on solutions to health issues	0.409	0.300	0	1

Note. Min = minimum; Max = maximum; FTE = full-time employee. (0, 1) indicates a dichotomous variable.

includes a number of subquestions that inquire about the degree to which the public health system performs specific activities associated with each performance standard. These subquestions, which we call *activity measures*, also use an ordinal Likert response scale. The instrument requires input from several people and cumulatively takes approximately 24 hours for completion. Respondents submit their data to CDC electronically by using a Web interface. The instrument has undergone extensive validity and reliability testing.[34–36]

To summarize and reduce the large number of measures included on the instrument, we constructed a composite measure of performance for each of the 10 essential services. Each composite measure was computed as the unweighted mean value of all of the summary performance measures associated with the essential service. For example, Essential Service 2 includes 4 performance indicators and their associated summary performance measures (Table 1), so the composite measure for this essential service is computed as the mean of these 4 summary measures. See Mays et al.[37] for a more detailed description of the composite variables. Given that the instrument underwent revision several times during the course of pilot testing, we use data only for the subset of performance indicators and measures that were worded consistently across different versions of the instrument. These indicators are shown in Table 1.

Measures of System and Community Characteristics

Using identifying information about each local public health jurisdiction and the county or counties in which it is located, we linked the performance data collected through the Performance Standards Program with several secondary sources of data. We obtained organizational, financial, and staffing data on local health departments from the 1997 National Profile of Local Health Departments Survey conducted by the National Association of County and City Health Officials (NACCHO).[20] These data were collected several years earlier than the performance data and therefore may introduce some measurement error into the analysis; however, the variables we used in the analysis were found to be relatively stable over time when compared with data from NACCHO's 1993 survey. We obtained county-level information on area demographic, socioeconomic, and health resource characteristics from the Area Resource File (ARF) for calendar year 2000. Finally, we obtained county-level information on direct federal public health spending from the Consolidated Federal Funds Report (CFFR) maintained by the Census Bureau for calendar year 2000. For simplicity we defined federal public health spending to include all programs administered by CDC and the Health Resources and Services Administration, recognizing that the broad definition would include funding for both public health and health care activities. For public health jurisdictions encompassing multiple counties, we aggregated the ARF and CFFR variables across the relevant counties before linking them with the performance data.

Of the original 315 public health systems included in the Performance Standards pilot tests, we dropped 30 systems (9.5%) from the analysis because they lacked identifying information needed to match pilot test data with secondary data sources. Thus, our analyses used a total of 285 observations on local

public health systems. Given the nonrandom, cross-sectional nature of the sample used in this analysis and the limitations of the pilot test data, these analyses should be viewed as exploratory.

Analysis

We used cross-sectional, multivariate regression models to estimate how organizational, financial, and community characteristics of local public health systems are associated with the performance of essential public health services. We developed a reduced-form model specification that expresses the performance of system *i* in state *j* as a function of (1) the exogenous organizational and financial characteristics of the local public health systems and (2) the characteristics of the local communities served by the system:

$$(1)\quad \text{Performance}_{i,j} = \beta\,\text{System}_{i,j} + \delta\,\text{Community}_{i,j} + \mu_j + \varepsilon_{i,j}$$

where the coefficient vectors β and δ are estimated by the model, μ_j is an error term that varies across states, and $\varepsilon_{i,j}$ is a random error term that varies across systems within states. We estimated the model by using both fixed-effects and random-effects specifications for the state effects μ_j, but because results were qualitatively similar, we present the latter results in this paper.

We estimated a separate regression model for each of the 10 essential services, using the Huber/White/Sandwich method to account for the clustering of local observations within states.[38,39] Our baseline models assume a semilogarithmic relationship between population size and performance; however, we also estimated models using population size splines to examine possible nonlinear relationships between size and performance. We tested various population threshold levels for the splines and selected the points that provided the best fit with the data: 20 000, 100 000, 500 000, and 1 million residents. All models were estimated with Stata 8.2 statistical software (Stata Corp, College Station, Tex). Table 3 presents the variable definitions and descriptive statistics for all of the variables included in the regression models.

RESULTS

Estimates from the multivariate models indicate that public health performance varies significantly with selected institutional and economic characteristics of the public health system as well as with several community characteristics. The strength and significance of the associations vary considerably across essential services, suggesting that system characteristics may have larger effects on some services than on others. Collectively, the system and community characteristics explain between 7% and 28% of the variance in the performance scores for each essential service, with all but 2 models explaining at least 16% of the variance.

