Resources That May Matter: The Impact of Local Health Department Expenditures on Health Status

Paul Campbell Erwin, MD, DrPH[a]
Glen P. Mays, PhD, MPH[b]
William J. Riley, PhD[c]

ABSTRACT

Objectives. This study examines the association between changes in local health department (LHD) expenditures, aggregated to the state level, and changes in state-level measures of health, from 1993 to 2005. The literature on the impact of LHD resources on health status has been limited by cross-sectional designs. With repeated surveys of LHDs, it is now possible to use longitudinal designs to explore the association between LHD inputs and outcomes.

Methods. This was a retrospective cohort study. We used a fixed-effects regression model to assess the association between LHD expenditures, aggregated to the state level, and seven separate health measures. We derived LHD expenditure data from the National Association of County and City Health Officials' surveys of LHDs in 1993, 1997, and 2005. We obtained secondary data on seven health measures—smoking and obesity prevalence, infectious disease morbidity, infant mortality, deaths due to cardiovascular disease and cancer, and overall premature death—through the *America's Health Rankings®* reports, 1990–2008. Usable data were available for 1,470 LHDs, representing 37 states.

Results. An increase in LHD expenditures, aggregated to the state level, was associated with a statistically significant decline in state-level infectious disease morbidity ($t = -3.28$, $p = 0.002$) and in years of potential life lost (YPLL) ($t = -2.73$, $p = 0.008$). For every $10 increase in aggregated LHD expenditures per capita, infectious disease morbidity decreased by 7.4%, and YPLL decreased by 1.5%.

Conclusion. LHD resources are associated with improvements in preventable causes of morbidity and mortality.

[a]The University of Tennessee, College of Education, Health, and Human Sciences, Department of Public Health, Knoxville, TN

[b]University of Kentucky, College of Public Health, Lexington, KY

[c]University of Minnesota, School of Public Health, Minneapolis, MN

Address correspondence to: Paul Campbell Erwin, MD, DrPH, The University of Tennessee, College of Education, Health, and Human Sciences, Department of Public Health, 1914 Andy Holt Ave., Room 387 HPER, Knoxville, TN 37996; tel. 865-974-5252; fax 865-974-6439; e-mail <perwin@utk.edu>.

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In the field of public health systems and services research (PHSSR), investigators explore the association between the investment of resources in public health, agency and systems performance, and the impact such inputs may have on the health of communities served.[1–3] Reviews of the literature have identified numerous studies that show significant associations between local health department (LHD) inputs, outputs, and outcomes.[4–6] In particular, LHDs with larger budgets and staffing, which serve larger jurisdictional populations and have governing boards of health, among other characteristics, have higher levels of performance. A small subset of studies has explored the associations between LHD capacity or performance and health outcomes.[7–11] While most studies have been limited to cross-sectional designs, repeated surveys of LHDs by the National Association of County and City Health Officials (NACCHO) have permitted recent studies to assume a longitudinal design, providing investigators the opportunity to examine the association between changes in LHD resources and services, and changes in morbidity and mortality at the community level.[11,12] Mays and Smith explored the association between LHD expenditures and several measures of mortality at the LHD jurisdictional level, finding that, as expenditures increase, infant mortality and deaths due to cardiovascular disease (CVD), diabetes, and cancer declined.[11] To gauge the larger impact of changes in LHD resources, county-level data have also been aggregated to the state level and measured against changes in state-level health indicators. Using this approach, Erwin et al. found a statistically significant relationship between increases in LHD expenditures and a decline in state-level infectious disease morbidity; a weaker, though still significant, association was found between increases in LHD staffing and declines in CVD mortality.[12]

Our study adds to the PHSSR literature by extending the time frame for the longitudinal approach and utilizing more robust methods in controlling for potentially significant but omitted variables. We examined the specific effect of changes in LHD expenditures, aggregated to the state level, on changes in several health measures from 1993 to 2005, namely, smoking and obesity prevalence, infant mortality, deaths due to CVD and cancer, and overall premature death.

