How Changes at the Local Health Department level are Associated with Improvements in Health Outcomes at the State Level

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ABSTRACT

Paul Campbell Erwin: How changes at the Local Health Department level are associated with improvements in health outcomes at the state level
(Under the direction of Sandra B. Greene)

The empirical evidence for guiding the resourcing of local public health departments (LHDs) and for what these agencies should be funded to do is limited primarily to cross-sectional studies of health department performance and effectiveness. There is relatively little published evidence showing an association between LHD activities or performance and health outcomes, and there is a lack of information from longitudinal studies on LHDs. The purpose of this study was to explore the association between changes in LHD resources and activities, and changes in health outcomes. A retrospective cohort design was used to analyze changes in LHD resources and changes in health outcomes at the state level. The National Association of County and City Health Officials (NACCHO) has collected data on LHD resources, such as expenditures and staffing, through multiple surveys. This study made use of a dataset which linked LHD responses in surveys conducted in 1997 and again in 2005. LHD data were aggregated to the state level, producing usable data for 42 states. Data for health outcomes were available through the *America's Health Rankings* reports for the same time period. Significant associations were found between overall LHD inputs and changes in state health rankings. In particular, increases in LHD expenditures were significantly associated with decreases in infectious disease morbidity at the state level ($p = 0.037$), and increases in full-time equivalent staff per capita were significantly associated with decreases in cardiovascular disease mortality ($p = 0.014$), when controlling for other factors. These

results add to the empirical evidence that local public health activity is associated with improved health outcomes. These findings can be used to advocate for LHD support and may have policy implications for developing evidence-based standards for a National Public Health Accreditation Program.

To my wife, Renee′ Hyatt, who has helped me understand Time, and to my parents, Claude Campbell Erwin, MD, last of the old country doctors, who taught that learning never ends, and Mildred Robertson Erwin, whose pride means most.

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LIST OF ABBREVIATIONS

AHR	*America's Health Rankings*
APEXPH	Assessment Protocol for Excellence in Public Health
APHA	American Public Health Association
ASTHO	Association of State and Territorial Health Officials
BRFSS	Behavioral Risk Factor Surveillance System
CAP	Committee on Administrative Practices
CDC	Centers for Disease Control and Prevention
EPHS	Essential Public Health Services
EPSDT	Early, Periodic, Screening, Diagnosis, and Treatment
FOPH	*Future of Public Health*
FTE	Full-Time Equivalent
HRSA	Health Resources and Services Administration
IOM	Institute of Medicine
IRB	Institutional Review Board
LHD	Local Health Department
LPHS	Local Public Health System
MAPP	Mobilizing for Action through Planning and Partnerships
MMWR	*Mortality and Morbidity Weekly Review*
NACCHO	National Association of County and City Health Officials
NALBOH	National Association of Local Boards of Health
NPHPSP	National Public Health Performance Standards Program
ODPM	Operational Definition Prototype Metrics

ABBREVIATIONS continued

PHF	Public Health Foundation
RWJ	Robert Wood Johnson Foundation
UNC	University of North Carolina
YPLL	Years of Potential Life Lost

CHAPTER I

INTRODUCTION

A. Statement of the Issue

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(p.7)] Since the Institute of Medicine's 1988 report on *The Future of Public Health* there have been numerous studies that describe and measure the performance of LHDs, the characteristics associated with performance, and whether and how such performance impacts health. Studies have most often described associations of performance with LHD size, jurisdictional size, and funding: LHDs with larger staffs, serving populations > 50,000 persons, and with higher funding per capita were more often higher performing.[2-13] Other notable characteristics of higher performing LHDs included greater community interaction, having a director with higher academic degrees, and leadership functioning within a management team.[4, 8, 10, 14] Only four published studies have specifically attempted to link LHD characteristics, activities, or performance to health outcomes.[8, 12, 15, 16] Almost all of these studies are limited by their cross-sectional design, making it difficult to determine cause and effect.

In the absence of a stronger empirical base regarding LHD performance and activities, public health leaders and policy makers are confronted with an existential

challenge: on what basis do we decide what LHDs should be doing, and what measuring tool do we use to determine whether LHDs have the requisite capacities and capabilities? The first question has policy implications that can inform, as *The Guide to Community Preventive Services* puts it, "the recommendations for interventions that promote health and prevent diseases in our nation's communities and healthcare systems" [17(p. ix)] For all the efforts of LHDs and other health system partners, the empirical evidence for what works is woefully inadequate, as documented by *The Guide*.

The second question (on the measuring tool) is germane to the current efforts to establish a National Voluntary Accreditation Program for state and local health agencies.[18] Ostensibly, the development of accreditation standards should follow from empirical studies that document the linkage between specific LHD characteristics, activities, and performance level, and the health of the community. A logic model for accreditation implies that an accredited LHD is more likely to (ultimately) achieve better outcomes than a non-accredited LHD, because the accredited LHD has the characteristics that the empirical evidence points out as being significant.[19] As with the empirical evidence on "what works", the evidence-base for public health accreditation standards also lacks robustness. The goal of this dissertation will be to strengthen the evidence-base for decision-making on LHD inputs and for the standards by which LHDs are measured by correlating longitudinal data on LHD inputs with health outcomes, based on two datasets described below.

