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*Annual Review of Public Health*

# How Much Do We Spend? Creating Historical Estimates of Public Health Expenditures in the United States at the Federal, State, and Local Levels

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## Keywords

public health finance, public health spending, public health systems, public health systems research

## Abstract

The United States has a complex governmental public health system. Agencies at the federal, state, and local levels all contribute to the protection and promotion of the population's health. Whether the modern public health system is well situated to deliver essential public health services, however, is an open question. In some part, its readiness relates to how agencies are funded and to what ends. A mix of Federalism, home rule, and happenstance has contributed to a siloed funding system in the United States, whereby health agencies are given particular dollars for particular tasks. Little discretionary funding remains. Furthermore, tracking how much is spent, by whom, and on what is notoriously challenging. This review both outlines the challenges associated with estimating public health spending and explains the known sources of funding that are used to estimate and demonstrate the value of public health spending.

## BACKGROUND

Public health measures had significant success in reducing morbidity and mortality throughout the twentieth century (2, 28, 77, 95). However, public health has not received nearly as much recognition or resources as the medical care system during that same period. In 1988, the Institute of Medicine (IOM) published *The Future of Public Health*, a landmark report on public health (51). It inaugurated a substantial new effort to bring public health the attention it needed (39). This report defined the mission of public health in the United States as “assuring conditions in which people can be healthy” (p. 7). It recognized public health as a mechanism by which population health could be improved. Furthermore, the IOM report established that governmental public health at the federal, state, and local levels has three functions: assessment, policy development, and assurance (24). These have been further refined as comprising 10 essential public health services (24).

### The Importance of Public Health Spending Estimates

Governmental public health services are an amalgam of federal, state, and local programs and activities, arranged such that they perform the 10 essential public health services to promote health and protect the public from illness. However, many questions arise about the capacity of governmental public health units to succeed in this role. The most enduring issue is the relation of public health and medical care, including the fragmented arrangements between providers and payers for medical care services and attention to illness, as opposed to promoting population health (33–36, 40, 64, 73, 87, 94, 98, 99). Other major considerations in public health include the allocation of resources and challenges associated with accurately estimating levels of total governmental public health spending and parsing out such spending and public health responsibilities at each level of government (13, 21, 26, 38, 45–49, 53, 57, 63, 69, 76, 85, 88, 93, 96). As compared with health care spending in the United States, public health spending is derived almost entirely from governmental sources (89). A complex web of health departments, other governmental agencies, private or quasi-private public health institutes, universities, colleges, and nonprofits all play important roles in the system.

This article reviews governmental public health spending estimates and data sources with an eye toward the differing definitions of what constitutes public health and the consequent implications of such definitions on spending estimates. Each level of governmental public health in the United States—federal, state, and local—has particular sources of expenditure data, as well as peculiarities in each data set. This complex structure and web of funding make it challenging to accurately estimate public health spending nationwide. The goals of this article are to illuminate this complexity using the best available data on funding flows and to highlight promising ways to improve understanding and ultimately performance of the nation’s myriad public health units on the basis of learning more about funding flows. These issues are focal points of the 2012 IOM report on public health finance (50). To understand the nature of the public health system, one may find a brief history of US public health and an overview of the public health system to be helpful.

### History of the US Public Health System

The United States has no coherent system for governmental funding of public health (44, 50), which reflects that the various governmental levels of public health developed independently and largely without intergovernmental planning. The Tenth Amendment to the Constitution reserves to states all rights not assigned to the federal government. Thus the protection and promotion of health, not mentioned in the Constitution, belong largely to the states. Nevertheless, the first efforts in the development of a public health *system*, rather than merely a host of independent

agencies and services, arguably occurred at the federal level (104). In 1798, John Adams signed a law that created the Marine Hospital Service, which was established to serve merchant seamen (104).

Local health department (LHD) creation in the United States preceded the creation of state health departments as port cities established committees that were responsible for the quarantine of ships to prevent the importation of diseases such as cholera and yellow fever (77). LHDs consisted of a concerned group of citizens and may or may not have had a physician as a member. The first US state health department was created in 1869 by the state of Massachusetts, with the Louisiana State Health Department not far behind. The creation of the first state health department and the effort that led to its creation were primarily the work of a Boston statistician, Lemuel Shattuck. Shattuck was concerned by the lack of vital statistics to help guide sanitary efforts, which led to legislation in 1842 to require better registration of vital statistics. Shattuck's sanitary survey in 1850 led to the creation of the Massachusetts Department of Public Health. To this day, surveillance is largely a state-driven responsibility.

The federal relationship to both state and local health departments was, until the middle of the twentieth century, cursory at best. After the transition of the Marine Hospital System to the US Public Health Service (USPHS) by 1912, the USPHS assumed the quarantine function that many port communities had entrusted to their LHDs. In the early 1900s, the USPHS began loaning personnel to state and local governments for specific disease control activities. The major event that created a funding relationship among the federal, state, and local levels of government was the passage of the Social Security Act in 1935. Titles V and VI of that act provided federal funding to state health departments to use for maternal and child health (MCH) services. However, to obtain the funding, state health departments were required to have a series of local organizations to accomplish these MCH tasks and to submit a plan for the utilization of these funds. Since that time, there has been a continuing stream of federal funding tied to a specific disease or health problem; this practice is known as categorical funding or siloed funding. These categorical funds typically flow from the federal government through the state health department, where they are then dispersed to LHDs for implementation.

Efforts have been made to convert categorical grants to more flexible block grants that have a specific allocation without an established specific disease target. Such a conversion ostensibly allows local discretion in the expenditure of appropriations. Yet, such flexibility has typically been accompanied by cuts in the total amount of funding, theoretically reflecting a decreased administrative cost for use of these monies (10, 60). Moreover, these block grant efforts have been eroded as special interest groups have worked to protect traditional, protected categorical grant or related funding arrangements to assure continued resources and attention to their specific disease or cause of interest (27, 51). Additionally, block grants are sometimes repurposed or raided for unrelated programs. For example, the Obama administration's redirection of \$6.25 billion in funds in 2012 from the Affordable Care Act (ACA)-created Prevention and Public Health Fund offset a scheduled cut in Medicare's payments to physicians, in addition to billions in other cuts due to Congressional mandates and the sequester (1, 43).

## Modern Structure of Funding

Today's public health system still reflects its origins, as local public health departments remain financially supported by cities, counties, and other local governments. The structure of the public health system in a jurisdiction is determined by how state and local health departments are empowered within a state. In so-called centralized states, state health agencies (SHAs) operate LHDs as local offices or branches of the SHA. In decentralized states (as well as in mixed and shared states), LHDs retain more authority and responsibility for the delivery of public health services

(74). Local departments are typically partially funded through local property taxes or through a dedicated public health revenue stream from local government. Although it is a substantial source of revenue for LHDs of any governance type, local government support of public health agencies is typically modest—about 3% of total local taxes, on average (72, 85). State legislatures also fund local public health, typically through grants and contracts administered by the state health agency, general state fund support, and other dedicated revenue. The federal government also supports a few very large local governments (e.g., New York City, Chicago) directly with some grants; however, federal dollars more typically flow to state health departments where they are then disbursed as a pass-through to local agencies (50).

An additional concern is that health departments vary in their service provision and funding implications from such service provision. This concern is particularly relevant for health departments that provide direct clinical services, as opposed to those departments focused on population-based services (15, 20, 31, 42, 55, 86, 106). Given ongoing health care reforms, demand for direct patient services from LHDs is uncertain in many jurisdictions as patients who gain access to the traditional medical care system will likely have less demand for primary care and clinical preventive services from their LHDs (59, 106).

