Template.cfm?Section=Ohio&template=/ ContentManagement/ContentDisplay. cfm&ContentID-22329. Published April 5, 2005. Accessed January 6, 2011.

30. Pharma 40 2007. World Pharmaceutical Frontiers Web site. Available at: http://www.worldpharmaceuticals.net/ editorials/011/Pharma%2040.pdf. Accessed January 6, 2011.

31. National Breast Cancer Coalition Fund. Legislative accomplishments. Available at: http://www.stopbreast

cancer.org/what-we-do/policy/accomplishments. Accessed April 27, 2010.

32. National Breast Cancer Coalition. 2007 lobby day. *Newsletter*. 2007;fall:6.

33. National Breast Cancer Coalition Fund. 2007 annual report. Available at: http://www.stopbreastcancer.org/about/ assets/documents/nbcc-2007-annual-report.pdf. Accessed December 17, 2009.

34. American Diabetes Association launches "CheckUp America" to curb rise in type 2 diabetes, heart disease [press

release]. Alexandria, VA: American Diabetes Association; April 18, 2007. Available at: http://www.diabetes.org/ for-media/2007/checkup-america-2007-release.html. Accessed April 27, 2010.

35. American Diabetes Association. CheckUp America Web site. Available at: http://www.diabetes.org/diabetes-basics/prevention/checkup-america. Accessed April 8, 2010.

36. Eli Lilly and Company. Amylin Pharmaceuticals. Available at: http://

www.lilly.com/about/partnerships/ profiles/amylin. Accessed April 6, 2010.

37. American Diabetes Association. 2007 annual report. Available at: http:// www.diabetes.org/assets/pdfs/2007-ada-annual-report.pdf. Accessed April 8, 2010.

38. National Health Council. Guiding Principles for Voluntary Health Agencies in Corporate Relationships. 1998. Available at: http://www.imapny.org/about_ imap/news__announcements/01-13-11. Accessed January 13, 2011.

Publisher's Note: During the copyediting process, reference #38 in the above article was changed and erroneously cited the current (2008) "Standards of Excellence" from the National Health Council. The authors actually used the "Guiding Principles for Voluntary Health Agencies in Corporate Relationships" from 1998, a document that was available online when the study was conducted. Reference #38 has been corrected to link to the document used for the study. The National Health Council's "Standards of Excellence" is the policy currently applicable to, among other things, the issues discussed by the authors. The policy articulates different standards of transparency for health advocacy organizations than the document used by the authors. It can be viewed at http:// www.nationalhealthcouncil.org/forms/soe.pdf.

The Association of Changes in Local Health Department Resources With Changes in State-Level Health Outcomes

| Paul Campbell Erwin, MD, DrPH, Sandra B. Greene, DrPH, Glen P. Mays, PhD, MPH, Thomas C. Ricketts, PhD, MPH, and Mary V. Davis, DrPH, MSPH

We explored the association between changes in local health department (LHD) resource levels with changes in health outcomes via a retrospective cohort study.

We measured changes in expenditures and staffing reported by LHDs on the 1997 and 2005 National Association of County and City Health Officials surveys and assessed changes in state-level health outcomes with the America's Health Rankings reports for those years. We used pairwise correlation and multivariate regression to analyze the association of changes in LHD resources with changes in health outcomes.

Increases in LHD expenditures were significantly associated with decreases in infectious disease morbidity at the state level (P=.037), and increases in staffing were significantly associated with decreases in cardiovascular disease mortality (P=.014), controlling for other factors. (*Am J Public Health.* 2011;101:609–615. doi:10.2105/AJPH.2009. 177451)

THE ULTIMATE AIM OF LOCAL health departments (LHDs) is to improve the quality of life for the communities they serve—a part of the larger mission of public health, which is "the fulfillment of society's interest in assuring the conditions in which people can be healthy."[1(p7)] Since the Institute of Medicine's 1988 report, *The Future of Public Health,* there have been numerous studies that have described and measured the performance of