Data on LHD characteristics such as jurisdictional size, governance, expenditures, and programmatic activities have been gathered by the National Association of County and City Health Officials (NACCHO) through four surveys – in 1989, 1992-93, 1996-97, and 2005. The first *National Profile of Local Health Departments* was produced in 1989 by

NACCHO's predecessor, the National Association of County Health Officials.[20] The survey was conceived in 1987 and meant to be a companion document to NACCHO's self-assessment model for LHDs – the Assessment Protocol for Excellence in Public Health (APEXPH). The intent of the survey was to document LHD capacities in a manner that would shape the development of APEXPH to make it more useful to LHDs. The 1989 survey gathered information on 2,269 of the 2,932 "local health entities" that NACCHO's predecessors were able to identify, producing a comprehensive picture of LHD characteristics and activities. The survey provided a better understanding of LHD functions, "the constraints within which they operate, and their fit within the framework of all services in the community…"[20(p.9)] Subsequent versions of the *National Profile of Local Health Departments* have continued to provide comprehensive descriptions of the infrastructure and practice of LHDs. Although questions have changed over time, and LHDs may not have responded to all (or even any) surveys, a core set of questions on LHD characteristics provides an opportunity to document changes in capacities and activities over time. Since 2000, several separate analyses have utilized the NACCHO profiles to link LHD characteristics to performance or outcomes.[8, 10, 21, 22]

During the same time that NACCHO has been producing the profiles of LHDs, the United Health Foundation (UHF) – in partnership with the American Public Health Association (APHA) and the Partnership for Prevention - has produced the *America's Health Rankings* (AHR) report.[23] The AHR reports, provided annually since 1990, utilize selected state-level health determinant and health outcome data, combine the data to provide a single score for each state, and then rank states according to these scores. The purpose of the AHR is to "is to stimulate action by individuals, communities, public health professionals, health

industry employees and public administration and health officials to improve the health of the population of the United States".[23(p.2)] Individual state rankings have changed over time, with states improving, remaining the same, or falling in the rankings according to changes in specific health indicators. By tracking these changes, it is hoped that states can learn from each other regarding best practices and can use such information to set realistic targets for improvements.[24](K. Davis)

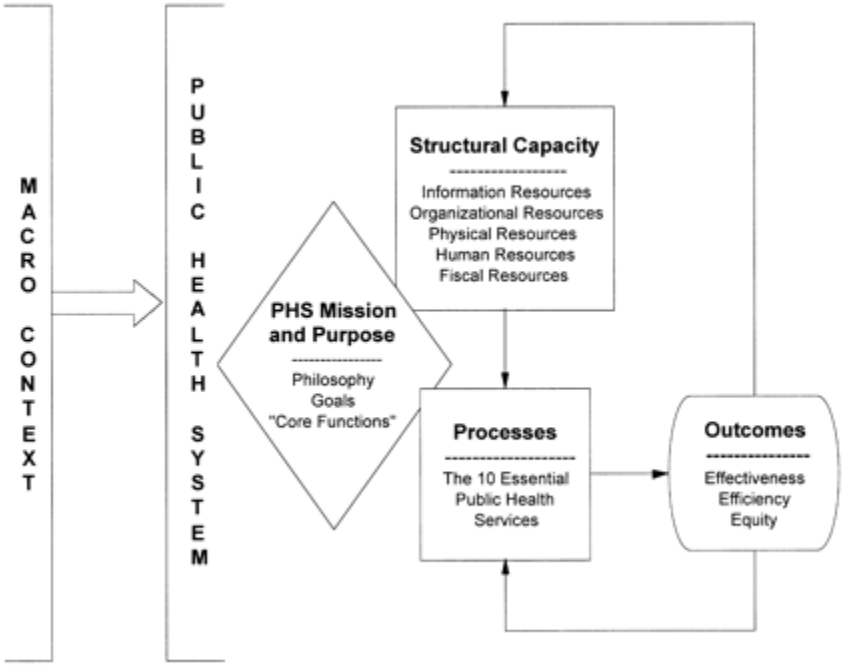
Rationale for the dissertation, and a Conceptual Model

A limitation of many of the studies regarding LHD performance and outcomes is that such studies have been cross-sectional, blurring the lines of cause and effect. Turnock and Handler pointed out succinctly that "Performance measurement in the public health system must be able to measure inputs, processes, outputs, and outcomes in ways that allow for *changes* (emphasis added) in one to be linked with another".[25(p.279)] The opportunity presents itself to examine such changes by linking changes in LHD characteristics and activities, as documented through multiple NACCHO surveys, to changes in state-level health outcomes as tracked through the annual AHR reports. By including this element of change over time for inputs, outputs, and outcomes I am aiming to bring clarity to the cause and effect relationships that previous studies have found problematic.

The conceptual model for this dissertation is from Handler *et al* [26], and is shown below in Figure 1.1. The LHD, as part of the Local Public Health System, functions within a larger macro-context, which includes social, political, and economic forces. The framework connects the LHD inputs as part of the "structural capacity" to "processes" (or outputs/services), and ultimately to "outcomes" through measures of effectiveness,

efficiency, and equity. Thus, this framework brings together the elements of the AHR reports and NACCHO *Profiles*.