For most essential services, the strongest predictor of public health system performance was the size of the system as measured by the population residing within the jurisdiction (Table 3). Size was positively associated with performance for all but 3 of the 10 essential services, and was most strongly associated with enforcing public health laws and regulations (essential service 6) and participating in public health research (essential service 10). The standardized regression coefficient for essential service 6 indicated that an increase in the size variable by 1 SD was associated with an increase in performance of 0.33 SD after control for the effects of other variables in the model. When splines were used to test for nonlinearities in these associations, the effect of size on performance was greatest for jurisdictions serving 20 000 to 100 000 residents (see Figure 1). For larger jurisdictions, population size had only small positive effects on performance, and for jurisdictions of more than 500 000 residents, population size was negatively associated with the performance of selected essential services.

Local health department spending emerged as the most consistent predictor of public health system performance across the 10 essential services examined in this analysis. Local per-capita spending was positively associated with the performance of all 10 services after accounting for the effects of other variables in the model (Table 3). Coefficient estimates indicated that an increase in per-capita spending by 1 SD was associated with increases in performance ranging from a low of 0.09 SD for evaluating health services (Essential Service 9) to a high of 0.19 SD for public health research (Essential Service 10). By comparison, federal per-capita spending was associated with increased levels of performance for only 5 of the 10 essential services at conventional levels of statistical significance ($P<.05$). Moreover, federal spending generally had a smaller effect on system performance than did local spending.

Local health department staffing levels were significantly associated with only 2 of the 10 public health system performance measures after accounting for the effects of other characteristics. Staffing was positively associated with informing and educating the public (Essential Service 3) and negatively associated with linking people to needed health services (Essential Service 7).

Performance varied markedly with the type of governmental public health jurisdiction in place at the local level, with county and combined city–county jurisdictions generally achieving the highest performance levels. City–county jurisdictions achieved significantly higher performance levels than all other types of jurisdictions in 4 of the essential services, including diagnosing and investigating health threats (Essential Service 2), informing and educating the public (Essential Service 3), enforcing laws and regulations (Essential Service 6), and linking people to needed health services (Essential Service 7). Multicounty jurisdictions showed lower performance levels than did county and city–county jurisdictions for 6 of the essential services.

Performance also varied significantly with the type of administrative relationship that exists between local and state public health agencies. For 3 essential services, performance was higher in decentralized public health systems—where local agencies have independent authority over most public health issues—than in systems where local and state agencies share authority. These services were health status monitoring (Essential Service 1), informing and educating the public (Essential Service 3), and workforce development (Essential Service 8). For 4 other essential services, performance was higher in shared-authority systems than in both centralized

TABLE 3—Effects of System Characteristics on Performance of Essential Services: Standardized Regression Estimates