LHDs, the characteristics associated with performance, and whether and how such performance affects health.[2] Studies have most often described associations of performance with LHD size, jurisdictional size, and funding: LHDs with larger staffs, serving populations greater than 50 000 persons, and with higher funding per capita were more often higher performing.[3–14] Higher performing LHDs also had greater community interaction, a director with higher academic degrees, and leadership functioning within a management team.[5,9,11,15]

Only 4 published studies have attempted to link LHD characteristics, activities, or performance to health outcomes.[9,13,16,17] All of these studies are limited by their cross-sectional design. One study has examined the longitudinal

relationship between LHD inputs and health outcomes, showing significant associations between changes in local public health spending and infant mortality and deaths attributable to cardiovascular disease (CVD), diabetes, and cancer at the county level.[18]

We focused on the relationship between changes in LHD inputs (financial resources, staffing), aggregated to the state, and changes in state-level health measures (smoking and obesity prevalence, infectious disease morbidity, infant mortality, cancer and CVD mortality, and premature death). Aggregating LHD inputs to a state level not only allows the opportunity to explore the impact of LHDs' combined resources but also reduces the complexities inherent in studies

that have compared LHDs to one another, always a challenging task with the very large differences in LHD size, functions, and jurisdictions.

Conceptual and logic models pertaining to public health in general posit that an increase in inputs leads to enhanced capacity to provide the essential public health services, which, in turn, leads to improved public health performance and, ultimately, to improvements in community health status.[19] The health measures included in this study were selected on the basis of amenability to public health interventions for which logic models may be specified. The primary and secondary prevention methods that may lead to improvements in these health measures—e.g., community-based efforts to enhance physical activity opportunities to reduce CVD and targeted immunization campaigns to reduce vaccine-preventable diseases[20]—are interventions that are commonly led by LHDs.

The relative paucity of empirical evidence that supports such logic models for LHDs remains a challenge for public health. This serves as rationale for our study, the goal of which is to identify LHD inputs that may ultimately lead to health improvements. We investigated the association between LHD inputs—aggregated to the state—and health outcomes at the state level. This association has relevance both for local public health leaders, who are being held more accountable for how local resources are used, and for state leaders, who are often challenged to show how investments at the local level can deliver on a promise of improving state-level health measures.

METHODS

We examined 2 data sets to determine the extent to which changes in LHD inputs are associated with changes in health measures: surveys of LHDs by the National Association of County and City Health Officials (NACCHO) and America's Health Rankings (AHR), produced by the United Health Foundation.

We utilized LHD expenditures, staffing, and jurisdictional population data from field surveys conducted by NACCHO in 1997 and 2005. Completed surveys were returned for 2492 of the 2832 (88%) identified LHDs in 1997 and 2300 of the 2864 (80%) identified in 2005. A total of 1924 LHDs reported in both 1997 and 2005.

Local health departments reported actual total expenditures for the most recent fiscal year before the survey; 1997 expenditures were adjusted to 2005 dollars. The method of adjustment follows the model proposed by NACCHO and used by Mays and Smith, with spending measures adjusted to represent 2005 constant dollars by using a weighted average of the general Consumer Price Index (CPI) and the medical care CPI.[18,21] Local health departments reported the total number of full-time equivalents (FTEs) employed by their agency. We aggregated local health department expenditures, FTEs, and jurisdictional populations to the state level. We calculated changes in LHD expenditures and FTEs per capita between 1997 and 2005 on the basis of both proportional change

and absolute change between these 2 points in time.

We derived state-level health measures from the AHR reports, which have been produced annually since 1990.[22] We included 7 health measures in this study: smoking and obesity prevalence, infectious disease morbidity, infant mortality, mortality from CVD and cancer, and years of potential life lost (YPLL). America's Health Rankings derives data for these health measures from other secondary sources as described subsequently.