Handler et al. provided a conceptual model linking public health systems inputs (funding, staffing, and other resources), outputs (services and activities), and outcomes (ultimately, health status).[13] Given the array of services and activities provided through public health agencies, this model supports the focus on specific health measures selected for this study on the basis of their being amenable to public health interventions. The methods of prevention 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) are interventions commonly led by LHDs.

Our study examined changes in public health funding in the context of four unfolding events, which have the potential to significantly impact local, state, and federal public health agencies and activities. First, federal support for public health preparedness, which began in the late 1990s and supported expansion of public health capacity to address bioterrorism and other related activities, has steadily declined since peak funding in 2005.[14] Second, the fallout from the national economic crisis has included major staffing reductions in state and local public health agencies.[15] Third, while the Patient Protection and Affordable Care Act (PPACA) of 2010 includes authorization for a public health fund, such funding is already being allocated to entities outside the current public health system.[16] And fourth, comparative effectiveness research, which may serve to drive the health services research agenda to better inform the health-care reform efforts, does not specifically include public health research.[17]

METHODS

This was a retrospective cohort study utilizing three cross-sectional surveys to examine the association between changes in LHD resources and changes in state-level health measures. The NACCHO surveys of the approximately 3,000 LHDs in the U.S in 1993, 1997, and 2005 served as the source of LHD expenditures as the independent variable in the research model.[18] LHDs were asked to report total expenditures for the most recently completed fiscal year for which expenditure data were available. These are self-reported data that are not independently verified. To maintain consistency across the three surveys, we only examined data for the 1,470 LHDs that reported in all three surveys. This approach resulted in the exclusion of four states: Rhode Island because it has no LHDs; Hawaii and Alaska because they had no LHDs report expenditures for 1997; and Mississippi because it reported as county-level LHDs in 1993 and 1997 and as multi-county districts in 2005. A sensitivity analysis on this approach was also conducted in which all LHDs reporting in each of the three separate profiles were included and were considered to represent three samples of all possible LHDs.

We adjusted expenditures reported in 1993 and

1997 to 2005 U.S. 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.[11,19] Mays and Smith based their weighting method on the proportion of each LHD's revenue obtained from Medicaid, Medicare, and private health insurance. This method approximated the proportion of each LHD's expenditures devoted to population health services as opposed to medical care services.

We aggregated LHD expenditure data to the state level; overall state-level per-capita expenditures were computed by using the sum of the reported LHD jurisdictional populations. For reliability, we excluded states from the final dataset if the summed jurisdictional population represented less than 40% of the state's actual population for any of the three surveys. This resulted in removing an additional nine states, leaving 37 states in the final dataset for analysis.

The sources of dependent variables for this study were the *America's Health Rankings*® (*AHR*) reports, produced annually since 1990 by the United Health Foundation.[20] We included seven health measures in this study: smoking and obesity prevalence, infectious disease morbidity, infant mortality, mortality from CVD and cancer, and premature death, as measured by years of potential life lost (YPLL). *AHR* derives data for these health measures from other secondary sources, as described subsequently.

Smoking prevalence is a measure of the percentage of the population older than 18 years of age who have smoked at least 100 cigarettes and currently smoke 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 or higher. The source of data for smoking and obesity was the Behavioral Risk Factor Surveillance System.[21]

Infectious disease morbidity includes the three-year average occurrences of acquired immunodeficiency syndrome, tuberculosis, and hepatitis (A and B), as representative of all infectious diseases, per 100,000 population, as reported by state health departments to the Centers for Disease Control and Prevention (CDC).

Infant mortality is the rate of infant deaths per 1,000 live births in a year. CVD deaths are measured using a three-year average, age-adjusted death rate (per 100,000 population) due to heart disease, strokes, and other forms of CVD. Cancer deaths are measured using a three-year average, age-adjusted death rate (per 100,000 population) due to cancer. YPLL measures the loss of productive life due to death before age 75 years (YPLL-75) and serves as an overall measure of premature deaths. The source of data for these measures of mortality was the National Center for Health Statistics.[22]