SHAs receive funds primarily from two sources, their state's legislature and the federal government. The latter, on average, is now the largest funder of public health within a state (5). However, other funders, such as foundations and even for-profit institutions, have more recently begun to constitute a larger portion of state public health revenue (5, 61). Additionally, states and local agencies typically collect some user fees and fines, for example for vital health records or environmental permits and inspections, which in turn support many of their services. However, depending on the state or local jurisdiction, substantial portions of these fee-for-service revenues may be allocated to the health department or could be returned to the state or local general fund for either allocation back to public health or to other purposes unrelated to public health (61).

As discussed in the seminal 2012 IOM report on public health finance, the funding structure of public health remains largely a series of silos (50). Federal agencies fund grants or contracts for particular categorical diseases or programs, as described above. In some respects, this practice decreases public health practitioners' ability to respond to local needs and priorities. However, these categorical dollars are most often necessary to offset continued budget cuts at the state and local levels and to assure provision of services or programs. In addition, the categorical funds frequently do not cover the entire program cost and require augmentation with state or local funds. States and even local governments are increasingly funding health departments in such a categorical fashion, designating resources for particular program codes or silos (97), which leaves relatively little discretion in state and local health agency budgets to cover overall infrastructure (e.g., workforce training, technology) or other unfunded or unanticipated needs (e.g., ongoing prevention efforts or disease outbreaks) (10, 61, 75). National efforts, discussed at length below, are attempting to create more precise cost estimates of what is needed for infrastructure-support programs, sometimes referred to as capacity development or foundational capabilities (81).

## **PUBLIC HEALTH SPENDING ESTIMATES**

Public health spending estimates exist separately at the federal, state, and local levels. Whereas federal estimates are relatively standardized and centralized, functionally coming from one core source of financial data (i.e., the US budget and chart of accounts), state and local financial data sets can be disparate. This reflects the many and varied ways that state and local governments create budgets, general ledgers, and charts of accounts. Efforts are under way to create integrated estimates across all levels of government to get a better sense of public health system spending holistically.

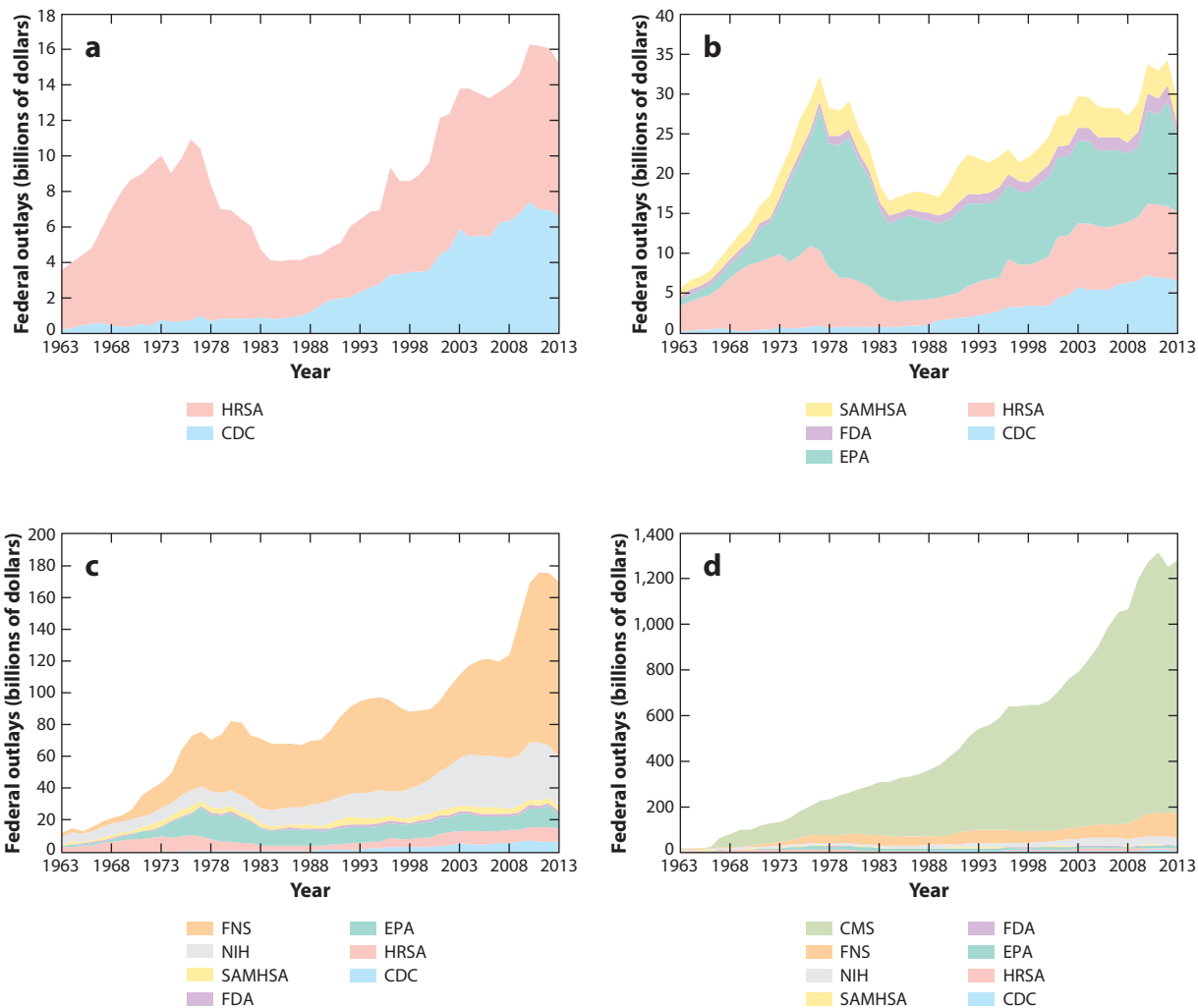
## Federal Estimates

The Centers for Disease Control and Prevention (CDC) is responsible for much of the federal government's population health improvement and protection activities, although they have a relatively small budget (\$10 billion in 2013) (22). Other federal agencies responsible for performing some—or many—public health functions include other agencies within the US Department of Health and Human Services (DHHS), such as the Health Resources and Services Administration (HRSA), the Food and Drug Administration (FDA), the Substance Abuse and Mental Health Services Administration (SAMHSA), and the National Institutes of Health (NIH). However, many public health programs exist in federal agencies other than the DHHS; the Food and Nutrition Services (FNS) under the Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) are examples. Still others exist for related programs, such as the Veterans Affairs health system, the military health system, branches of the uniformed services (namely the US Public Health Service), and federal correctional health.

As **Figure 1** shows, the inclusion or exclusion of certain agencies and activities can change the estimate of federal investment by more than an order of magnitude (103). In the upper-left quadrant of **Figure 1**, federal outlays for the CDC and the HRSA are shown for more than 50 years of spending, inflation adjusted to 2013 dollars. In total, in the past several years, the Office of Management and Budget data show less than \$25 billion is spent per year between the two agencies. Arguably, much of the HRSA's (and some of the CDC's) spending might fall outside of "public health" spending into areas of personal health care or related services, which means that, under the assumption that the HRSA and the CDC are the only federal agencies included, the federal investment in public health may be even less. However, when other federal agencies, such as the EPA and the FDA, are included as public health service providers (upper-right quadrant of **Figure 1**), the scale of potential federal public health investment doubles. To the extent that activities within the NIH or the USDA [which includes the Women and Infants Nutrition Program (WIC) and other nutrition programs] are included in the public health umbrella, the scale of potential federal investment in "public health" increases by an order of magnitude. Finally, to the extent that any activities within the Centers for Medicare and Medicaid Services (CMS) are included (the whole of whose federal outlays are added in the lower-right quadrant of **Figure 1**), the scale of federal public health investment becomes unrecognizable (103). Thus, how public health is defined and characterized has major implications for estimating public health expenditures and ultimately for determining the value of such spending.