Figure 1.1. *A conceptual framework for linking Local Health Department Inputs and Outputs to Outcomes. After Handler et al*[26]**.**



This conceptual model has roots in, or shows congruence with, older models that have been used to explore the factors influencing health and quality of care, most notably those of Andersen[27] and Donabedian.[28] In the late 1960's Andersen described a set of "predisposing characteristics" that influenced the use of health services, including demographic, social structure, and health belief factors. These and other factors make up Handler's "macro context". Donabedian's classic model of quality assessment includes structure, process, and outcome – the reinforcing loop in Handler's model for public health systems performance. In my use of this conceptual model, the macro-context includes the social determinants of health as described by Marmot *et al*, at a population and systems level:

socioeconomic status – including the social gradient and income distribution - education, employment, housing, opportunity, health care services, and social support networks.[29] All of these factors influence an individual's health status, whether directly – e.g., in having sufficient income to buy needed medicines, or indirectly – e.g., through chronic stress produced by the lack of control over one's life when in a lower social class. In addition, these same factors influence how systems function across households and communities[30] – especially true for public health systems which depend on linkages with the education system, employment and transportation systems, and the medical care system. Although not usually considered as a social determinant *per se*, geography becomes the canvas on which this macro-context is landscaped. This is especially true for the U.S., which has great geographical diversity, with many of the social determinants of health showing sharp geographical differences, whether by rural-urban designation or by major region of the U.S. (i.e., the South, the Midwest, the Northeast). The macro-context makes clear a simple truism: health does not happen in a vacuum, and thus LHDs cannot function in isolation or outside the influence of these larger forces of change.

A significant challenge in connecting LHD inputs and outputs to health outcomes is the great variability in LHD capacities and capabilities. NACCHO defines a LHD as "an administrative or service unit of local or state government concerned with health, and carrying some responsibility for the health of a jurisdiction smaller than the state".[31(p.3)] Applying such a definition identifies a range of 2 LHDs in Maine, Delaware, and New Hampshire, to 159 LHDs in Georgia and 324 LHDs in Massachusetts. LHDs vary in size from one employee to more than 1,000, with mean per capita LHD expenditures ranging from $41 for smaller LHDs to $74 for the largest LHDs.[31] 62% of all LHDs serve

jurisdictions of less than 50,000 population, although this accounts for only 10% of the U.S. population, while 54% of the U.S. population is covered by the 6% of LHDs that serve populations of more than 500,000.[31]

In the context of the conceptual model described above, the research question for this dissertation can be stated simply: ***are changes in LHD inputs associated with improvements in health outcomes at the state level?*** The approach of this dissertation will be to identify LHD characteristics – infrastructure and financing – that may account for changes in health outcomes. The policy–related component of the dissertation will explore the implications of such potentially identified characteristics for decision-making on what and how much LHDs are funded to do, for the development of empirically-derived standards for LHDs in a public health accreditation program, and for advancing the use of NACCHO and AHR datasets in public health systems and services research.

B. Background

Although the characteristics, activities, and performance of LHDs have been subjects of interest dating back to the early years of the previous century, the vast majority of published studies have usually focused on processes or outputs rather than health outcomes. From the use of the Appraisal Form beginning in 1920 all the way to the development of the National Public Health Performance Standards in 2000 and the Operational Definition of a Functional LHD in 2003, the difficulties in linking LHD inputs to health outcomes have remained large and too often insurmountable.[19, 25, 32] Yet what could be more desirable from a policy perspective and more useful for the public health practice community than to be able

to show that certain LHD inputs can lead to specific improvements in community health outcomes?

To date there are only four published studies which specifically attempt to link LHD characteristics, activities, or performance to health outcomes. In the first of such studies, Schenck *et al* found that higher performing LHDs were more likely to be associated with unfavorable health status and risks, while low performing LHDs were more likely associated with favorable health status and risks.[15] Kennedy reported on the initial pilot project of the National Public Health Performance Standards Program (NPHPSP), and found that higher performing local public health *systems* (associated with 47 LHDs) were correlated with higher all-cause, but lower premature, death rates.[8] In 2004 Honore′ *et al* reported on another NPHPSP pilot test involving 80 LHDs in one state, and linked performance data to state financial and health-related data and data from the U.S. Economic Census for Health Care and Social Assistance. High performing local public health systems were associated with higher age-adjusted mortality rates.[12] Finally, Kanarek *et al* merged LHD performance data with the 1996-97 NACCHO profile of LHDs, the Community Health Status Indicators database, and the Area Resource File from Health Resources and Services Administration.[16] Employing a principle component analysis, Kanarek determined that 13-57% of the explained variation in health status was attributable to LHD performance.

One unpublished study has examined the relationship between changes in LHD data derived from the multiple NACCHO surveys – specifically the financing of LHDs – and health outcomes (Mays and Smith, in press).[33] Using both a fixed-effects multivariate model and an instrumental variables model the authors found significant associations between

changes in local public health spending and infant mortality, and deaths due to cardiovascular disease, diabetes, and cancer.

C. Significance of the Issue

Addressing questions on how systems can be designed and operated to provide population-based services which are both effective and efficient is a fundamental focus of the emerging field of public health systems research.[34] There have been renewed efforts in the past several years to strengthen the evidence-base of public health services and systems through partnerships involving NACCHO, the Association of State and Territorial Health Officials (ASTHO), Centers for Disease Control and Prevention (CDC), APHA and the Robert Wood Johnson Foundation (RWJF). CDC and RWJ in particular have provided resources to support public health systems research and public health accreditation. Research on the linkage between LHD inputs and outputs to health outcomes can help to inform evidence-based practice and contribute to science-based recommendations for implementing community preventive services.