	Standardized Regression Coefficient[a]									
	Service 1	Service 2	Service 3	Service 4	Service 5	Service 6	Service 7	Service 8	Service 9	Service 10
Population size, ln	0.3076**	0.2921**	0.2796**	0.2259**	0.1709**	0.3268**	0.1241	0.0636	0.0683	0.3267**
	(0.1082)	(0.1134)	(0.0840)	(0.0846)	(0.0541)	(0.0968)	(0.0667)	(0.0819)	(0.0699)	(0.1168)
LHD spending per capita, $1000s	0.1719**	0.1285***	0.1601***	0.1720***	0.2107***	0.1726***	0.1455***	0.1540***	0.0945**	0.1860***
	(0.0581)	(0.0117)	(0.0181)	(0.0162)	(0.0152)	(0.0378)	(0.0168)	(0.0113)	(0.0289)	(0.0077)
Federal spending per capita, $1000s	0.0468	–0.0355	0.1354**	0.0728*	0.1109**	0.0256	0.0755**	0.1240***	0.0988**	0.1219*
	(0.0563)	(0.0264)	(0.0516)	(0.0352)	(0.0452)	(0.0337)	(0.0276)	(0.0249)	(0.0284)	(0.0521)
LHD staff per 100 000 population, ln	–0.0521	–0.1017	0.1127*	0.0911	–0.0308	–0.0490	–0.1371**	0.1028	0.0677	0.0892*
	(0.0428)	(0.0555)	(0.0573)	(0.0945)	(0.0336)	(0.0674)	(0.0484)	(0.0919)	(0.0654)	(0.0411)
State–local public health authority										
Centralized (0,1)	–0.0895	-0.0187	0.0149	–0.2156	–0.3253**	–0.1723**	–0.5302***	0.1447	–0.2615**	–0.0170
	(0.0662)	(0.0596)	(0.0978)	(0.1370)	(0.0898)	(0.0547)	(0.1153)	(0.1397)	(0.1026)	(0.0825)
Decentralized (0,1)	0.1429***	–0.1689**	0.0954**	0.0075	–0.1463***	–0.2817***	–0.3593***	0.1012***	–0.1372	–0.0754**
	(0.0335)	(0.0505)	(0.0376)	(0.0413)	(0.0334)	(0.0280)	(0.0675)	(0.0204)	(0.0726)	(0.0282)
Shared authority (omitted)	…	…	…	…	…	…	…	…	…	…
Governmental jurisdiction type										
City/township (0,1)	–0.1159	–0.0600	–0.1597**	–0.0922*	–0.0349	–0.0159	–0.1014	–0.0174	0.0021	–0.0552
	(0.0651)	(0.0352)	(0.0461)	(0.0432)	(0.0438)	(0.0587)	(0.0563)	(0.0617)	(0.0754)	(0.0320)
Combined city–county (0,1)	0.0256	0.1438***	0.1087***	0.0574	0.0912	0.1149**	0.1227**	0.0799	0.0159	0.0503
	(0.1328)	(0.0303)	(0.0144)	(0.0406)	(0.0488)	(0.0318)	(0.0294)	(0.0486)	(0.0527)	(0.0240)
Multicounty (0,1)	–0.1131*	–0.1946**	–0.1710**	–0.1336***	–0.1244	–0.0868	–0.0535	–0.1161	–0.1284**	0.1363**
	(0.0515)	(0.0667)	(0.00583)	(0.0276)	(0.0719)	(0.0620)	(0.0577)	(0.0495)	(0.0451)	(0.0491)
County (omitted)	…	…	…	…	…	…	…	…	…	…
Poverty rate, %	–0.0685	0.0092	–0.1997***	–0.1531*	–0.1179*	0.0559	0.1023**	–0.1316	0.0891	–0.1792**
	(0.0603)	(0.0735)	(0.0388)	(0.0778)	(0.0482)	(0.0705)	(0.0321)	(0.0735)	(0.0632)	(0.0495)
Physicians per 100 000 population	0.0333	0.0464**	–0.0240	–0.0146	–0.0126	0.0939**	0.0168	–0.0280	–0.0681	0.0568
	(0.0818)	(0.0185)	(0.0360)	(0.0314)	(0.0389)	(0.0323)	(0.0151)	(0.0204)	(0.0413)	(0.0358)
Adjusted R^2	0.1687	0.2034	0.1799	0.1643	0.2109	0.2828	0.2287	0.1022	0.0745	0.2415
Mean squared error	0.2447	0.2123	0.2371	0.2731	0.2473	0.2567	0.2213	0.2274	0.2460	0.2703
N	275	285	285	282	284	284	283	284	283	282

Note. LHD = local health department; R^2 = coefficient of determination. Numbers shown are standardized regression coefficient estimates with standard errors in parentheses. (0,1) indicates a dichotomous variable. The coefficients for variables not listed in this table did not reach statistical significance in any model.
*P < .10; **P < .05; ***P < .01.