**Current federal estimates.** Several federal websites track federal spending. These include the Catalog of Federal Domestic Assistance (CFDA) (102), the HHS-specific Tracking Accountability in Government Grants System (TAGGS) (<https://taggs.hhs.gov/>), and Data.gov (<https://www.data.gov/>). Other potential sources of federal expenditure data include the Office of Management and Budget (103) and Congressional reports and legislation. Historical records exist in the now-defunct Consolidated Federal Funds Report (101). Additionally, both the CDC and the HRSA offer grant funding profiles for recent years (23; <https://datawarehouse.hrsa.gov/>).

**Challenges with federal spending estimates.** Many agencies—the CDC included—do not publish the final location and disposition of subawards. For example, the CDC may award a large grant to a state health agency, and the state agency may then pass down some portion of the CDC funds to local agencies. These pass-through amounts are not systematically tracked or made publicly available. This lack of reporting is further complicated by the fact that the CDC sometimes directly awards grants to large municipal health departments (e.g., New York



**Figure 1**

Federal outlays for select government agencies, 1963–2013, (a) including CDC and HRSA; (b) adding AHRQ, EPA, FDA, SAMHSA; (c) adding FNS and NIH; and (d) adding CMS. Inflation adjusted to 2013 dollars. Data from OMB (74). Abbreviations: AHRQ, Agency for Healthcare Research and Quality; CDC, Centers for Disease Control and Prevention; CMS, Centers for Medicare and Medicaid Services; EPA, Environmental Protection Agency; FDA, Food and Drug Administration; FNS, Food and Nutrition Service; HRSA, Health Resources and Service Administration; NIH, National Institutes of Health; SAMHSA, Substance Abuse and Mental Health Services Administration.

City or Chicago) that may also receive additional CDC funding via pass-through funds from the state health agency (50). These diverse funding pathways make it difficult, if not impossible, to directly and comprehensively trace federal investments to state and local public health agencies (57).

Unlike state or local spending, differing agencies within the federal government generally use similar definitions and spending categorizations (typically based on the CFDA). However, a major challenge rests in whether the databases reflect spending under the agency’s authority versus both agency spending and other federal sources of funds (e.g., the Prevention and Public Health Fund)



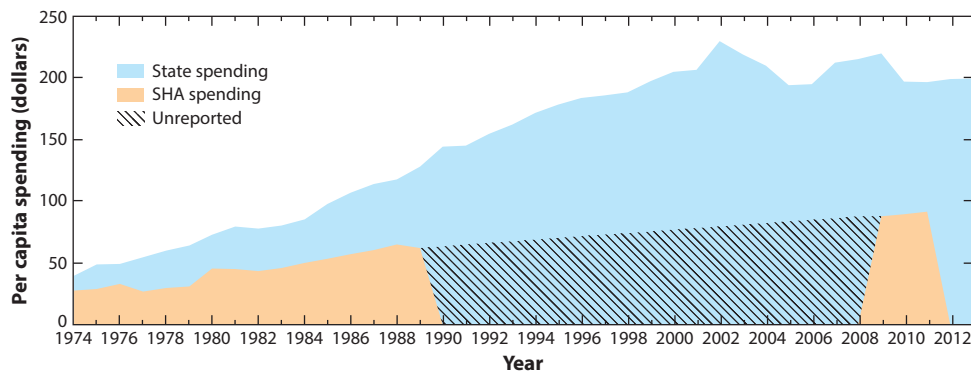
(57). This lack of clarity is further complicated by data sets that may include or exclude mandatory and/or discretionary spending and whether such budgetary details are explicitly identified to the data user (49).

## State Spending Estimates

Spending estimates from SHAs go back to the early 1970s. Financial data were collected from state health departments by the Association of State and Territorial Health Officials (ASTHO) and the Public Health Foundation until 1992 with support of the federal government (9). Between 1992 and 2007, such spending data were not systematically collected from SHAs because federal support for tracking this spending had ended. More current estimates for SHA spending come from the ASTHO Profiles, which are large-scale organizational surveys self-reported by the SHAs approximately triennially since 2007. In successive waves of the Profile, the SHA expenditure reports have become more robust and standardized (5).

Another significant, though underutilized, source of SHA-level spending on community health care and public health comes from the US Census Bureau's division of state finance. Whereas all the ASTHO data capture spending solely by SHAs, the Census Bureau captures spending on health activities across all state governmental entities (e.g., environment, human services, agriculture) (100). A small number of Census functional codes relate directly to health spending, especially vendor payments for medical care (function 74), public hospital (function 36), protective inspections and licensing (function 66), and all other nonhospital health spending (function 32). Census function 32 includes spending by all state agencies for public health activities (**Figure 2**) (100). However, these function 32 data also include substantial amounts of behavioral health care, disability-related clinical care, and community health care/outpatient care spending (57, 84, 88).

Trust for America's Health (TFAH), a public health advocacy organization, publishes an additional, major source of state-level spending estimates (97). TFAH's estimates are published roughly annually in their *Investing in America's Health* reports, which are based on legislative and federal data gathered and processed by TFAH (97). The major distinction in TFAH's approach is its parsing total expenditures by sources of revenue—e.g., state legislative/general fund support



**Figure 2**

Per capita spending on nonhospital health activities by all state governments and state health agencies (SHAs). Inflation adjusted to 2013 dollars. Association of State and Territorial Health Officials (ASTHO) data from 1974/1989 are decremented from the reported total to remove behavioral health spending (which was included in the aggregate totals at the time). Data from ASTHO Profiles (2007–2014), ASTHO Reporting System (1974–1989), US State Finance Division (1974–2014).

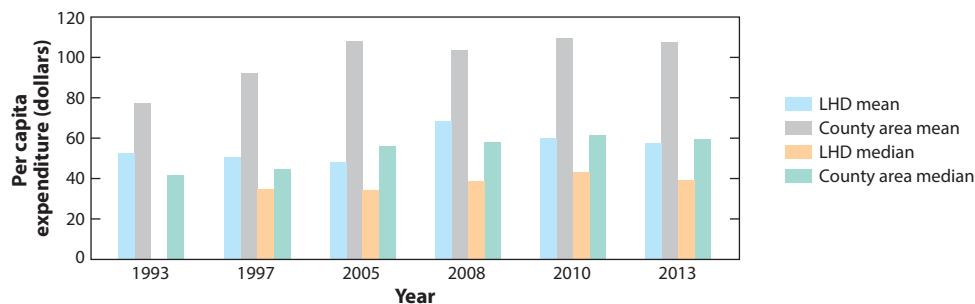
versus federal expenditures. From an advocacy perspective, this approach allows separate messaging within a state about how much the state is directly supporting public health. It also shows state and local policy makers just how much support is coming from the federal government. To maximize comparability, TFAH excludes from their state-based estimates any behavioral health care services, federally supported programs, and state-specific programs (97). The TFAH approach, like that of ASTHO or the Census, has noteworthy challenges and limitations.

**Challenges with state spending estimates.** Estimates from the Census and SHAs (by way of ASTHO) are difficult to reconcile, as different characterizations of public health are used among the different organizations. Whereas ASTHO collects data on SHAs alone, the Census collects data on all state agencies performing public health activities (57, 88). Moreover, the fact that the Census collects data on all health activities (including, separately, Medicaid and public hospital spending) means the scope and scale of spending are quite different between the two estimates. This discrepancy has widened over time (**Figure 2**), suggesting that an increased proportion of state-level nonhospital health spending is going toward personal health care activities—likely especially toward behavioral health care and outpatient community health care (84).