Such research may also provide stronger scientific rationale for the development of standards by the recently established National Public Health Accreditation Board, which will establish a national voluntary accreditation program for state and local health departments. Basing standards on empirical data which point to the linkage between specific LHD characteristics, activities, and performance – equating to inputs, outputs, and processes in the logic model – and health outcomes should increase the likelihood that an accredited LHD will have a higher impact on community health. The degree to which the LHD inputs to be

explored in this dissertation relate to the recently developed framework for defining LHD standards will be explored in more detail in the chapter on policy implications.

Finally, this dissertation has potential policy implications for the on-going work of NACCHO – in conducting subsequent Profiles – and for the AHR report: can these efforts contribute to the establishment of a LHD surveillance system (the NACCHO Profile) and a national system for tracking health outcomes and underlying social determinants (the AHR report) longitudinally? The relative lack of longitudinal data has been a barrier to previous efforts to link changes in inputs and performance to changes in outcomes. Showing that datasets from such systems have value in understanding these linkages may provide greater justification for supporting such work in the long-term.

While the primary research question for this dissertation is - *are changes in LHD characteristics associated with improvements in health outcomes at the state level?* – sub-questions to this primary question will include the following:

- Which characteristics of LHDs have the strongest associations with health outcomes, and to what degree are such characteristics amenable to local or state control?
- If associations can be established, what can we predict about possible future changes in outcomes given a certain level of inputs?
- What are the policy implications – for either local or state health departments – regarding the findings related to the above questions?
    - What are the policy implications related to structure, organization, and functions, and the public support for LHDs?

- What are the policy implications related to the development of a National Voluntary Accreditation Program?
- What are the policy implications for NACCHO and the UHF in maintaining longitudinal surveillance and tracking data?

In view of the fact that few studies have specifically attempted to link LHD inputs, activities, and performance to health outcomes, the literature review which follows will focus on the nearest proxy to health outcomes in the logic model – LHD performance. The approach will be to address the question, to what extent have LHD characteristics been associated with LHD performance? This literature review will include efforts to define or characterize *what* LHDs do (or should do, i.e., functions or activities), and the frameworks and methodologies for defining *how* LHDs should accomplish their work, and how *effective* LHDs are in carrying out their functions. *Effectiveness* will be described in terms of *performance* (process and outputs) and *outcomes*, the subsequent development of *performance standards*, and any evidence of impact on health outcomes.

CHAPTER II

LITERATURE REVIEW

Defining Local Health Department Functions and Measuring LHD Characteristics, Performance, and Outcomes

The literature on LHD functions and performance can perhaps best be reviewed by era: 1) before 1988, the date of the IOM's *The Future of Public Health*; and 2) after 1988, first with performance measurement tools and processes developed primarily by Miller *et al* at the University of North Carolina/Chapel Hill, and Turnock *et al* at the University of Illinois/Chicago; and then following the implementation of the National Public Health Performance Standards Program by CDC and partner organizations. The literature review will follow the outline described below.

A. LHD Functions and Performance, pre-1988

B. LHD Performance, after 1988:

1. The Measurement Frameworks

    a. The Ten Organizational Practices/10 Public Health Practices

    b. The Ten Essential Public Health Services and the National Public Health Performance Standards

2. The association of LHD characteristics with LHD performance

    a. Studies based on the 10 Organizational Practices

b. Studies based on the National Public Health Performance Standards Program

c. Summary

3. The association of LHD characteristics and/or LHD performance with health outcomes.

A. LHD Functions and Performance, pre-1988

Prior to the IOM's 1988 report, the efforts to define LHD functions and to measure performance were largely intertwined with characterizations about public health agency resources and services; however, the attempts to understand and define the linkages between health department resources and the public's health should not be undervalued in these early years. Although there were notable individual efforts to characterize health department activities prior to 1920 – including C.V. Chapin's study of state health departments in 1913-1915 – the first comprehensive approach to assessing health department practices began with the establishment of APHA's Committee on Municipal Public Health Practice in 1920.[32] Later re-named the Committee on Administrative Practices (CAP), the initial work of this committee sought to "forward the movement for the simplification and standardization of health department practice in our cities" through in-depth surveys completed by the directors of the 83 city health departments covering populations of at least 100,000.[35]

This initial survey of municipal health department activities laid the foundation of the CAP's work to more objectively quantify performance of health departments through its development of, first, the Appraisal Form, then beginning in 1929, the Evaluation Schedule. By the mid 1940's CAP discontinued use of the Appraisal Form, and promoted the use of

the Evaluation Schedule in producing Health Practice Indices.[36] This development culminated in the work of Haven Emerson, who led the Local Health Units subcommittee of CAP, through delineating *what* public health departments should do, and *how* they should be organized in order to maximize efficiency while providing public health access to every citizen.[32] Local Health units should provide six standard health activities: 1) vital statistics; 2) communicable disease control; 3) environmental sanitation; 4) public health laboratory services; 5) hygiene of maternity, infancy, and childhood; and, 6) health education.[37] Emerson found that such activities should be provided by local health units covering 50,000 persons – thus 1,127 such units, each with a full-time health officer, would be needed to reach every citizen in the country.[37] W. L. Halverson, as Chair of CAP, presented Emerson's work as "the post-war plan for public health".[38] Although Emerson's plan never materialized, the Emerson Report of 1945 was a landmark event in the development of local public health, and the "six functions" became the organizing framework for structuring or re-structuring LHD practice.