We measured changes in state-level aggregate LHD expenditures per capita against changes in each of the state-level health measures using a fixed-effects regression model. The fixed-effects model has the advantage of controlling for potential omitted time-invariant variables that may impact health. We provide estimates for each of the seven health measures separately, which expresses the outcome (y) for state (i) at time (t) as

$$y_{it} = \beta_0 + X_{it}\beta + \alpha_i + u_{it}$$

where X_{it} reflects the aggregated LHD expenditures, α_i is the unobserved (state-specific) fixed effect, and u_{it} is the error term. Variables known to influence health at the community level and that varied over time served as control variables and included the percentage of the state population who were >25 years of age and high school graduates; uninsured; living below the federal poverty line; nonwhite; and >65 years of age. We incorporated each of the control variables individually into the fixed-effects model. Data were analyzed using Stata® version 10.[23]

RESULTS

Table 1 shows the descriptive statistics for dependent and independent variables across the 37 states. Of the 37 states in the final dataset, 15 showed a steady increase in expenditures per capita across the three time periods, four states showed a steady decrease, and the remaining 18 states showed no consistent trend in expenditures per capita (data not shown).

Table 2 shows the extent of variation in expenditures per capita, both between and within states. Results for the fixed-effects model estimates are shown in Table 3. An increase in state-level aggregate LHD expenditures per capita was significantly associated with a decrease in infectious disease morbidity (b= −0.3058, t= −3.28, p=0.002) and a decrease in YPLL (b= −12.5852, t= −2.73, p=0.008). More specifically, the model estimates that, for each $10 increase in spending, infectious disease morbidity declined by three cases per 100,000 population over the 12-year period of the study. This reduction can be converted to a relative effect by dividing three cases per 100,000 population by the state-level median case rate (41.1/100,000) for the initial year (1993). Thus, for each $10 increase in expenditures per capita, infectious disease mortality declined by 7.4% over the 12-year period of the study. For premature deaths, a $10 increase in expenditures per capita was associated with a 1.5% decline in YPLL. There were

Table 1. The impact of local health department expenditures on health status: descriptive statistics for dependent, independent, and control variables across 37 states, 1993, 1997, and 2005

	1993			*1997*			*2005*		
Dependent variable	*Mean*	*SD*	*Median*	*Mean*	*SD*	*Median*	*Mean*	*SD*	*Median*
Smoking prevalence (percent)	23.14	2.26	22.70	23.85	2.65	23.20	20.34	3.07	19.60
Obesity prevalence (percent)	15.72	2.21	16.00	16.90	2.54	16.90	26.48	2.70	26.50
Infectious disease cases (rate per 100,000 population)	42.87	23.25	41.14	38.71	20.37	33.76	15.62	9.20	14.00
Infant mortality (rate per 1,000 live births)	8.48	1.16	8.50	7.56	1.16	7.60	6.86	1.27	6.50
CVD deaths (rate per 100,000 population)	358.71	30.79	355.80	359.84	31.99	356.40	296.19	37.60	301.60
Cancer deaths (rate per 100,000 population)	210.09	12.56	208.64	211.05	13.42	209.52	196.27	13.02	196.60
YPLL-75	8,053.71	1,196.88	8,301.60	7,962.56	1,090.09	7,997.40	7,547.86	1,315.95	7,615.00
Independent variable									
Expenditures per capita[a] (in U.S. dollars)	$34.68	$15.21	$33.47	$38.89	$18.19	$33.71	$41.24	$24.98	$34.25
Control variable[b]									
High school graduate (percent)	75.13	8.04	76.00	71.83	9.66	72.20	86.57	3.44	87.40
Uninsured (percent)	13.60	4.23	13.30	14.26	3.90	13.50	13.88	3.39	13.40
Living below poverty line (percent)	13.94	3.43	13.60	12.52	2.94	11.70	12.60	2.86	12.31
Nonwhite (percent)	13.37	8.04	12.07	13.96	8.25	12.60	16.32	8.53	14.76
>65 years of age (percent)	12.95	1.63	12.98	12.94	1.60	12.80	12.70	1.44	12.95

[a]Local health department expenditures aggregated to the state level

[b]Control variables for each model estimated high school graduation (percentage of the state population >25 years of age who have graduated from high school), health insurance (percentage of the state population who are uninsured), poverty (percentage of the state population living below the federal poverty line), racial composition (percentage of the state population who are nonwhite), and age structure (percentage of the state population >65 years of age). Total (actual U.S.) population of each state was also included as a control variable, primarily for scaling effects; mean, standard deviation, and median are not shown.