### Local Estimates

**Local health department estimates from NACCHO.** A significant portion of the public health enterprise takes place at the local level, as locals deliver most public health services. The National Association of County and City Health Officials (NACCHO) estimates that there are approximately 2,800 LHDs in the United States (56). These range dramatically in size and complexity: Approximately 61% of LHDs serve jurisdictions with populations under 50,000, 33% serve populations between 50,000 and 500,000, and 6% serve populations of 500,000 or more. However, that 6% equates to about 51% of the nation's population (42, 58). The variety in LHD size and activities/services provided has complicated efforts to create spending estimates of LHDs for decades (7, 21, 30, 37, 47, 53, 88). Since the late 1980s, NACCHO's Profile of LHDs has captured basic financial information—namely, revenues and expenditures—self-reported by the nation's LHDs. In more recent iterations of the survey, specific sources of revenue have been parsed, which has allowed for a number of studies examining trends in revenue generation for LHDs but has also highlighted data quality issues (49). These NACCHO Profiles have presented substantial variation in per capita spending, resulting from a combination of differences in the types of activities/services provided (especially clinical versus population based) as well as differences in the level of support received from state and local governmental revenue. While city and county funds continue to prove critical to the support of LHDs, state funds have decreased in recent years; this decrease, however, has been somewhat offset by greater federal revenues (in direct funds and/or as state passed-through revenues or in the use of local funding increases) (10, 30, 90, 105).

**Specialty estimates of LHD spending.** Beyond the NACCHO Profile, many scholars have constructed spending data sets for LHDs across the United States. These include, notably, the Public Health Activities and Services Tracking (PHAST) study, Bernet's database of Florida LHD spending since 2000, the Public Health Uniform National Data System (PHUNDS; <http://phunds.naccho.org/>), and Brown's database of California LHD spending (11, 14, 18, 83). Brown has published numerous seminal studies using these data to examine the value of local public health spending, whereas Mays has used NACCHO data to examine similar issues (18, 70, 93). These data sets continue to demonstrate substantial variety in local public health



**Figure 3**

Per capita expenditures at local health departments (LHDs) and on nonhospital health services, 1993–2013. Inflation adjusted to 2013 dollars. LHD includes spending from local health department. County area includes all nonhospital health spending (function 32). Data from National Association of County and City Health Officials (NACCHO) profile estimates and census’ county area estimates.

spending across the United States, driven largely by the extent of LHD public health activity (high/medium/low capacity), as well as by the level of clinical services provided by the LHD.


**Census estimates of local government spending on health.** As at the state level, the US Census Bureau collects financial data from the nation’s 87,000 local governments on a regular basis. A full local government census is conducted every five years, and state-based estimates of local spending are created from a sample of local governments annually. Similar to the state-level Census data, three major health-related activities are captured in the local Census data: reimbursements to vendors for medical services, public hospital spending, and all other nonhospital health spending (function 32) (100).

County area estimates are created by aggregating expenditures from all local governments within a county area and deducting governmental transfers. McCullough & Leider (71) have recently shown that annual county-level estimates may be constructed by interpolating missing data for each government within a county area. Larger governments are sampled more frequently than smaller ones; most report yearly. As such, the approach may be reliable over time and is shown in **Figure 3** (71).

**Territories or tribal nation public health spending estimates.** Little public health spending information is available for territories or for tribal nations, who are generally externally funded by the federal government. As such, estimates are complicated by a structural issue: Both territories and tribal nations tend not to have distinct public health operations, instead integrating population-oriented services with clinical or other direct health care services (5, 54).

## National Estimates

The CMS annually publish their National Health Expenditure Accounts (NHEA), which serve as the nation’s official estimates for health and health care spending, as well as a single aggregate national estimate of state and local spending on public health—the Public Health Activity estimate (PHAE) (25, 41). Data on nonhospital health spending (function 32) are critical for the national estimates of public health spending because they are the bases for the PHAE. The PHAE represents the nation’s official estimate of how much federal, state, and local spending goes toward governmental public health. However, as described in more detail in the **Supplemental Material**,

 **Supplemental Material**

the CMS's approach to calculating the PHAE has been called into question by scholars, including the authors of this review, whose findings indicate that the PHAE is likely an overestimation (57, 62, 84). A recent study suggested that only 36% of the Census function 32 spending at the state level in the United States went toward traditional public health activities (84). The CMS use the whole of the Census function 32 estimate in their construction of the PHAE despite that Census function 32 and CMS PHAE capture different types of health spending—i.e., the definitions are nonequivalent. Thus, the PHAE may be much larger than reality. Indeed, if critics are correct, actual spending on governmental public health may be less than half of official estimates from CMS over the past several decades (62, 84).

Additionally, scholars have noted that the PHAE likely underestimates federal investment in state and local public health (57, 84) as a proportion of the total PHAE. In creating the PHAE, CMS deduct some federal spending to eliminate the double counting of federal to state/local transfers, as well as expenditures made through the MCH Program and the Crippled Children's Service Program (which are counted elsewhere in the NHEA). This approach has resulted in CMS estimates showing that federal investment in public health has accounted for only 10–20% of total public health expenditures since the 1980s (41). Evidence suggests that this may be a significant underestimation of federal support for public health, especially given recent reports from state and local health department membership organizations showing that federal funds represent approximately one-half and one-quarter of total revenue for SHAs and LHDs, respectively (3–6, 8, 53, 57, 61, 63, 65–68, 78, 82, 92, 97). In short, many dollars that the PHAE currently ties to as state or local spending are federal in origin.

## DISCUSSION

As the nation continues to grapple with poor health outcomes and rising health costs, it is increasingly critical to address the public health spending estimate challenges outlined above. For the nation to achieve part of the “triple aim” (15), improving population health, we must know how much we are spending on public health, for which activities, and to what end. The problems and issues in funding public health services prompted the National Academy of Medicine (formerly the IOM) to issue a report from its Committee on Public Health Strategies to Improve Health entitled *For the Public's Health: Investing in a Healthier Future* (50). This report pointed to two major concerns with our current mechanisms for funding public health (50, p. 51):

- “Compartmentalized inflexible funding, often competitive, which leaves many health departments without financing for key priorities or for needed cross-cutting capabilities (such as information systems and policy analysis).”
- “Uncoordinated, usually discretionary funding from different levels of government with different rules for use. From a public health financing standpoint, there is no overall point of accountability and no agreement on or definition of a minimum package of services that all funders commit to ensuring in each state and locality.”

On the basis of this work, the National Academy of Medicine proposed the establishment of a minimum package of public health services to be provided to every jurisdiction in the United States. This idea has since evolved into the Foundational Public Health Services (FPHS) model (81). It consists of Foundational Areas and Foundational Capabilities. The Foundational Areas look somewhat like historical categorical spending areas: MCH, chronic disease, injury, communicable disease, etc. The Foundational Capabilities are programs and services across the whole of the agency that support the Foundational Areas. These, according to the IOM committee, represent the trunk of the public health tree, whereas the branches constitute the Foundational Areas.

Unfortunately, the Foundational Capabilities are rarely considered in funding provided by either federal or state governments to LHDs (50). However, for health departments to carry out basic core public health programs, the Foundational Capabilities are the necessary base. The IOM further suggested that a set amount of funds be provided per capita in any categorical program, similar to grant indirect costs, to cover these infrastructure items. They also suggest that the CDC take the lead on this effort to provide financial support for the infrastructure necessary to provide basic public health services. It is interesting to observe that in some ways such recommendations mirror Haven Emerson's recommendations from the 1940s for the Basic Six public health services that all health departments provide (29).

The FPBS provides a framework to characterize public health services and capabilities to be offered to every community, as well as additional programs and activities tailored to address needs specific to individual communities. A uniform chart of accounts crosswalk with the FPBS was developed by Ross et al. and Bekemeier et al. to allow for comparable cost estimates and aggregation of spending for this minimum package of services in communities across the nation (12, 32, 47). Efforts should be expended to examine the per capita cost of these basic public health services and to assure that the funding is available to provide those services. This aim is, unfortunately, currently impossible given the complex, uncoordinated, and widely varying funding provided to public health by state, local, and federal governments. We have no simple straightforward mechanism to bring together all the funding streams to create an unduplicated set of financial data to be able to make reasonable estimates of the resources available to a LHD to provide this infrastructure and carry out these basic programs (63).