In an official statement of APHA in 1950, the six functions - which had already expanded to seven with the addition of controlling chronic disease - were re-framed as "services and responsibilities", with considerable attention to "methods" for attainment.[39] These seven services included recording and analysis of health data, health education and information, supervision and regulation, provision of direct environmental health services, administration of personal health services, operation of health facilities, and coordination of activities and resources. The statement goes on to describe the organization and staffing of LHDs as well as the responsibilities of state health departments.[39]

Following the demise of CAP in 1956, when APHA re-assigned its activities to a variety of committees, the attention to LHDs waned in the face of a greater focus on federal health policy, including the growing concerns on access to medical care.[32] During approximately the next two decades, LHDs became increasingly involved in providing a medical care safety net, and there was relatively little attention paid to examining other LHD functions, especially from a performance perspective. Hanlon described these years by noting how LHDs were "trapped" into providing direct personal health services to a limited segment of the population, to the extent that such involvement prevented the LHDs from considering broader issues that affected the entire population.[40]

Two initially unconnected sets of activities which began in the 1970's presaged much of the LHD performance-related work of the 1990's: the efforts of Arden Miller and colleagues at the University of North Carolina/Chapel Hill to re-ignite interest in and a focus on LHD functions, services, and activities; and, the establishment of the national *Model Standards for Community Preventive Health Services* in 1979.

Beginning with a 1974 survey of all local health officers in the U.S., Miller *et al* sought to describe the organizational structure, financing, staffing, and functions of the nation's LHDs.[41] From this initial and subsequent publications Miller *et al* described the varying organizational structures of LHDs and their relationships to state health departments; identified the statutory authorizations for the work of LHDs, and the actual services they provided[42]; and, defined the role of the LHD in providing personal health services and the relationships between LHDs and private providers of care[43-45]

The second of the two performance-foreshadowing initiatives of the 1970's was the development of the *Model Standards for Community Preventive Health Services*.[46] This

development began as a collaborative effort of CDC, APHA, the Association of State and Territorial Health Officials (ASTHO), and the predecessors to NACCHO (the National Association of County Health Officials and the U.S. Conference of City Health Officers), and resulted in a statutory requirement as the Health Programs Extension Act of 1977 (Public Law 95-83). The *Model Standards* covered 28 program areas organized in three broad groups: health care services, environmental services, and support services. For each program area, one or more goals and objectives were identified, for a total of 41 goals, 67 outcome objectives, and 221 process objectives. The actual quantification of the goals and objectives ("filling in the blanks") was meant to be the result of negotiations between state and local health departments, with such quantification appropriate to each community, given the resources available and the predominant health problems of its citizens.

The first published article on the use of the *Model Standards* appeared in 1982, which described the negotiation process and implementation methodology in four California counties.[47] The authors found that negotiation processes were strongly influenced by the attitudes of local health officials, including their receptivity to the use of standards, and by the frequency of contacts between state and local officials in the given program area. The availability of resources to address specific objectives was found to be the most important constraint on implementation. This initial study on model standards was particularly important for emphasizing the critical relationship between state and local health officials in setting priorities. Spain *et al*[48] would later confirm these initial findings on the use of the *Model Standards* by showing that program performance improved in LHDs which voluntarily chose to negotiate program objectives with the state, compared to LHDs which chose not to negotiate and instead set their own program objectives.

In the early 1980's, the efforts that produced the *Model Standards* and the work of Miller *et al* at UNC/Chapel Hill in focusing on LHD performance began to dovetail. The same committee (Preventive Standards Work Group) which was convened by the U.S. Secretary of Health, Education, and Welfare in 1977 and produced the *Model Standards* also identified a small group of "exemplar" health departments that could be studied closely and followed over time.[45] The initial study efforts on this group of 15 LHDs were aimed at their involvement in providing personal health services. Miller *et al* would continue to study, follow, and report on these 15 LHDs over the course of the next decade, and much of this work served as foundational for developing tools and processes to measure LHD performance.[49-51]

By 1986, a survey of a sample of LHDs nationwide found that only 9.2% were exclusively using *Model Standards*, while 33% used the standards in developing their own program performance standards.[52] Already the different organizational relationships between state and local health departments, with the resulting variance in financing and supervisory responsibilities, were being seen as a constraint to wider and more consistent implementation of the *Model Standards.* Schaefer surmised that without a stronger national-level policy framework, which could bring consensus to state and local agency responsibilities, it remained to be seen whether the *Model Standards* alone could create and sustain a "standards movement" that itself would define a common paradigm of public health.[53] Hardy observed that "the very diversity which both produces and characterizes the strengths and the weaknesses of our public health system is also the major determinant in a community's use or non-use of preventive health standards."[54(p.589)]

The diversity noted by Hardy, the varying organizational relationships and their effect on standards implementation identified by Schaefer, and Miller's description of an uneven public health infrastructure that was "understaffed, underfunded, and widely ignored"[41(p.938)] all became encompassed in a single phrase: public health is in disarray. This was the status of public health by the late 1980's as described by the Institute of Medicine in its report on *The Future of Public Health* in 1988.[1] Years of neglect of the public health infrastructure and the lack of focus on LHD functions – already cogently described by the mid-70's by Vaughn, Hanlon, and others – were reaping their just reward. Fragmentation of responsibilities, disjointed efforts, uncertainties in the knowledge base, and a constraint on the ability to respond to new challenges were all seen as part and parcel of this "disarray". Without a clear delineation of *what* health departments should be doing, it would be impossible to measure their performance or impact. Thus, a starting point for the IOM was to define the three core functions of public health as assessment, policy development, and assurance. The IOM made specific reference to the *Model Standards* in its recommendation that states should establish standards for local public health functions, and that they should hold localities accountable for these services. The specification of the three core functions, the specific recommendation regarding standards, and the numerous other recommendations the IOM provided were all critically important for advancing the work of public health, although the IOM did not provide a clear roadmap for how state and local agencies would get there.