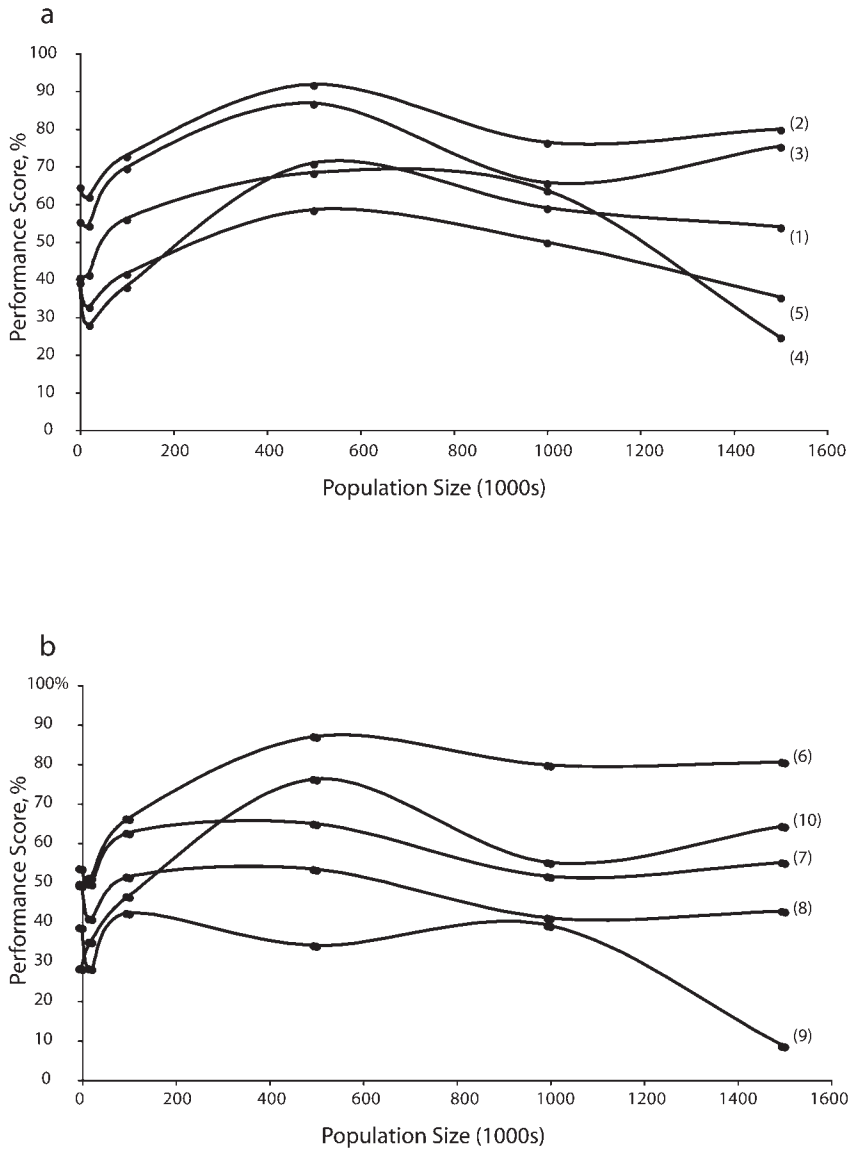
and decentralized systems. Decentralized systems performed lower than shared-authority systems for 2 remaining essential services: investigation (Essential Service 2) and research (Essential Service 10).

Other institutional characteristics were not significantly associated with public health system performance after control for the effects of other variables in the model. These characteristics included the presence of local boards of health and the number of partnerships reported between local public health agencies and other community organizations. Regarding community characteristics, the local poverty rate and the physician-to-population ratio were significantly associated with the performance of selected services, but location within a metropolitan area was not associated with performance for any of the 10 services after control for other variables in the model.

DISCUSSION

Local public health systems vary considerably in the extent to which they perform essential services, and the institutional and economic characteristics of these systems appear to play important roles in shaping their performance. Information about the services most sensitive to these characteristics, and about the relative influence of the characteristics, provides insight into strategies for improving public health system performance.

System size was the strongest predictor of performance for most public health services, suggesting that public health systems can realize economies of scale in the delivery of these services. This finding implies that small public health systems may face special challenges in performing services even if they enjoy funding and staffing levels that are comparable to those of their larger peers on a per-capita basis. Because small systems typically operate



Note. Data points indicate predicted performance scores at different population thresholds after control for all other variables in the model and holding these variables constant at their mean values. Lines drawn between data points have been smoothed. Essential service numbers are shown in parentheses. Essential services are numbered as follows: 1 = Monitor health status to identify community problems; 2 = Diagnose and investigate health problems and health hazards in the community; 3 = Inform, educate, and empower people about health issues; 4 = Mobilize community partnerships to identify and solve health problems; 5 = Develop policies and plans that support individual and community health efforts; 6 = Enforce laws and regulations that protect health and ensure safety; 7 = Link people to needed personal health services and ensure provision of care; 8 = Ensure a competent public and personal health care workforce; 9 = Evaluate the effectiveness, accessibility, and quality of personal and population-based health care; 10 = Research for new insights and innovative solutions to health problems.

FIGURE 1—Population size and performance of essential public health services 1 through 5 (a) and 6 through 10 (b).

with fewer total dollars and staff, they may lack sufficient resources to support the specialized public health infrastructure and diversified workforce needed to achieve high levels of performance—such as information and communication systems and professionals trained in epidemiology, biostatistics, and health education.