It is incumbent on a major federal organization, most likely the CDC, to support the development of a data system that can capture a unified set of accounts to ascertain the amount of funding available to state and local public health jurisdictions so as to assure that their populations receive basic public health services. Relatedly, a voluntary accreditation of state, tribal, and LHDs—the Public Health Accreditation Board (PHAB)—was initiated to advance the quality and performance of the public health system. The FPBS and accreditation standards and measures were deemed critical elements of effective public health practice (79). As such, in 2016, an alignment of FPBS and accreditation standards and measures was developed by PHAB to foster best practices, innovation, and quality improvement in state and LHDs across the United States (79–81).

In addition, community health problems likely vary alongside community assets; the Affordable Care Act now requires that nonprofit hospitals undertake a community health needs assessment and develop a plan to address health problems identified by that assessment, in consultation with public health expertise. Both of these strategies suggest that local communities will likely identify and focus on different problems, depending on the community. The capacity to assure funding to address these locally identified concerns and prioritize health problems requires flexibility in funding.

## **CONCLUSION: RECONCILING FUNDING WITH MISSION**

The mission of public health in the United States is to assure “conditions in which people can be healthy” (51). Yet, adequately fulfilling this mission requires a nimble and flexible, high-quality public health system that has adequate capacity and resources not only to respond to public health threats, but also to provide sustained public health protection that includes the ongoing assessment of community health and coordination with the health care system to prevent and/or address identified public health problems and threats. These aims cannot be achieved without an understanding and accounting of what we are spending on public health and to what end. Moreover, particularly during times of austerity, public health must better understand and demonstrate the

value of the services it provides and activities it conducts. The *Guide to Community Preventive Services* offers practitioners evidence-based programs, often with cost-benefit assessments (16). Cochrane similarly considers costs and benefits in its systematic reviews of public health-related interventions (91). The IOM has offered a framework for assessing the value of community interventions (52). What continues to be lacking, however, are compelling systems-level approaches to estimating the cost benefit for public health agencies and impacts in their communities. A handful of scholars have published in this arena (13, 17–19, 70, 93), but significantly more work must be done to enable agencies to defend their actual budgets and activities, as well as propose initiatives to address identified needs to policy makers from a cost-benefit perspective.

The first steps to improve understanding, accounting, and evaluation of public health spending are threefold:

1. Raise an awareness among the field, policy makers, and stakeholders of the complexity and piecemeal nature of current public health funding mechanisms and the resulting consequences;
2. Develop and disseminate tools, such as a uniform chart of accounts and its crosswalk, to foster improved tracking of public health spending; and
3. Advance research to improve public health spending estimates and evaluating the effectiveness of such spending.

Funding in public health is complicated. Its sources of revenue are fractured and fragmented. The tools for tracking spending are largely proprietary, dated, or underutilized. Official national estimates likely vastly overstate how much money is being spent on governmental public health in the United States (62). More must be done to accurately capture how much money is spent; only then can the true value of public health spending be ascertained.

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## LITERATURE CITED

1. APHA (Am. Public Health Assoc.). 2015. *Prevention and Public Health Fund Dedicated to improving our nation's public health*. Fact Sheet, APHA, Washington, DC. [https://www.apha.org/~media/files/pdf/topics/aca/2015\\_pphf\\_fact\\_sheet.ashx](https://www.apha.org/~media/files/pdf/topics/aca/2015_pphf_fact_sheet.ashx)
2. Armstrong GL, Conn LA, Pinner RW. 1999. Trends in infectious disease mortality in the United States during the 20th century. *JAMA* 281:61–66
3. ASTHO (Assoc. State Territ. Health Off.). 2011. *ASTHO Profile of Health*, Vol. 2. Arlington, VA: ASTHO. [http://www.astho.org/uploadedFiles/\\_Publications/Files/Survey\\_Research/ASTHO\\_State\\_Profiles\\_Single%5B1%5D%20lo%20res.pdf](http://www.astho.org/uploadedFiles/_Publications/Files/Survey_Research/ASTHO_State_Profiles_Single%5B1%5D%20lo%20res.pdf)

4. ASTHO (Assoc. State Territ. Health Off.). 2011. *Budget cuts continue to affect the health of Americans*. Update, May. ASTHO, Arlington, VA
5. ASTHO (Assoc. State Territ. Health Off.). 2014. *ASTHO Profile of Health*, Vol. 3. Arlington, VA: ASTHO. <http://www.astho.org/Profile/Volume-Three/>
6. ASTHO (Assoc. State Territ. Health Off.). 2014. *Budget cuts continue to affect the health of Americans*. Update, Sept. ASTHO, Arlington, VA. <http://www.astho.org/budget-cuts-Sept-2014/>
7. Atchison C, Barry MA, Kanarek N, Gebbie K. 2000. The quest for an accurate accounting of public health expenditures. *J. Public Health Manag. Pract.* 6:93–102
8. Avery G, Zabriskie-Timmerman J. 2009. The impact of federal bioterrorism funding programs on local health department preparedness activities. *Eval. Health Prof.* 32:95–127
9. Barry M, Bialek R. 2004. Tracking our investments in public health: What have we learned? *J. Public Health Manag. Pract.* 10:383–92
10. Baum NM, DesRoches C, Campbell EG, Goold SD. 2011. Resource allocation in public health practice: a national survey of local public health officials. *J. Public Health Manag. Pract.* 17:265–74
11. Bekemeier B. 2016. *The Public Health Activities and Services Tracking study*. Univ. Wash., Seattle. <https://phastdata.org/>
12. Bekemeier B, Singh S, Schoemann A. 2018. A uniform chart of accounts for public health agencies: an “essential ingredient” for a strong public health system. *J. Public Health Manag. Pract.* In press
13. Bekemeier B, Yang Y, Dunbar MD, Pantazis A, Grembowski DE. 2014. Targeted health department expenditures benefit birth outcomes at the county level. *Am. J. Prev. Med.* 46:569–77
14. Bernet P. 2016. *Florida expense loads*. Data set, Fla. Atl. Univ.
15. Berwick DM, Nolan TW, Whittington J. 2008. The triple aim: care, health, and cost. *Health Aff.* 27:759–69
16. Briss PA, Zaza S, Pappaioanou M, Fielding J, Wright-De Agüero L, et al. 2000. Developing an evidence-based *Guide to Community Preventive Services*—methods. *Am. J. Prev. Med.* 18:35–43
17. Brown TT. 2014. How effective are public health departments at preventing mortality? *Econ. Hum. Biol.* 13:34–45
18. Brown TT. 2016. Returns on investment in California County Departments of Public Health. *Am. J. Public Health* 106:1477–82
19. Brown TT, Martinez-Gutierrez MS, Navab B. 2014. The impact of changes in county public health expenditures on general health in the population. *Health Econ. Policy Law* 9:251–69
20. Buck JA. 2011. The looming expansion and transformation of public substance abuse treatment under the Affordable Care Act. *Health Aff.* 30:1402–10
21. CDC (Cent. Dis. Control Prev.). 1994. Selected characteristics of local health departments—United States, 1992–1993. *MMWR* 43:839–43
22. CDC (Cent. Dis. Control Prev.). 2015. *HHS FY2015 budget in brief*. US Dep. Health Hum. Serv., Washington, DC. <https://www.hhs.gov/about/budget/fy2015/budget-in-brief/cdc/index.html>
23. CDC (Cent. Dis. Control Prev.). 2017. *Grant funding profiles*. Updated March 22, CDC, Atlanta. <https://www.cdc.gov/fundingprofiles/index.htm>
24. CDC (Cent. Dis. Control Prev.). 2017. *The public health system and the 10 essential public health services*. Updated Sept. 20, CDC, Atlanta. <https://www.cdc.gov/stltpublichealth/publichealthservices/essentialhealthservices.html>
25. CMS (Cent. Medicare Medicaid Serv.). 2014. *National Health Expenditure Accounts: Methodology Paper: Definitions, Sources, and Methods*. Baltimore, MD: CMS. <https://www.cms.gov/research-statistics-data-and-systems/statistics-trends-and-reports/nationalhealthexpenddata/downloads/dsm-14.pdf>
26. Costich JF, Honoré PA, Scutchfield FD. 2009. Public health financial management needs: report of a national survey. *J. Public Health Manag. Pract.* 15:307–10
27. Cowell A, McCarty D, Cowell A. 2003. Impact of federal Substance Abuse Block Grants on state substance abuse spending: literature and data review. *J. Ment. Health Policy Econ.* 6:173–79
28. Cutler D, Miller G. 2005. The role of public health improvements in health advances: The twentieth-century United States. *Demography* 42:1–22