On the heels of the IOM report another event took place that seemed much smaller in comparison, but was to serve as a major stimulus in the development of tools and processes to measure public health performance: the establishment of Objective 8.14 in *Healthy People 2000*, which called for 90% of the U.S. population to be served by a local health department

that *effectively* (emphasis added) carries out the core functions of public health.[55] While it was considered a victory just to have such an objective included in a nationally-focused health planning document, it raised for many the obvious questions: what is meant by "effectively", and how will this be measured? Attempts to answer this basic question would be the focus of numerous investigators for the next 10 years.

B. LHD Performance, after 1988:

1. The Measurement Frameworks

a. The Ten Organizational Practices/10 Public Health Practices

In 1989, CDC established a Steering Committee to Measure Public Health Capacity, and subsequently funded two groups of investigators to initiate a series of studies on measuring the effectiveness of public health practice: the Miller *et al* team at UNC/Chapel Hill, and Turnock *et al* at the University of Chicago-Illinois. Although these two teams were not alone in their attempts to measure public health practice effectiveness, they were chiefly involved in developing measurement frameworks and then applying such frameworks to actual LHD practice.

CDC's Steering Committee to Measure Public Health Capacity initially developed a set of 10 Organizational Practices, with direct connections to the three core functions in the *FOPH*, the *Model Standards for Community Preventive Health Services*, *Healthy People 2000* (which included Objective 8.14), and a new planning model from NACCHO, the *Assessment Protocol for Excellence in Public Health* (APEXPH). These 10 Organizational Practices are listed in Table 2.1.

Table 2.1. *Ten Organizational Practices*

Assessment Practices
1. Assess the health needs of the community
2. Investigate the occurrence of adverse health events and health hazards in the community
3. Analyze the determinants of identified health needs
Policy Development Practices
4. Advocate public health, build constituencies, and identify resources in the community
5. Set priorities among health needs
6. Develop plans and policies to address priority health needs
Assurance Practices
7. Manage resources and organizational structure
8. Implement programs
9. Evaluate programs and provide quality assurance
10. Inform and educate the public

Before describing the subsequent development of performance measures based on the 10 Organizational Practices, it is important to make further note of NACCHO's planning model, APEXPH.[56] Developed in 1990 as a partnership effort between NACCHO, CDC and others, APEXPH provided an organizational self-assessment as well as a community health assessment and planning model. The organizational self assessment required the LHD Director to establish a team, which would subsequently examine the LHD's authority and capacity (for conducting community assessments as well as for carrying out its mandated activities), then develop appropriate policies, including policies which would guide the management of administrative tasks.[57] APEXPH became a very popular and widely used tool by LHDs, with over half of LHDs using it by the mid-late 1990's.[25]

Throughout the 1990's, investigators used the 10 Organizational Practices (renamed as the 10 Public Health Practices) as a basis for developing performance measurement tools and applied these tools most often in the form of surveys to be completed by LHD Directors. The development process began with 10 performance measures – one for each of the 10

Public Health Practices – followed by a survey of 84 indicators, then 26 indicators, and finally a panel of 20 performance measures (see Appendix 1).

b. The Ten Essential Public Health Services and the National Public Health Performance Standards

Although, for the most part, public health leaders resonated with the IOM's three core functions and the 10 Public Health Practices, by the early to mid 1990's there was growing concern that these descriptions of public health were not effective means to communicate the purpose and activities of public health to the general population. With the addition of NACCHO's "10 Essential Elements" in 1994 – an effort to answer the question "What does it take to maintain a healthy community?" – the landscape became even more cluttered with definitions and jargon.[58] The activities surrounding the Clinton health care reform efforts in 1994 served as further impetus for public health leaders to develop a unified definition and description of public health, in part to better locate a role for public health in the reform plans. The Public Health Service convened a Public Health Functions Steering Committee, with a wide array of partner organizations, which resulted in another landmark statement, entitled *Public Health in America*.[59] This statement (Table 2.2) attempted to clearly define what public health is, what it does, and how it does it, through a set of 10 Essential Public Health Services (EPHS).

Table 2.2. ***Public Health in America***

Vision:

Healthy People in Healthy Communities

Mission:

Promote Physical and Mental Health and Prevent Disease, Injury, and Disability

What Does Public Health Do?

- Prevents epidemics and the spread of disease
- Protects against environmental hazards
- Prevents injuries
- Promotes and encourages healthy behaviors
- Responds to disasters and assists communities in recovery
- Assures the quality and accessibility of health services

How Do Health Departments Achieve The Mission Of Public Health?