In view of the apparent advantages of size, small public health systems may benefit by combining their resources and operations with those of other small systems—perhaps through consolidation with neighboring public health systems or through collaborative initiatives to deliver services jointly. However, for the larger public health systems included in this analysis, our findings indicate that the performance improvements to be gained from consolidation may diminish with size, with further gains appearing unlikely beyond a threshold of approximately 500 000 residents. These results suggest that at some point the economies associated with delivering public health services to large populations may erode because of the difficulties of managing multiple programs and activities for numerous demographic and geographic subgroups within the population. In view of these findings, administrators of large public health systems should weigh carefully the potential benefits of consolidation against the possible complexities of large-scale public health operations.

Our findings lend empirical support to the widely held view that adequate governmental funding is a necessary ingredient for strong and effective public health systems. From an accountability perspective, it is reassuring to find that increased local health department spending is associated with higher levels of public health system performance. Although all 10 essential services were sensitive to local health department expenditures, the results implied that substantial improvements in performance would require relatively large outlays of additional funds. Interestingly, the 2 essential services most sensitive to local public health expenditures—policy development and planning (Essential Service 5) and research (Essential Service 10)—are areas where public health systems appear to experience the most difficulty in meeting national performance standards.[36] Higher levels of public investment in these 2 areas may help local public health systems achieve the performance standards.

System performance appeared less sensitive to direct federal expenditures than to local expenditures. For example, results implied that a $100 per-capita increase in local health department spending would raise performance scores by up to 7.6 percentage points in the average public health system

studied, whereas a similar increase in direct federal spending would raise performance by at most 2.8 percentage points. In addition, not all essential services were sensitive to federal spending levels. One possible explanation for these findings is that federal grant-in-aid programs often include tight specifications on the use of funds, thereby limiting local flexibility. In addition, our measure of federal funding includes only those funds provided directly to local grantees; it does not include the significant amount of "pass-through" federal funding that is directed to state governments for subsequent distribution to local agencies. These measurement limitations preclude us from estimating the full impact of federal spending on local public health system performance.

Our study also provides some evidence that local public health system performance is influenced by the forms of governmental authority and control that exist within the system, but we fail to find evidence that 1 form of authority produces consistently superior performance for all services. For many services, mixed or shared systems performed better than centralized or decentralized systems. One possible explanation is that mixed or shared systems are able to take advantage of the public health expertise and infrastructure available at the state level while also maintaining the local flexibility to adapt activities to community needs as appropriate. However, these findings could also arise if the shared and mixed systems examined in this study enjoy other advantages that are not explicitly accounted for in the analysis, such as higher levels of state-provided funding, staffing, and in-kind support. In any event, our results suggest that state public health agencies may find it beneficial to reexamine their relationships with local agencies in order to identify ways of providing support and assistance without limiting the ability to tailor programs and services to local circumstances.

How can public health decisionmakers use information about the determinants and correlates of public health system performance? In the short run, public health administrators and policymakers can use findings from this study to identify the public health systems and essential services that are most likely to experience gaps in performance so that technical assistance and resources can be targeted to those areas. By focusing public health improvement efforts on areas of greatest need, decisionmakers can make the most effective and efficient use of the new resources now becoming available to state and local public health systems. Over the longer term, stakeholders can use the evidence from this study to inform structural changes in public health systems that will support and reinforce performance. These structural changes may include system consolidation and collaboration with neighboring jurisdictions, efforts to improve intergovernmental relationships in public health, and public health financing reforms.

It is important to remember the exploratory nature of this study and the limitations of the pilot test data on which it is based. The performance data cannot be considered representative of local public health systems nationally, and variation in the instrument design and administration may introduce measurement errors that accumulate in the composite performance measures examined in this study. Moreover, the large number of comparisons made between system characteristics and performance measures creates the possibility that some of the relationships were statistically significant simply because of chance. Nevertheless, this study demonstrates some of the ways in which information produced through performance measurement efforts can generate valuable insight into strategies for public health system improvement. It will be important to assess how well these results generalize to a larger and more representative collection of systems.