29. Emerson H. 1945. *Local Health Units for the Nation*. New York: Commonw. Fund
30. Erwin PC, Shah GH, Mays GP. 2014. Local health departments and the 2008 recession: characteristics of resiliency. *Am. J. Prev. Med.* 46:559–68
31. Fielding JE, Teutsch S, Koh H. 2012. Health reform and Healthy People initiative. *Am. J. Public Health* 102:30–33
32. Found. Public Health Serv. Subgroup. 2013. *Foundational Public Health Services Preliminary Cost Estimation Model. Final Report*. Seattle, WA: Agenda for Change
33. Frieden TR. 2004. Asleep at the switch: local public health and chronic disease. *Am. J. Public Health* 94:2059–61
34. Frieden TR. 2015. The future of public health. *N. Engl. J. Med.* 373:1748–54
35. Frieden TR, Bassett MT, Thorpe LE, Farley TA. 2008. Public health in New York City, 2002–2007: confronting epidemics of the modern era. *Int. J. Epidemiol.* 37:966–77
36. Georgeson M, Thorpe LE, Merlino M, Frieden TR, Fielding JE, Big Cities Health Coalit. 2005. Short-changed? An assessment of chronic disease programming in major US city health departments. *J. Urban Health* 82:183–90
37. Gerzoff RB, Gordon RL, Richards TB. 1996. Recent changes in local health department spending. *J. Public Health Policy* 17:170–80
38. Gordon RL, Gerzoff RB, Richards TB. 1997. Determinants of US local health department expenditures, 1992 through 1993. *Am. J. Public Health* 87:91–95
39. Handler AS, Turnock BJ. 1996. Local health department effectiveness in addressing the core functions of public health: essential ingredients. *J. Public Health Policy* 17:460–83
40. Handler AS, Turnock BJ, Hall W, Potsic S, Munson J, et al. 1995. A strategy for measuring local public health practice. *Am. J. Prev. Med.* 11:29–35
41. Hartman M, Martin AB, Lassman D, Catlin A, Natl. Health Expend. Acc. Team. 2015. National health spending in 2013: growth slows, remains in step with the overall economy. *Health Aff.* 34:150–60
42. Hearne S, Castrucci BC, Leider JP, Rhoades EK, Russo P, Bass V. 2015. The future of urban health: needs, barriers, opportunities, and policy advancement at large urban health departments. *J. Public Health Manag. Pract.* 21(Suppl. 1):S4–13
43. Himmelstein DU, Woolhandler S. 2016. Public health’s falling share of US health spending. *Am. J. Public Health* 106:56–57
44. Holsinger JW Jr., Scutchfield FD. 2012. Introduction: History and Context of Public Health Care. In *Contemporary Public Health: Principles, Practice, and Policy*, pp. 1–24. Lexington: Univ. Press Ky.
45. Honoré PA. 2012. Measuring progress in public health finance. *J. Public Health Manag. Pract.* 18:306–8
46. Honoré PA, Clarke RL, Mead DM, Menditto SM. 2007. Creating financial transparency in public health: examining best practices of system partners. *J. Public Health Manag. Pract.* 13:121–29
47. Honoré PA, Leider JP, Singletary V, Ross DA. 2015. Taking a step forward in public health finance: establishing standards for a uniform chart of accounts crosswalk. *J. Public Health Manag. Pract.* 21:509–13
48. Honoré PA, Simoes EJ, Jones WJ, Moonesinghe R. 2004. Practices in public health finance: an investigation of jurisdiction funding patterns and performance. *J. Public Health Manag. Pract.* 10:444–50
49. Ingram RC, Bernet PM, Costich JF. 2012. Public health services and systems research: current state of finance research. *J. Public Health Manag. Pract.* 18:515–19
50. IOM (Inst. Med.), Comm. Public Health Strateg. Improve Health. 2012. *For the Public’s Health: Investing in a Healthier Future*. Washington, DC: Natl. Acad. Press
51. IOM (Inst. Med.), Comm. Study Future Public Health. 1988. *The Future of Public Health*. Washington, DC: Natl. Acad. Press
52. IOM (Inst. Med.), Comm. Valuing Community-Based Non-Clin. Prev. Polic. Wellness Strateg. 2012. *An Integrated Framework for Assessing the Value of Community-Based Prevention*. Washington, DC: Natl. Acad. Press
53. Kinner K, Pellegrini C. 2009. Expenditures for public health: assessing historical and prospective trends. *Am. J. Public Health* 99:1780–91
54. Knudson AD, Hernandez A, Kronstadt J, Allis P, Meit M, et al. 2012. *A Profile of Tribal Health Departments*. Bethesda, MD: NORC, Univ. Chicago. [http://www.norc.org/PDFs/Walsh%20Center/KnudsonA\\_Profile\\_Tribal\\_Health\\_Dept\\_FINAL\\_2012.pdf](http://www.norc.org/PDFs/Walsh%20Center/KnudsonA_Profile_Tribal_Health_Dept_FINAL_2012.pdf)