SD = standard deviation

CVD = cardiovascular disease

YPLL-75 = years of potential life lost before 75 years of age

Table 2. The impact of local health department expenditures on health status: variation in expenditures per capita, between and within states, 1993–2005

Variable	*Mean*	*SD*	*Minimum*	*Maximum*	*Observations*
Expenditures per capita	38.42712	17.26409	13.39819	87.29019	*n*=108
Overall		16.08804	18.59459	71.00709	*n*=36
Between states		6.63788	19.63474	57.65637	t=3
Within states		17.26409	13.39819	87.29019	*n*=108

SD = standard deviation

no other statistically significant associations between expenditures and other health determinants. The sensitivity analysis, which included all LHDs reporting in each separate profile, yielded findings consistent with those described previously (data not shown). In addition, although modifying the cutoff of the summed jurisdictional population for inclusion from 40% of the state's actual population to 50% and 60% resulted in fewer states included, the results were consistently statistically significant for the association between an increase in spending and a decrease in infectious disease morbidity (data not shown).

DISCUSSION

When aggregated to the state level, improvements in LHD resources are associated with reductions in preventable morbidity and mortality. These findings are consistent with Mays and Smith, who found a significant relationship between changes in LHD expenditures and changes in community-level health outcomes for infant mortality, CVD mortality, and other measures of preventable causes of death.[11] The findings are also consistent with and extend the findings of Erwin et al., showing similar associations between changes in LHD resources aggregated to the state level and infectious disease morbidity from 1997 to 2005.[12] Grembowski et al.'s recent finding of an association between improvements in LHD expenditures and declines in the black-white mortality gap in certain age and gender subgroups is an additional piece of evidence that LHD resources matter.[24]

An association between LHD expenditures and infectious disease morbidity clearly fits within the conceptual model that links LHD inputs, outputs, and outcomes. LHDs and state agencies are specifically funded by CDC to monitor, investigate, and respond to infectious diseases; this, in turn, reflects the fact that infectious disease reporting is codified in all states. In 2000, CDC and the Health Resources and Services Administration significantly expanded funding to state health agencies to strengthen state and local capacities to address emerging threats such as bioterrorism and to increase emergency preparedness capabilities through the Public Health Threats and Emergencies Act.[25] Many states used the funding to expand epidemiologic capacity, which could serve dual purposes: to prepare for emergency events such as a bioterrorist

Table 3. Association between local health department expenditures (aggregated to the state level) and health measures, using fixed-effects regression, 1993–2005

Dependent variable	*Beta coefficient*	*t*	*P-value*	*Standard error*	*Relative effect*[a] *(percent)*
Smoking prevalence	0.0127	0.82	0.417	0.0155	0.56
Obesity prevalence	−0.0116	−0.44	0.663	0.0265	−0.73
Infectious disease morbidity	−0.3058	−3.28	0.002	0.0932[b]	−7.40
Infant mortality	−0.0061	−0.86	0.390	0.0070	−0.72
CVD mortality	−0.1534	−0.74	0.460	0.2064	−0.43
Cancer mortality	−0.0367	−0.70	0.487	0.0526	−0.18
YPLL-75	−12.5852	−2.73	0.008	4.6026[b]	−1.52

[a]Percentage change with each $10 increase in expenditures per capita

[b]$p<0.01$

CVD = cardiovascular disease

YPLL-75 = years of potential life lost before 75 years of age

attack, while, at the same time, improving the ability of state and local agencies to address the everyday challenges of more routine infectious diseases. NACCHO reported that, by 2005, 73% of LHDs were receiving funds from state agencies for public health preparedness, and more than half had reported hiring additional personnel to carry out this work.[19] The reduction of three cases of infectious disease per 100,000 population for each $10 increase in spending is not trivial in terms of cost benefit. For example, lifetime costs of human immunodeficiency virus alone may vary from $199,800 to $385,200 per person, with an estimate of 22 years of life after diagnosis, while hepatitis B lifetime costs vary from $0 (asymptomatic cases) to $32,837 per person.[26,27]