Smoking prevalence is a measure of the percentage of the population aged 18 years and older that has smoked at least 100 cigarettes and currently smokes tobacco products regularly. Obesity prevalence is a measure of the percentage of the population estimated to be obese, defined as having a body mass index of 30.0 kg/m^2 or higher. The source of data for smoking and obesity is the Behavioral Risk Factor Surveillance System.[23]

Infectious disease morbidity includes the 3-year average occurrences of AIDS, tuberculosis, and hepatitis (A and B), as representative of all infectious diseases, per 100 000 population, as reported by state health departments in the *Morbidity and Mortality Weekly Report* from the Centers for Disease Control and Prevention (CDC).

Infant mortality is the rate of infant deaths per 1000 live births in a year. Cardiovascular deaths were measured by using a 3-year average, age-adjusted death rate (per 100 000 population) attributable to heart disease, strokes, and other forms of CVD. Cancer

deaths were measured by using a 3-year average, age-adjusted death rate (per 100 000 population) attributable to cancer. YPLL measures the loss of productive life because of death before age 75 years. The source of data for these measures of mortality was the US National Center for Health Statistics.[24]

Data Management

To improve comparability between the 1997 and 2005 data, we only included the 1924 LHDs that reported in both surveys in the initial data set. We removed LHDs that did not report expenditure data for both years, reducing the data set to 1852 LHDs in 1997 and 1856 LHDs in 2005. Four states were excluded: Rhode Island, because it has no LHDs; Hawaii and Alaska, because they both had only 1 LHD report expenditure for 2005 and no reported expenditures for 1997; and Mississippi, because the state reported by county-level LHDs in 1997 and multicounty districts in 2005.

We aggregated LHDs' jurisdictional populations by state. We excluded states that had less than 40% of their actual total population represented, for either 1997 or 2005, from further data analysis. This removed an additional 4 states: Maine, New Hampshire, New Mexico, and South Dakota. The final data set included data from 1843 LHDs in 1997 and 1845 LHDs in 2005, covering 42 states, with a 97% match for LHDs with usable data for both 1997 and 2005. For the 42 states that were retained, the actual state population represented in 1997

ranged from 40.8% to 96.5%, with a mean of 78.7% and a median of 81.3%. For 2005, the range of actual state population represented was 40.6% to 100%, with a mean of 83.6% and a median of 85.9%. Total aggregated data for the 42 states represented 78.4% of the US population for 1997 and 82.9% of the US population in 2005.

We selected data from the AHR reports by most closely matching the source years of the data for both AHR reports and NACCHO surveys. The 1997 NACCHO survey data matched most closely with the data included in the 1998 AHR report, whereas the 2005 NACCHO survey matched most closely with the 2008 AHR report. We determined changes for each of the 7 health measures between the 1998 and 2008 AHR reports by calculating proportional and absolute changes between the 2 points in time.

Data Analysis

Changes in LHD expenditures and staffing per capita, aggregated to the state level, served as independent variables, and changes in the 7 health measures from AHR served as dependent variables. We assessed the association between the changes in specific dependent variables with the changes in independent variables with the Spearman rank correlation, and with multivariate regression. To analyze data, we used Stata version 10 (StataCorp LP, College Station, TX). Control variables in the regression models included factors known to influence health at the community level: high-school graduation (percentage of the population aged older than 25 years that has graduated), health insurance (percentage with health insurance), poverty (percentage below federal poverty line), racial composition (percentage of population that is non-White), and age structure

(percentage of the population aged older than 65 years). Data for these control variables were for 1996 only, the primary source year of data for variables in the 1997 NACCHO profile and the 1998 AHR report.

RESULTS

Results are presented by changes in independent variables, changes in dependent variables, and the association between these changes.

Changes in Independent Variables

State-level mean expenditures per capita (Table 1) fell between 1997 and 2005. Expenditures per capita expressed in constant dollars varied widely, ranging from $13.40 in Vermont to $169.30 in California in 1997, and $15.60 in New Jersey to $143.60 in New York in 2005. Twenty-three states experienced a decline

in expenditures per capita, whereas 19 states had an increase between 1997 and 2005. Although the overall mean proportional change for these 42 states was a positive 2.6%, the total sum of LHD expenditures per capita across all states was 15.8% lower in 2005 than in 1997.