55. Koh HK, Sebelius KG. 2010. Promoting prevention through the Affordable Care Act. *N. Engl. J. Med.* 363:1296–99
56. Leep CJ, Shah GH. 2012. NACCHO's National Profile of Local Health Departments study: the premier source of data on local health departments for surveillance, research, and policymaking. *J. Public Health Manag. Pract.* 18:186–89
57. Leider JP. 2016. The problem with estimating public health spending. *J. Public Health Manag. Pract.* 22:E1–11
58. Leider JP, Castrucci BC, Hearne S, Russo P. 2015. Organizational characteristics of large urban health departments. *J. Public Health Manag. Pract.* 21(Suppl. 1):S14–19
59. Leider JP, Castrucci BC, Russo P, Hearne S. 2015. Perceived impacts of health care reform on large urban health departments. *J. Public Health Manag. Pract.* 21(Suppl. 1):S66–75
60. Leider JP, Resnick B, Kass N, Sellers K, Young J, et al. 2014. Budget- and priority-setting criteria at state health agencies in times of austerity: a mixed-methods study. *Am. J. Public Health* 104:1092–99
61. Leider JP, Resnick B, Sellers K, Kass N, Bernet P, et al. 2015. Setting budgets and priorities at state health agencies. *J. Public Health Manag. Pract.* 21:336–44
62. Leider JP, Resnick BA, Sensenig AL, Alfonso N, Brady E, Bishai DM. 2016. Assessing the Public Health Activity Estimate from the National Health Expenditure Accounts: why public health expenditure definitions matter. *J. Health Care Financ.* 43:225–40
63. Leider JP, Sellers K, Shah G, Pearsol J, Jarris PE. 2012. Public health spending in 2008: on the challenge of integrating PHSSR data sets and the need for harmonization. *J. Public Health Manag. Pract.* 18:355–63
64. Lenihan P. 2005. The public health system: an idea whose time has come. *J. Public Health Manag. Pract.* 11:165–67
65. Levi J, Juliano C, Richardson M. 2007. Financing public health: diminished funding for core needs and state-by-state variation in support. *J. Public Health Manag. Pract.* 13:97–102
66. Lin F, Lasry A, Sansom SL, Wolitski RJ. 2013. Estimating the impact of state budget cuts and redirection of prevention resources on the HIV epidemic in 59 California local health departments. *PLOS ONE* 8:e55713
67. Lindley MC. 2013. Billing practices of local health departments providing 2009 pandemic influenza A (H1N1) vaccine. *J. Public Health Manag. Pract.* 19:220–23
68. Madamala K, Sellers K, Pearsol J, Dickey M, Jarris PE. 2010. State landscape in public health planning and quality improvement: results of the ASTHO survey. *J. Public Health Manag. Pract.* 16:32–38
69. Mays GP, Public Health Cost Estim. Workgr. 2014. *Estimating the Costs of Foundational Public Health Capabilities: A Recommended Methodology*. Lexington, KY: Univ. Ky. Natl. Coord. Cent. Public Health Serv. Syst. Res.
70. Mays GP, Smith SA. 2011. Evidence links increases in public health spending to declines in preventable deaths. *Health Aff.* 30:1585–93
71. McCullough JM, Leider JP. 2016. Government spending in health and nonhealth sectors associated with improvement in county health rankings. *Health Aff.* 35:2037–43
72. McCullough JM, Leider JP, Riley WJ. 2015. Local fiscal allocation for public health departments. *Am. J. Prev. Med.* 49:921–29
73. Meit M, Knudson A. 2009. Why is rural public health important? A look to the future. *J. Public Health Manag. Pract.* 15:185–90
74. Meit M, Sellers K, Kronstadt J, Lawhorn N, Brown A, et al. 2012. Governance typology: a consensus classification of state-local health department relationships. *J. Public Health Manag. Pract.* 18:520–28
75. Miller CA. 2015. *The use of local tax dollars in Kentucky local health departments to sustain programs from 2009–2013*. PhD Thesis, Univ. Ky., Coll. Public Health
76. Moulton AD, Halverson PK, Honoré PA, Berkowitz B. 2004. Public health finance: a conceptual framework. *J. Public Health Manag. Pract.* 10:377–82
77. Novick LF, Morrow CB, Mays GP. 2007. *Public Health Administration: Principles for Population-Based Management*. Sudbury, MA: Jones & Bartlett
78. Ogden LL, Sellers K, Sammartino C, Buchler JW, Bernet PM. 2012. Funding formulas for public health allocations: federal and state strategies. *J. Public Health Manag. Pract.* 18:309–16

79. PHNCI (Public Health Natl. Cent. Innov.). 2016. *Aligning Accreditation and the Foundational Public Health Capabilities*. Alexandria, VA: PHNCI
80. PHNCI (Public Health Natl. Cent. Innov.). 2016. *Foundational Public Health Services*. Washington, DC: PHNCI. <http://phnci.org/>
81. Public Health Leadersh. Forum. 2014. *Defining and constituting foundational “capabilities” and “areas” version 1*. March. RESOLVE, Washington, DC. <http://www.resolve.org/site-healthleadershipforum/files/2014/03/Articulation-of-Foundational-Capabilities-and-Foundational-Areas-v1.pdf>
82. Reschovsky A, Zahner SJ. 2016. Forecasting the revenues of local public health departments in the shadows of the “Great Recession.” *J. Public Health Manag. Pract.* 22:120–28
83. Resnick B, Bishai D, Leider JP, Colrick I. 2017. *State Health Expenditure Dataset (SHED), 2000–2013*. ICPSR 36741, Univ. Mich., Ann Arbor. <http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/36741>
84. Resnick B, Leider J, Le J, Kish N, Brady E, et al. 2015. *State-level spending on public health by all governmental agencies: using Census of Government data to create a new finance dataset for the field*. Presented at Am. Public Health Assoc. Annu. Meet. Expo., 143rd, Oct. 31—Nov. 4, Chicago
85. Riley WJ, Gearin KJ, Parrotta CD, Briggs J, Gyllstrom ME. 2013. Tax levy financing for local public health: fiscal allocation, effort, and capacity. *Am. J. Prev. Med.* 45:776–81
86. Rosenbaum S. 2011. The Patient Protection and Affordable Care Act: implications for public health policy and practice. *Public Health Rep.* 126:130–35
87. Schlenker T, Huber CA. 2015. A unique funding opportunity for public health in Texas. *J. Public Health Manag. Pract.* 21(Suppl. 1):S81–86
88. Sensenig AL. 2007. Refining estimates of public health spending as measured in national health expenditures accounts: the United States experience. *J. Public Health Manag. Pract.* 13:103–14
89. Sensenig AL, Resnick BA, Leider JP, Bishai DM. 2017. The who, what, how, and why of estimating public health activity spending. *J. Public Health Manag. Pract.* 23:556–59
90. Shah GH, Ye J, Leep CJ, Leider JP. 2016. Local health departments’ approaches to deal with recession: what strategies are used to minimize the negative impact on public health services to community? *J. Public Health Manag. Pract.* 22:537–41
91. Shemilt I, Mugford M, Drummond M, Eisenstein E, Mallender J, et al. 2006. Economics methods in Cochrane systematic reviews of health promotion and public health related interventions. *BMC Med. Res. Methodol.* 6:55
92. Shila Waritu A, Bulzacchelli MT, Begay ME. 2015. Use of fees to fund local public health services in Western Massachusetts. *J. Public Health Manag. Pract.* 21:167–75
93. Singh SR. 2014. Public health spending and population health: a systematic review. *Am. J. Prev. Med.* 47:634–40
94. Singh SR, Bakken E, Kindig DA, Young GJ. 2016. Hospital community benefit in the context of the larger public health system: a state-level analysis of hospital and governmental public health spending across the United States. *J. Public Health Manag. Pract.* 22:164–74
95. Stewart ST, Cutler DM. 2014. *The contribution of behavior change and public health to improved US population health*. Natl. Bur. Econ. Res. Work. Pap. 20631
96. Suen J, Christenson GM, Cooper A, Taylor M. 1995. Analysis of the current status of public health practice in local health departments. *Am. J. Prev. Med.* 11:51–54
97. Trust for America’s Health. 2012. *Investing in America’s Health: A State-by-State Look at Public Health Funding and Key Health Facts*. Washington, DC: Trust for America’s Health. <http://healthyamericans.org/assets/files/Investing.pdf>
98. Turnock BJ. 2004. *Public Health: What It Is and How It Works*. Sudbury, MA: Jones & Bartlett Learn.
99. Turnock BJ, Handler A, Hall W, Potsic S, Nalluri R, Vaughn EH. 1994. Local health department effectiveness in addressing the core functions of public health. *Public Health Rep.* 109:653–58
100. US Bur. Census. 2006. *Government Finance and Employment Classification Manual*. Washington, DC: US Bur. Census. [https://www2.census.gov/govs/pubs/classification/2006\\_classification\\_manual.pdf](https://www2.census.gov/govs/pubs/classification/2006_classification_manual.pdf)
101. US Census Bur. 2016. *Consolidated Federal Funds Report*. Baltimore, MD: Fed. Financ. Stat. Progr.
102. US OMB (Off. Manag. Budg.). 1980. *Catalog of Federal Domestic Assistance*. Washington, DC: US Gov. Print. Off.