(**Ten Essential Services**)

1. Monitor health status to identify community health problems
2. Diagnose and investigate health problems and health hazards in the community
3. Inform, educate, and empower people about health issues
4. Mobilize community partnerships to identify and solve health problems
5. Develop policies and plans that support individual and community health efforts
6. Enforce laws and regulations that protect health and ensure safety
7. Link people to needed personal health services and assure the provision of health care when otherwise unavailable
8. Assure a competent public health and personal health care workforce
9. Evaluate effectiveness, accessibility, and quality of personal and population-based health services
10. Research for new insights and innovative solutions to health problems

Over the next few years following their release, the 10 EPHS were used in numerous assessment frameworks, from a focus on maternal and child health, to professional capacity needs – including training and education – to a wider application on LHD *capacity* to provide essential services.[58] The use and uptake of the 10 EPHS framework advanced significantly

with the establishment of the National Public Health Performance Standards Program (NPHPSP) by CDC's Public Health Practice Program Office in 1997.[60] In developing the Standards Program, CDC was responding to the accumulating evidence from the field through studies led by Turnock and Miller that LHD performance could be measured, and to the growing movement for accountability and the use of evidence to drive public health practice. Joined by partners representing public health practice in the field – NACCHO, ASTHO, the National Association of Local Boards of Health (NALBOH), APHA, and the Public Health Foundation (PHF) – the efforts focused on building a set of performance standards for state and local health departments, and for governing entities such as Boards of Health, with such standards being based on the 10 EPHS. The overarching goal of "strengthening public health practice by effectively translating the Essential Services into practice" played out through specific goals of 1) improving quality and performance; 2) increasing accountability; and 3) increasing the science-base for public health practice.[58, 61]

Although the Standards Program clearly built upon the earlier use of the 10 Public Health Practices and related performance measurement tools, a significant shift took place with the change in focus from the LHD to what was termed the *Local Public Health System* (LPHS). The LPHS may be defined as all organizations, agencies, and individuals which collectively provide the essential services of public health in any given community. The LPHS thus goes beyond the governmental public health agency – which may be "necessary but not sufficient" to provide the 10 EPHS.[61] The larger focus on the LPHS was in response to the growing body of evidence that organizations other than the governmental public health agencies were contributing significantly to the total community public health effort, and that public health was more than just what the LHD did.[62]

CDC and partner organizations developed three performance measurement tools – one each for the state health department, the LHD, and the governing Boards of Health. The work which produced the tool for LHD use dovetailed with NACCHO's development of MAPP - Mobilizing for Action through Planning and Partnerships – a strategic planning approach to community health improvement.[63] The local tool for performance measurement became one of the four assessments within MAPP.

The performance measurement tool for LHDs – known as the Local Tool – describes a set of optimum model standards for each essential service, defines indicators for each essential service, then provides a comprehensive list of capacities, processes, or outcomes meant to serve as measures towards achieving the model standards. Validity and reliability of the Local Tool were determined through a set of studies by investigators at the University of Kentucky.[64, 65] The Local Tool is meant to be completed not just by the LHD Director, but by a group (perhaps convened by the LHD Director) that actually represents the broader LPHS. Following completion of the performance measurements, data are entered into a CDC-managed software program, and CDC returns an analysis which is meant to serve as a basis for prioritizing action. As of 2008, the Local Tool (version 1) had been used in 30 states, with 10 states reporting widespread use (> 2/3 of LHDs) and another 6 states showing moderate use (1/3-2/3 of LHDs). The Local Tool underwent an extensive revision (and downsizing) in 2007.[60]

2. The association of LHD characteristics with LHD performance:

A summary of the key separate investigations throughout the development of the 10 Organizational Practices/10 Public Health Practices, the 10 EPHS, and the NPHPSP

measurement frameworks is provided below. The focus will be on the results of these investigations as they relate to the association of LHD characteristics or inputs with LHD performance or effectiveness. Additional detail will be provided for those studies which used the NACCHO surveys as sources of data for exploring these associations.

a. Studies based on the10 Organizational Practices/10 Public Health Practices

Turnock *et al*[2] began with a survey instrument based on performance expectations for the 10 Organizational Practices (renamed as the 10 Public Health Practices); this was closely followed by studies which examined 84 indicators of performance [66, 67], then a screening survey of 26 indicators.[68-70]

The common results of these initial studies showed that smaller, multi-county health departments (serving less than 25,000) had lower performance scores compared to larger, city health departments (serving > 100,000 population)[2, 68]; LHDs functioning in a centralized administrative structure, i.e., with greater state oversight and control of LHD functions, had higher performance scores compared to LHDs functioning in a more decentralized relationship (although not controlled for jurisdiction size)[68]; and that overall, LHDs were achieving only approximately 50% of the maximum attainable performance score. Although the use of planning models resulted in improved performance capacity[70], these studies in general found that only approximately a third of the U.S. population was being served by a LHD effectively carrying out the core functions of public health.[2]

In 1995 Suen *et al* [3]reported on a post hoc analysis of NACCHO's 1992-93 profile of LHDs by measuring performance on eight core public health functions. Larger LHDs serving populations greater than 50,000 performed higher in every core function compared to LHDs

serving populations less than 50,000. Higher performance scores were also associated with higher LHD annual expenditures and LHDs in larger or more centralized administrative units (state and city-county) compared to LHDs in towns or townships. LHDs which used a health planning model – such as APEXPH – scored higher on each of the core functions compared to LHDs not using a model.

Handler and Turnock[4] merged data from their earlier study on the performance of 10 Public Health Practices with NACCHO's 1992-93 profile of LHDs[71], matching results for 264 LHDs which responded to both surveys. LHD "effectiveness" was defined as it had been in the earlier study – meeting 7 of 10 performance measures. Four variables were consistently and independently associated with effectiveness: effective LHDs were more likely to have a higher number of LHD staff, higher total LHD expenditures, private insurance comprising a significant source of LHD revenue, and a female head of the agency. Effective LHDs were also more likely in general to provide a broader array of direct preventive, treatment, and health education services. Jurisdiction size and type (county, city, multi-county) were not significant correlates of effectiveness.