State-level mean FTEs per capita (Table 1) also fell between 1997 and 2005. The number of FTEs per capita ranged from 2.31 (per 10 000 population) in Vermont to 13.38 in Alabama in 1997, and 1.53 in Arizona to 10.46 in Maryland in 2005. Only 12 states experienced an increase in FTEs per capita between 1997 and 2005.

Changes in Dependent Variables

The changes in the dependent variables between the 1998 and 2008 AHR reports are shown in Table 2. Overall, rates for all health measures declined between 1998 and 2008, with 1 exception: obesity prevalence increased. All 42 states showed declines in infectious disease morbidity and CVD mortality, with all but 1 state also showing declines in smoking prevalence and cancer mortality. Changes in infant mortality and premature deaths (YPLL) showed a mix of states with declining and increasing rates, with the majority of states still showing a decline. Obesity prevalence increased in all 42 states by a mean change of almost 58%.

Pairwise Correlations of Independent and Dependent Variables

With the measures of proportional change, there were statistically significant negative associations

TABLE 1—Overall 1997 and 2005 Aggregated LHD Expenditures per Capita and FTEs per Capita, and State-Level Proportional and Absolute Changes Between 1997 and 2005: 42 US States

Variable	Mean	Median	SD	Minimum[a]	Maximum[b]	Composite IQR
Expenditures per capita						
1997 overall	$44.13	$34.24	$29.80			
2005 overall	$42.17	$34.30	$23.92			
Proportional change, %	2.57	–1.72	27.35	–57.28	71.33	25.17
Absolute change	–1.96	–0.71	21.74	–84.87	59.79	9.96
FTEs per capita (×10 000)						
1997 overall	6.12	5.73	2.66			
2005 overall	5.12	4.66	1.97			
Proportional change, %	–11.48	–16.47	26.66	–64.22	83.76	28.02
Absolute change	–1.00	–0.80	2.01	–8.12	3.95	1.74

Notes. FTE = full-time-equivalent employee; IQR = interquartile range; LHD = local health department.
[a]For negative numbers, greatest decrease, 1998–2008.
[b]Greatest increase.

TABLE 2—Changes in Dependent Variables From America's Health Rankings Reports Between 1998 and 2008: 42 US States

Dependent Variable	Mean	Median	SD	Minimum[a]	Maximum[b]	IQR
Proportional change (%)						
Smoking prevalence	–14.58	–14.31	7.83	–29.41	4.87	11.95
Obesity prevalence	57.65	54.53	16.55	29.24	108.06	15.71
Infectious diseases	–58.76	–57.68	17.47	–96.41	–29.23	25.05
Infant mortality	–9.05	–10.13	10.87	–34.21	20.00	13.17
Cardiovascular disease deaths	–17.72	–18.16	4.49	–28.25	–4.66	5.36
Cancer deaths	–7.06	–7.17	–13.26	–13.26	2.22	5.45
Years of potential life lost	–5.08	–4.86	8.29	–28.34	14.02	11.59
Absolute change						
Smoking prevalence	–3.41	–3.25	1.90	–7.70	1.20	2.20
Obesity prevalence	9.50	9.45	2.11	6.00	14.30	2.50
Infectious diseases	–24.96	–21.02	16.60	–67.05	–4.79	26.30
Infant mortality	–0.68	–0.80	0.83	–2.60	1.50	1.00
Cardiovascular disease deaths	–62.83	–62.30	14.59	–100.70	–17.90	12.80
Cancer deaths	–14.83	–14.26	7.67	–29.09	3.91	10.29
Years of potential life lost	–385.80	–370.95	684.85	–2462.70	1160.40	806.70

Note. IQR = interquartile range.
[a]For negative numbers, greatest decrease, 1998–2008.
[b]Greatest increase.

between changes in expenditures per capita and infectious disease morbidity (r=−0.3407; *P*=.0272) and CVD deaths (r=−0.3723; *P*=.015) and between FTEs per capita and CVD deaths (r=−0.3689; *P*=.016; Table 3). The correlations that used absolute change showed a significant inverse relationship between FTEs per capita and CVD deaths (r=−0.3482; *P*=.024). For the majority of these correlations, the results were consistent in direction and significance between using proportional change and absolute change.