103. US OMB (Off. Manag. Budg.). 2015. *Historical tables*. OMB, Washington, DC. <https://obamawhitehouse.archives.gov/omb/budget/Historicals>
104. US Public Health Serv. 2014. *History*. Updated Sept. 5, US Dep. Health Hum. Serv., Washington, DC. <https://www.usphs.gov/aboutus/history.aspx>
105. Willard R, Shah GH, Leep C, Ku L. 2012. Impact of the 2008–2010 economic recession on local health departments. *J. Public Health Manag. Pract.* 18:106–14
106. Williams SL, Nichols BL, Barton MK, De LaCruz M, Hernandez B. 2015. Local leadership and the Affordable Care Act. *J. Public Health Manag. Pract.* 21(Suppl. 1):S87–92



# Contents

## Symposium

Commentary: Increasing the Connectivity Between Implementation Science and Public Health: Advancing Methodology, Evidence Integration, and Sustainability  
*David A. Chambers* ..... 1

Selecting and Improving Quasi-Experimental Designs in Effectiveness and Implementation Research  
*Margaret A. Handley, Courtney R. Lyles, Charles McCulloch, and Adithya Cattamanchi* ..... 5

Building Capacity for Evidence-Based Public Health: Reconciling the Pulls of Practice and the Push of Research  
*Ross C. Brownson, Jonathan E. Fielding, and Lawrence W. Green* ..... 27

The Sustainability of Evidence-Based Interventions and Practices in Public Health and Health Care  
*Rachel C. Shelton, Brittany Rhoades Cooper, and Shannon Wiltsey Stirman* ..... 55

## Epidemiology and Biostatistics

Selecting and Improving Quasi-Experimental Designs in Effectiveness and Implementation Research  
*Margaret A. Handley, Courtney R. Lyles, Charles McCulloch, and Adithya Cattamanchi* ..... 5

Agent-Based Modeling in Public Health: Current Applications and Future Directions  
*Melissa Tracy, Magdalena Cerdá, and Katherine M. Keyes* ..... 77

Big Data in Public Health: Terminology, Machine Learning, and Privacy  
*Stephen J. Mooney and Vikas Pejaver* ..... 95

Environmental Determinants of Breast Cancer  
*Robert A. Hiatt and Julia Green Brody* ..... 113

Meta-Analysis of Complex Interventions <i>Emily E. Tanner-Smith and Sean Grant</i> .....	135
Precision Medicine from a Public Health Perspective <i>Ramya Ramaswami, Ronald Bayer, and Sandro Galea</i> .....	153
Relative Roles of Race Versus Socioeconomic Position in Studies of Health Inequalities: A Matter of Interpretation <i>Amani M. Nuru-Jeter, Elizabeth K. Michaels, Marilyn D. Thomas, Alexis N. Reeves, Roland J. Thorpe Jr., and Thomas A. LaVeist</i> .....	169

## **Social Environment and Behavior**

The Debate About Electronic Cigarettes: Harm Minimization or the Precautionary Principle <i>Lawrence W. Green, Jonathan E. Fielding, and Ross C. Brownson</i> .....	189
Harm Minimization and Tobacco Control: Reframing Societal Views of Nicotine Use to Rapidly Save Lives <i>David B. Abrams, Allison M. Glasser, Jennifer L. Pearson, Andrea C. Villanti, Lauren K. Collins, and Raymond S. Niaura</i> .....	193
E-Cigarettes: Use, Effects on Smoking, Risks, and Policy Implications <i>Stanton A. Glantz and David W. Bareham</i> .....	215
Increasing Disparities in Mortality by Socioeconomic Status <i>Barry Bosworth</i> .....	237
Neighborhood Interventions to Reduce Violence <i>Michelle C. Kondo, Elena Andreyeva, Eugenia C. South, John M. MacDonald, and Charles C. Branas</i> .....	253
The Relationship Between Education and Health: Reducing Disparities Through a Contextual Approach <i>Anna Zajacova and Elizabeth M. Lawrence</i> .....	273

## **Environmental and Occupational Health**

Building Evidence for Health: Green Buildings, Current Science, and Future Challenges <i>J.G. Cedeño-Laurent, A. Williams, P. MacNaughton, X. Cao, E. Eitland, J. Spengler, and J. Allen</i> .....	291
Environmental Influences on the Epigenome: Exposure-Associated DNA Methylation in Human Populations <i>Elizabeth M. Martin and Rebecca C. Fry</i> .....	309

From Crowdsourcing to Extreme Citizen Science: Participatory Research for Environmental Health <i>P.B. English, M.J. Richardson, and C. Garzón-Galvis</i> .....	335
Migrant Workers and Their Occupational Health and Safety <i>Sally C. Moyce and Marc Schenker</i> .....	351
Mobile Sensing in Environmental Health and Neighborhood Research <i>Basile Chaix</i> .....	367

## Public Health Practice and Policy

Commentary: Increasing the Connectivity Between Implementation Science and Public Health: Advancing Methodology, Evidence Integration, and Sustainability <i>David A. Chambers</i> .....	1
Building Capacity for Evidence-Based Public Health: Reconciling the Pulls of Practice and the Push of Research <i>Ross C. Brownson, Jonathan E. Fielding, and Lawrence W. Green</i> .....	27
The Sustainability of Evidence-Based Interventions and Practices in Public Health and Health Care <i>Rachel C. Shelton, Brittany Rhoades Cooper, and Shannon Wiltsey Stirman</i> .....	55
The Debate About Electronic Cigarettes: Harm Minimization or the Precautionary Principle <i>Lawrence W. Green, Jonathan E. Fielding, and Ross C. Brownson</i> .....	189
Harm Minimization and Tobacco Control: Reframing Societal Views of Nicotine Use to Rapidly Save Lives <i>David B. Abrams, Allison M. Glasser, Jennifer L. Pearson, Andrea C. Villanti, Lauren K. Collins, and Raymond S. Niaura</i> .....	193
E-Cigarettes: Use, Effects on Smoking, Risks, and Policy Implications <i>Stanton A. Glantz and David W. Bareham</i> .....	215
Neighborhood Interventions to Reduce Violence <i>Michelle C. Kondo, Elena Andreyeva, Eugenia C. South, John M. MacDonald, and Charles C. Branas</i> .....	253
Mobile Sensing in Environmental Health and Neighborhood Research <i>Basile Chaix</i> .....	367
Policy Approaches for Regulating Alcohol Marketing in a Global Context: A Public Health Perspective <i>Marissa B. Esser and David H. Jernigan</i> .....	385

Problems and Prospects: Public Health Regulation of Dietary Supplements <i>Colin W. Binns, Mi Kyung Lee, and Andy H. Lee</i> .....	403
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## Health Services

Achieving Mental Health and Substance Use Disorder Treatment Parity: A Quarter Century of Policy Making and Research <i>Emma Peterson and Susan Busch</i> .....	421
Data Resources for Conducting Health Services and Policy Research <i>Lynn A. Blewett, Kathleen Thiede Call, Joanna Turner, and Robert Hest</i> .....	437
Designing Difference in Difference Studies: Best Practices for Public Health Policy Research <i>Coady Wing, Kosali Simon, and Ricardo A. Bello-Gomez</i> .....	453
How Much Do We Spend? Creating Historical Estimates of Public Health Expenditures in the United States at the Federal, State, and Local Levels <i>Jonathon P. Leider, Beth Resnick, David Bishai, and F. Douglas Scutchfield</i> .....	471
Modeling Health Care Expenditures and Use <i>Partha Deb and Edward C. Norton</i> .....	489
Promoting Prevention Under the Affordable Care Act <i>Nadia Chait and Sherry Glied</i> .....	507
Treatment and Prevention of Opioid Use Disorder: Challenges and Opportunities <i>Dennis McCarty, Kelsey C. Priest, and P. Todd Korthuis</i> .....	525

## Indexes

Cumulative Index of Contributing Authors, Volumes 30–39 .....	543
Cumulative Index of Article Titles, Volumes 30–39 .....	549

## Errata

An online log of corrections to *Annual Review of Public Health* articles may be found at <http://www.annualreviews.org/errata/publhealth>