Although the association between LHD expenditures and the individual measures of mortality was not significant, the overall efforts of LHDs to reduce preventable morbidity and mortality may be reflected in the association of expenditures with YPLL. CVD and cancer represent the leading causes of death, while unintentional injuries contribute most to YPLL and are the leading causes of infant mortality—and many LHDs provide both clinical and community-based preventive services focused on these issues. It remains noteworthy, however, that there was no relationship between public health expenditures and such measures as smoking and obesity rates. This may reflect the complex interactions mediating how governmental health departments interact with the public health system. While the exact mechanisms within the public health system that may cause infectious diseases and YPLL to decrease are unclear when related to public health expenditures, it is equally puzzling why expenditures are not associated with reductions in the other health measures that are considered amenable to public health action.

This finding raises two related issues. First, the causal model identifies local public health expenditures as inputs that are transformed into public health programs to produce outputs, leading to improved health outcomes; however, there is very little understanding of how these factors influence or are mediated by the public health system. Second, until research is available to understand how management leads the transformation of inputs to outputs in the public health department, there will be continued ambiguity surrounding the "black box" of health department operations.

The findings of this study have direct relevance to both the national economic landscape, in general, and to recent efforts in health reform, in particular. Even prior to the national economic crisis that began in late 2007, changes in federal funding for public health were beginning to take shape. From 2005 to 2009, federal funding for state and local preparedness was cut by more than 25%, and states are no longer receiving any supplemental funding for pandemic flu preparedness, despite increased responsibilities.[14] This study suggests that gains that may have been made in infectious disease morbidity may be jeopardized by reductions in funding that supported a significant expansion of epidemiologic capacity beginning in the late 1990s.

The current national economic crisis has also seriously impacted resources at the LHD level. Surveys by NACCHO indicate that "between January 2008 and December 2009, LHDs lost 23,000 jobs to layoffs and attrition, roughly 15% of the entire LHD workforce. In 2009, an additional 25,000 LHD employees were subjected to reduced hours or mandatory furloughs. More than half of LHDs had to make cuts during 2009 to important programs such as population-based primary prevention, maternal and child health, and environmental health."[15] The findings from our study suggest such reductions in resources may have negative consequences on community health status.

The findings of this study also have direct relevance to the recently enacted PPACA and to the related efforts focused on comparative effectiveness research. The PPACA authorized competitive grants "at the state and local level for programs that promote individual and community health by reducing chronic disease rates, addressing health disparities, and developing a stronger evidence base of effective prevention programming."[28,29] In late 2010, however, U.S. Department of Health and Human Services Secretary Kathleen Sebelius redirected $250 million from the public health fund established in PPACA to increasing the physician workforce, rather than public health interventions that may lessen the need for physician care in the first place.[16] In addition, while PPACA includes a focus on comparative effectiveness research, the Institute of Medicine's original list of 100 priorities did not mention the term "public health."[17] Thus, the research agenda that is meant to inform the process and measure the impact of health reform may ignore the very relationships that the field of PHSSR, including the findings from this study, is attempting to define.

Limitations

This study had several limitations. First, even within a longitudinal design, the association between changes in LHD expenditures and changes in health measures does not establish cause and effect. While the fixed-effects regression model provides a more robust method of showing this association, particularly with the ability to control for time-invariant influences on health, endogeneity is not completely resolved. Public health programs often operate with extended time

lags; thus, a fixed-effects model has the potential for underestimating the impact for selected outcomes. Second, this study does not include other federal and state public health expenditures that fall outside the measure of LHD expenditures. Third, this study did not explore the public health department or public health systems programs and outputs that serve as the connection between inputs and outcomes. While this study suggests, for example, that improving the resource base in local and state public health agencies may lead to improved health outcomes, it does not address the "black box" of what to resource within LHDs or how LHDs translate such resources to improved health at the community level. Additional research in this arena could yield valuable information for policy makers.

CONCLUSION

The primary contribution of this study is to add one more piece of evidence that public health resources matter, and this evidence should have value to the public health workforce, which is increasingly being asked to justify itself, and to policy makers, who are in positions to influence the fair but effective use of public allocations.

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