Multiple Linear Regression

As shown in Table 4, an increase in expenditures per capita was statistically significantly associated with a decrease in infectious diseases (t=−2.17; *P*=.037). For each 10 percentage point increase in expenditures per capita, infectious disease morbidity declined by 1.82 percentage points. An increase in FTEs per capita was statistically significantly associated with a decrease in CVD mortality (t=−2.59; *P*=.014). For each 10 percentage point increase in FTEs per capita, CVD mortality declined by 0.65 percentage points.

For states that experienced an increase in expenditures per capita, spending increased an average of 24.7%, which would have resulted in a decrease in infectious disease morbidity by 4.50 percentage points—a 7.0% reduction

in infectious disease morbidity that is associated with the increase in LHD spending. For states that showed an increase in FTEs per capita, staffing increased an average of 21.4%, which would have resulted in a decrease in CVD mortality by 1.39 percentage points—a 6.6% reduction in CVD mortality associated with the increase in LHD staffing.

DISCUSSION

The primary findings of this study revealed that an increase in LHD expenditures per capita was associated with a decrease in infectious disease morbidity at the state level, and an increase in FTEs per capita was associated with a decrease in CVD deaths.

Although these results point to an association between LHD inputs and state health outcomes, the mechanisms linking LHD services or activities to such inputs and outcomes can only be inferred.

The finding of an association between LHD expenditures and improvements in infectious disease mortality is consistent with cross-sectional studies that have identified positive correlations between absolute LHD expenditures[5,10,25] as well as expenditures per capita[8,12,14,26] with LHD performance or effectiveness. Mays and Smith provide the only evidence to date that changes in expenditures per capita are correlated with changes in health outcomes, with the strongest associations between LHD spending and infant mortality and CVD deaths; mortality from influenza changed in the expected direction but did not reach statistical significance.[18]

The association between changes in FTEs per capita and changes in CVD deaths is consistent with cross-sectional studies that have found positive correlations between the number of FTEs and LHD performance and effectiveness[5,6,10,27] and with studies that have specifically examined FTEs per capita.[8] None of these studies measured longitudinal changes in FTEs per capita, and no study directly correlates FTEs per capita with health outcomes.

If our results suggest that increases in LHD inputs may contribute to improvements in health outcomes, then what are the possible pathways? In the *2005 Profile of Local Health Departments*,

TABLE 3—Correlations of Changes in LHD Inputs (1997–2005) With Changes in Health Measures (1998–2008), Using Values of Proportional and Absolute Change: 42 US States

| | LHD Inputs | | | |
| | Proportional Change | | Absolute Change | |
Health Measures	Expenditures per Capita	FTEs per Capita, r (P)	Expenditures per Capita, r (P)	FTEs per Capita, r (P)
Smoking	NS	NS	NS	NS
Obesity	NS	NS	NS	NS
Infectious diseases	NS	NS	–0.3407 (.027)	NS
Infant mortality	NS	NS	NS	–0.2735 (.08)
Cardiovascular deaths	NS	–0.3482 (.024)	–0.3723 (.015)	–0.3689 (.016)
Cancer deaths	NS	NS	NS	NS
Years of potential life lost	NS	NS	NS	NS

Notes. FTE = full-time-equivalent employee; IQR = interquartile range; LHD = local health department; NS = not significant at $P<.05$. All correlations calculated with the Spearman rank coefficient.

NACCHO provided a comparison between LHD activities reported in the 1993 survey and responses to similar questions in the 2005 survey.[21] This comparison showed an increase in communicable disease surveillance and epidemiological investigations, which could provide a pathway to a decrease in infectious disease cases.

This may also link to the single area for which there has been a substantial increase in public health resources over the past several years: emergency preparedness. Since 2001, the CDC has provided $800 million to $1 billion annually to strengthen public health infrastructure and capacity to respond to public health emergencies, including bioterrorism.[28] These funds are provided for the most part through cooperative agreements with states, but there is good evidence that such funding has made its way to the local level. In 2005, NACCHO reported that 73% of LHDs were receiving public

health preparedness funds through their state agencies, at an average amount of $0.99 per capita, for a median of $35 000 per LHD.[21] Fifty-one percent of LHDs reported hiring additional FTEs by using funding from the CDC cooperative agreement.