In addition, the characteristics we examine in this study explained at most 28% of variation in public health system performance. This result may stem not only from errors in the measurement of performance but also from the fact that many factors outside the scope of the study are likely to influence performance, including the skills and competencies of the public health workforce, the quality of leadership and management within the system, the funding and other resources contributed by state health agencies, and the degree of community interest and involvement in the system. Measuring these additional factors and their effects on public health system performance, and measuring the effects of system performance on population health, are important areas for future research. ■

About the Authors

At the time of the study, Glen P. Mays and Megan C. McHugh were with Mathematica Policy Research in Washington, DC, and Kyumin Shim, Natalie Perry, Dennis Lenaway, Paul Halverson, and Ramal Moonesinghe were with the Public Health Practice Program Office, Centers for Disease Control and Prevention, Atlanta, Ga.

Requests for reprints should be sent to Glen P. Mays, PhD, Department of Health Policy and Management, Fay W. Boozman College of Public Health, University of Arkansas for Medical Sciences. 4301 W Markham St, #820, Little Rock, AR 72205 (e-mail: gpmays@uams.edu).

This article was accepted August 24, 2005.

Contributors

G.P. Mays initiated and supervised the study, performed all statistical analyses, and drafted the article. M.C. McHugh assisted with data analysis and interpretation, and participated in drafting the article. K. Shim consulted on the statistical analysis and interpretation, and participated in revising the article. N. Perry, D. Lenaway, P.K. Halverson, and R. Moonesinghe participated in interpreting the results of the analysis and revising the article.

Acknowledgments

This research was funded by the Division of Public Health Systems Development and Research, Public Health Practice Program Office, Centers for Disease Control and Prevention (CDC) (Contract 200-2001-00122, Task Order 0005).

We appreciate comments provided on earlier versions of this article by Ron Bialek, Jennifer Stanley, Laura Landrum, and participants at the CDC Public Health Systems Research Seminar.

Human Participant Protection

Institutional review board review was not required for this research.

References

1. Mays GP, Halverson PK, Baker EL, Stevens R, Vann JJ. Availability and perceived effectiveness of public health activities in the nation's most populous communities. *Am J Public Health.* 2004;94(6):1019–1026.

2. Handler AS, Turnock BJ, Hall W, et al. A strategy for measuring local public health practice. *Am J Prev Med.* 1995;11(suppl 2):29–35.

3. Richards TB, Rogers JJ, Christenson GM, Miller CA, Taylor MS, Cooper AD. Evaluating local public health performance at a community level on a statewide basis. *J Public Health Manag Pract.* 1995;1(4):70–83.

4. Turnock BJ, Handler A, Hall W, Potsic S, Nalluri R, Vaughn EH. Local health department effectiveness in addressing the core functions of public health. *Public Health Rep.* 1994;109:653–658.

5. Turnock BJ, Handler AS, Miller CA. Core function-related local public health practice effectiveness. *J Public Health Manag Pract.* 1998;4(5):26–32.

6. Miller CA, Moore KS, Richards TB, Monk JD. A proposed method for assessing the performance of local public health functions and practices. *Am J Public Health.* 1994;84(11):1743–1749.

7. Miller CA, Moore KS, Richards TB, Kotelchuck M, Kaluzny AD. Longitudinal observations on a selected group of local health departments: a preliminary report. *J Public Health Policy.* 1993;14(1):34–50.

8. Institute of Medicine. *The Future of Public Health.* Washington, DC: National Academy Press; 1988.

9. Mays GP, Halverson PK, Scutchfield FD. Behind the curve? What we know and need to learn from public health systems research. *J Public Health Manag Pract.* 2003;9(3):179–182.

10. Institute of Medicine, Committee on Assuring the Health of the Public in the 21st Century. *The Future of the Public's Health in the 21st Century.* Washington, DC: National Academy Press; 2003.

11. Halverson PK, Miller CA, Kaluzny AD, Fried BJ, Schenck SE, Richards TB. Performing public health functions: the perceived contribution of public health and other community agencies. *J Health Hum Serv Adm.* 1996;18(3):288–303.

12. Mays GP, Miller CA, Halverson PK. *Local Public Health Practice: Trends and Models.* Washington, DC: American Public Health Association; 2000.

13. Mays GP, Halverson PK, Stevens R. The contributions of managed care plans to public health practice: evidence from the nation's largest local health departments. *Public Health Rep.* 2001;116(suppl 1):50–67.

14. Cowan GA, Pines D, Meltzer D, Cowan G. *Complexity: Metaphors, Models, and Reality.* New York, NY: Perseus Books; 1999.