The evidence supporting a pathway between LHD inputs and improvements in CVD deaths that goes through LHD services or

activities is limited and indirect at best. Cardiovascular diseases remain the leading cause of death in the United States, even though overall heart disease death rates have been declining since 1968.[29] In a recent study exploring the reasons for this decline, Ford et al. determined that 47% of the decline in the coronary heart disease death rate was attributable to improved medical therapies, and 44% of the

decline was attributable to risk factor modifications—including reductions in total cholesterol, systolic blood pressure, smoking prevalence, and physical inactivity.[30]

Local health departments may influence risk factor modifications through clinical preventive services as well as through population-directed activities. A primary risk factor for CVD is tobacco use, and the NACCHO comparison of LHD services and activities over time shows that tobacco use prevention activities increased; however, chronic disease surveillance remained static, screening services for high blood pressure and diabetes fell, and the provision of comprehensive primary care decreased by more than 50%.[21] If the general movement away from clinical service provision was met with a concomitant increase in population-focused activities—such as through health assessment, planning, and policymaking—this may provide a pathway between LHD inputs and CVD mortality reduction. Although the evidence base for community activities is

TABLE 4—Multiple Linear Regression Results for Changes in Infectious Diseases With Changes in Expenditures per Capita, and for Changes in Cardiovascular Disease Deaths With Changes in FTEs per Capita: 42 US States

Variable	Coefficient (SE)	95% CI	t	P
Changes in infectious diseases with changes in expenditures per capita[a]	–0.18226 (0.08384)	–0.3524, –0.01206	–2.17	.037
Changes in cardiovascular disease deaths with changes in FTEs per capita[b]	–0.06504 (0.02515)	–0.1161, –0.01398	–2.59	.014

Notes. CI = confidence interval; FTE = full-time-equivalent employee.
[a]Adjusted $R^2 = 0.3873$; $F_{6,35} = 5.32$; $P<.001$.
[b]Adjusted $R^2 = 0.3612$; $F_{6,35} = 4.86$; $P = .001$.

improving,[20] this study did not attempt to explore such pathways.

There were no statistically significant findings in the regression models for the other health measures—smoking and obesity prevalence, infant mortality, cancer mortality, and premature death. These measures may be less amenable to change with LHD interventions; the timeframe for detecting change may have been too short; there may be fewer LHD services specifically addressing these health measures; and there may be no true effect of LHD inputs on these health measures. The preponderance of both bivariate and multivariate analyses that yielded nonsignificant results may also be a reflection of low power because of the relatively small sample size (n=42 states).

Although there is a growing body of literature that links LHD inputs to performance,[2] finding *any* association between LHD inputs and health outcomes, whether through cross-sectional or longitudinal studies, has been a methodological challenge. Only recently, with the ability to link repeated measures of LHD inputs through the NACCHO surveys, have investigators had access to data that allow for such studies.

Limitations

There are several limitations to this study and its findings. First, the association of changes in LHD inputs with changes in health outcomes does not prove cause and effect, and reverse causation, or endogeneity, cannot be ruled out. Second, we used proportional and absolute change between 2 points in time and did not consider the changes that may have occurred within the time period. Third, there is a potential ecologic fallacy in that the health outcome changes that took place may have been experienced by subpopulations other than those represented by the LHDs that were included in the analyses. Fourth, the timeframe covered by this study may be too short to detect real associations that may be detectable if studied over a longer period.

Fifth, although statistically significant, the coefficient for FTEs per capita in the regression model (−0.06504) indicates that the expected percentage decrease in CVD deaths given a 1 percentage point increase in FTEs per capita is relatively low. State and local health departments are frequently mandated by law to establish infectious disease control programs, whereas services to prevent or treat CVDs are more frequently optional. This creates a greater sensitivity for health outcomes that connect to activities for which LHDs exert more control—thus, there is a greater likelihood that the association of changes in LHD staffing and CVDs is spurious in contrast to the stronger, more robust association between LHD spending and infectious diseases. Sixth, this study did not consider state and federal public health spending that does not get included in the LHD expenditures measure, yet may still affect LHD functions, performance, and health outcomes.

Implications for Future Study

Our findings suggest at least 3 avenues for further study. First, there is the opportunity to carry out natural experiments, with the results of this study forming a baseline for later analyses. Since 2005, federal funding for state and local preparedness has been cut more than 25%, and states are no longer receiving any supplemental funding for pandemic influenza preparedness.[31] If expenditures per capita are linked to infectious disease morbidity through activities previously supported by such funding, future slowing of gains made—or even a reversal in infectious disease morbidity—may provide further evidence of the association between LHD inputs and health outcomes as well as the possible pathway.

Second, exploring statewide initiatives may help to explain the pathway between LHD inputs and health outcomes. It may be very instructive to examine—through documents and key informant interviews—whether states that improved in rankings and had increases in public health expenditures and FTEs implemented specific activities in response to early AHR reports.

Third, repeating the methodologies in this study with earlier and later NACCHO surveys will extend the timeframe for studying changes in LHD inputs and outputs.

Finally, all of these avenues for further study would be greatly enhanced if LHDs used a consistent, uniform chart of accounts, improving comparability. Collecting consistent state-level data, using the Association of State and Territorial Health Officials' 2009 State Public Health Survey[32] as a starting point, will likewise be of great benefit to future research in this field.

Conclusions

In keeping with what Turnock and Handler have suggested, our purpose was to "to measure [LHD] inputs, processes, outputs, and outcomes in ways that allow for *changes* [emphasis added] in one to be linked with another."[33(p279)] Our findings suggest that improvements in public health resources at the local level may contribute to improved health outcomes at the state level. Although it was not possible to identify changes in LHD services or activities that could provide a clear pathway between inputs and outcomes, there are opportunities to use the findings from this study to further strengthen the empirical base for what LHDs should be funded to do.■

About the Authors

Paul Campbell Erwin is with the Center for Public Health, University of Tennessee, Knoxville. Sandra B. Greene and Thomas C. Ricketts are with the Gillings School of Global Public Health, University of North Carolina, Chapel Hill, and the Cecil G. Sheps Center for Health Services Research, University of North Carolina, Chapel Hill. Glen P. Mays is with the Fay W. Boozman College of Public Health, University of Arkansas for Medical Sciences, Little Rock. Mary V. Davis is with the North Carolina Institute for Public Health, University of North Carolina, Chapel Hill, and the Gillings School of Global Public Health, University of North Carolina, Chapel Hill.

Correspondence should be sent to Paul Campbell Erwin, MD, DrPH, Professor and Director, Center for Public Health, University of Tennessee, 302 Bailey Education Complex, Knoxville, TN 37996 (e-mail: perwin@utk.edu). Reprints can be ordered at http://www.ajph.org by clicking on the "Reprints/Eprints" link.

This article was accepted December 9, 2009.

Human Participant Protection

This study made use of secondary data only, available to the public, and did not require institutional review board approval through the University of Tennessee.

References

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

2. Erwin PC. The performance of local health departments: a review of the literature. *J Public Health Manag Pract.* 2008; 14(2):E9–E18.

3. Turnock BJ, Handler A, Hall W, et al. Local health department effectiveness in addressing the core functions of public health. *Public Health Rep.* 1994;109(5): 653–658.

4. Suen JC, Christenson GM, Nicola RM. The key role of nurses in local health departments. *Am J Public Health.* 1995; 85(1):120–121.

5. Handler AS, Turnock BJ. Local health department effectiveness in addressing the core functions of public health: essential ingredients. *J Public Health Policy.* 1996;17(4):460–483.

6. Mayer JP, Konstant L, Wartman GC. Typology of local health departments based on maternal and child health core functions. *J Public Health Manag Pract.* 1997;3(5):1–10.