15. Halverson PK. Embracing the strength of the public health system: why strong government public health agencies are vitally necessary but insufficient. *J Public Health Manag Pract.* 2002;8(1):98–100.

16. Pfeffer J, Salancik G. *The External Control of Organizations.* New York, NY: Harper and Row; 1978.

17. Ulrich D, Barney JB. Perspectives in organizations: resource dependence, efficiency, and population. *Acad Manag Rev.*1984;9(3):471–481.

18. Handler A, Issel M, Turnock BJ. A conceptual framework to measure performance of the public health system. *Am J Public Health.* 2001;91(8):1235–1239.

19. Miller CA, Moore KS, Richards TB, Kotelchuck M, Kaluzny AD. Longitudinal observations on a selected group of local health departments: a preliminary report. *J Public Health Policy.* 1993;14(1):34–50.

20. National Association of County and City Health Officials. 1997 National Profile of Local Health Departments. Washington, DC: National Association of County and City Health Officials; 1998.

21. Gordon RL, Gerzoff RB, Richards TB. Determinants of US local health department expenditures, 1992 through 1993. *Am J Public Health.* 1997;87(1):91–95.

22. Kennedy VC, Moore FI. A systems approach to public health workforce development. *J Public Health Manag Pract.* 2001;7(4):17–22.

23. Halverson PK, Mays GP, Kaluzny AD. Working together? Organizational and market determinants of collaboration between public health and medical care providers. *Am J Public Health.* 2000;90(12):1913–1916.

24. DeFriese GH, Hetherington JS, Brooks EF, et al. The program implications of administrative relationships between local health departments and state and local government. *Am J Public Health.* 1981;71(10):1109–1115.

25. Tiebout C. A pure theory of local expenditures. *J Polit Econ.* 1956;64(5):416–424.

26. Stigler G. Tenable range of functions for local government. In: *Federal Expenditure Policy for Economic Growth and Stability.* Washington, DC: Joint Economic Committee, Subcommittee on Fiscal Policy; 1957:213–219.

27. Gordon R. An optimal approach to fiscal federalism. *Quart J Econ.* 1983;98:567–586.

28. Aikin J, Hutchinson P, Strumpf K. *Decentralization and public provision of public goods: the public health sector in Uganda.* Measure Evaluation Working Paper 0135. Chapel Hill, NC: Carolina Population Center, University of North Carolina at Chapel Hill; March 2001.

29. Kennedy VC. Rural urban differences in public health performance in Texas. Academy for Health Services Research and Health Policy Annual Meeting; 2003. In press.

30. Halverson PK, Nicola RM, Baker EL. Performance measurement and accreditation of public health organizations: a call to action. *J Public Health Manag Pract.* 1998;4(4):5–7.

31. Corso LC, Wiesner PJ, Halverson PK, Brown CK. Using the essential services as a foundation for performance measurement and assessment of local public health systems. *J Public Health Manag Pract.* 2000;6(5):1–18.

32. Centers for Disease Control and Prevention. *National Public Health Performance Standards Program Local Assessment Instrument.* Atlanta, Ga: Centers for Disease Control and Prevention; 2003.

33. Public Health Functions Steering Committee, Office of Disease Prevention and Health Promotion, Office of Public Health and Science, US Department of Health and Human Services. *Public Health in America.* Washington, DC: US Department of Health and Human Services; 1994.

34. Beaulieu J, Scutchfield FD, Kelly AV. Content and criterion validity evaluation of National Public Health Performance Standards measurement instruments. *Public Health Rep.* 2003;118(6):508–517.

35. Beaulieu J, Scutchfield FD. Assessment of validity of the national public health performance standards: the local public health performance assessment instrument. *Public Health Rep.* 2002;117(1):28–36.

36. Beaulieu JE, Scutchfield FD, Kelly AV. Recommendations from testing of the National Public Health Performance Standards instruments. *J Public Health Manag Pract.* 2003;9(3):188–198.

37. Mays GP, McHugh MC, Shim K, et al. Identifying dimensions of performance in local public health systems: results from the National Public Health Performance Standards Program. *J Public Health Manag Pract.* 2004;10(3):193–203.

38. Huber PJ. The behavior of maximum likelihood estimates under nonstandard conditions. In: *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability.* 1967;1:221–233.

39. Norton EC, Bieler GS, Ennett ST, Zarkin GA. Analysis of prevention program effectiveness with clustered data using generalized estimating equations. *J Consult Clin Psychol.* 1996;64(5):919–926.