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

8. Freund CG, Liu Z. Local health department capacity and performance in New Jersey. *J Public Health Manag Pract.* 2000;6(5):42–50.

9. Kennedy VC. A study of local public health system performance in Texas. *J Public Health Manag Pract.* 2003;9(3): 183–187.

10. Mauer BJ, Mason M, Brown B. Application of quality measurement and performance standards to public health systems: Washington State's approach. *J Public Health Manag Pract.* 2004;10(4): 330–337.

11. Scutchfield FD, Knight EA, Kelly AV, Bhandari MW, Vasilescu IP. Local public health agency capacity and its relationship to public health system performance. *J Public Health Manag Pract.* 2004;10(3): 204–215.

12. Mays GP, McHugh MC, Shim K, et al. Getting what you pay for: public health spending and the performance of essential public health services. *J Public Health Manag Pract.* 2004;10(5):435–443.

13. Honore PA, Simoes EJ, Jones WJ, Moonesinghe R. Practices in public health finance: an investigation of jurisdiction funding patterns and performance. *J Public Health Manag Pract.* 2004;10(5):444–450.

14. 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.

15. Lovelace K. Multidisciplinary top management teamwork: effects on local health department performance. *J Public Health Manag Pract.* 2001;7(1):21–29.

16. Schenck SE, Miller CA, Richards TB. Public health performance related to selected health status and risk measures. *Am J Prev Med.* 1995;11(6 suppl):55–57.

17. Kanarek N, Stanley J, Bialek R. Local public health agency performance and community health status. *J Public Health Manag Pract.* 2006;12(6):522–527.

18. Mays GP, Smith SA. Effects of local public health spending on population health: does more money matter? *Health Serv Res.* In press.

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

20. Zaza S, Briss PA, Harris KW, eds. *The Guide to Community Preventive Services.* New York, NY: Oxford University Press Inc; 2005.

21. *2005 National Profile of Local Health Departments.* Washington, DC: National Association of County and City Health Officials; 2006.

22. United Health Foundation. America's Health Rankings: A call to action for people and communities. Available at: http://www.unitedhealthfoundation.org/ahr2007/index.html. Accessed January 31, 2008.

23. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. Available at: http://cdc.gov/brfss. Accessed February 16, 2007.

24. National Center for Health Statistics, Centers for Disease Control and Prevention. National Vital Statistics System. Available at: http://www.cdc.gov/nchs/nvss.htm. Accessed March 1, 2008.

25. Suen J, Christenson GM, Cooper A, Taylor M. Analysis of the current status of public health practice in local health departments. *Am J Prev Med.* 1995;11(6 suppl):51–54.

26. Mays GP, McHugh MC, Shim K, et al. Institutional and economic determinants of public health system performance. *Am J Public Health.* 2006;96(3):523–531.

27. Zahner SJ, Vandermause R. Local health department performance: compliance with state statutes and rules. *J Public Health Manag Pract.* 2003;9(1):25–34.

28. Public Health Emergency Preparedness Partners. Public health emergency preparedness: six years of achievement. Available at: http://www.aphl.org/aphlprograms/ep/ahr/Documents/PHEP_Partners_Report.pdf. Accessed April 18, 2010.

29. Lloyd-Jones D, Adams R, Carnethon M, et al. for the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2009 update. A report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation.* 2009;119(3): 480–486.

30. Ford ES, Ajani UA, Croft JB, et al. Explaining the decrease in US deaths from coronary disease, 1980-2000. *N Engl J Med.* 2007;356(23):2388–2398.

31. Trust for America's Health. Ready or not? Protecting the public's health from diseases, disasters, and bioterrorism. Available at: http://healthyamericans.org/reports/bioterror08. Accessed January 2, 2009.

32. Association of State and Territorial Health Officials. State Public Health Survey. Available at: http://www.astho.org/research/data-and-analysis. Accessed October 13, 2009.

33. Turnock BJ, Handler AS. From measuring to improving public health practice. *Annu Rev Public Health.* 1997; 18:261–282.