In 1998, research teams directed separately by Turnock and Miller collaborated to produce a merged panel of 20 practice performance measures (see Appendix 1).[6] Six of these measures pertained to the assessment function, six pertained to policy development, and eight pertained to assurance. A random sample of 503 LHDs was surveyed and data were analyzed for the 298 LHDs which responded. Surveys were completed by LHD directors or their surrogates, who were asked to report whether each of the 20 measures was performed in their jurisdictions. "Effectively served" was defined by the LHD performing at least four of the six assessment measures, four of six policy development measures, and six of eight

assurance measures. The overall weighted mean score for all 20 measures was 56%, with only slight variation around that mean for the separate assessment, policy development, and assurance-related measures. Results showed that city and county LHDs serving jurisdictions larger than 50,000 were more effective in core function-related performance compared to other LHD types and LHDs serving smaller jurisdictions.

Subsequent studies using these 20 "Turnock/Miller" performance measures continued to confirm that in general larger LHDs performed at a higher level than smaller LHDs. Reporting on a survey that was sent to all LHDs nationwide, Suen found that performance scores increased with increasing size of the LHD jurisdiction, with the largest differences between LHDs serving less than 25,000 and those serving more than 25,000.[72] City/municipal LHDs had the lowest performance scores, with city/county, county, district, and regional LHDs all with approximately equal performance scores.

Mays *et al*[13]used the 20 Turnock/Miller performance measures to assess availability and perceived effectiveness of public health activities focusing on LHD jurisdictions serving populations greater than 100,000 people. Overall, in terms of availability, 64% of the 20 measures were performed in LHD jurisdictions. LHD directors rated the effectiveness of LHD performance at 35% of the maximum possible score, with ratings slightly higher for assessment and assurance-related measures than for policy development. Correlates of higher performance in availability of public health activities were noted for LHDs serving communities with larger populations, lower poverty rates, and higher per capita LHD expenditures. LHDs that functioned in a shared or mixed state-local relationship performed higher in availability of activities compared to large LHDs functioning in a centralized state-local relationship. Perceived effectiveness was positively correlated with lower community

poverty rates, jurisdictional populations with a lower proportion of non-whites, and the presence of a policymaking board of health.

Studies by Lovelace and by Freund and Liu explored other correlates of LHD performance, with results that both re-affirmed and extended the earlier findings of Miller *et al* and Turnock *et al*. In a survey of LHD directors in North Carolina, Lovelace found that the greater the degree of interactions with community partners, and the more productive the relationships were reported, the higher the LHD's performance.[73] The largest variance in performance was related to interactions with city/county government, boards of health, community members, citizens' groups, and hospitals. In a separate analysis of the same dataset, Lovelace[14] reported results on LHD management (top management teams, or TMTs) and the relationship of TMT makeup, discussions, and disagreements with performance. Overall, LHDs with TMTs performed better than LHDs without TMTs.

In a survey of LHDs in New Jersey, Freund and Liu[7] showed larger LHDs, with larger budgets and serving larger populations, had higher performance scores for assessment-related measures, but not for policy development or assurance-related measures. Adjusting for population size, higher performing LHDs had more staff per population served, higher budgets, and greater communications capacity than lower performing LHDs.

b. Studies based on the National Public Health Performance Standards Program

Scutchfield *et al* [10]were the first to report on a study linking data from the NPHPSP with the NACCHO Profile of LHDs (using the 1996-97 survey). Data from LHDs using field-test versions of the Local Tool of the NPHPSP in 3 states were matched with NACCHO Profile data, resulting in a merged data set on 152 LHDs. Results from multiple regression

analyses showed significant correlates of performance with total expenditures per LHD staff, having a LHD director with a master's or bachelor's degree, and having partnerships with universities. Having a LHD director with a public health degree was actually a negative correlate of performance.

Mays *et al* [11]conducted a similar analysis focusing on financial determinants of performance by merging data on LHDs which participated in various pilot stages of the NPHPSP in 1999-2001 with NACCHO's 1996-97 Profile of LHDs. County-level data were also obtained from the Area Resource File and the Consolidated Federal Funds Report for the year 2000. The pilot testing dataset included 315 LHDs across 7 states; the final merged dataset included observations on 285 LHDs. Results of multiple regression analyses showed significant predictors of public health performance for LHD per capita spending and federal spending; state per capita spending had the weakest association with performance. Further analysis of the same datasets by Mays *et al* [22]showed that the strongest predictor of performance was the size of the jurisdiction population. LHD per capita spending was the most consistent predictor of performance. Although no one single form of LHD organization was consistently associated with better performance for all services, LHDs with mixed or shared systems of state-local control often performed better than centralized or decentralized systems.

c. Summary of the literature review on the association of LHD characteristics with LHD performance

Several themes emerge from these studies, most notably relating LHD performance to size and organizational structure of the LHD, jurisdictional size, and LHD expenditures. In

general, LHDs serving smaller populations tended to perform at a lower level compared to LHDs serving larger populations. Although only 10% of the U.S. population is served by LHDs covering less than 50,000, this represents 62% of all LHD organizations.[31] Of note is that the Emerson Report of 1945, which became the blueprint for post World War Two public health in the U.S., called for LHDs to serve jurisdictions of not less than 50,000 persons.[25] Economies of scale and efficiencies of operation likely play into the higher performing, larger LHDs: for example, if even the smallest LHD requires a full-time, degreed registered nurse (RN), then a larger LHD may be able to function with an RN and lower level (thus less costly) staff such as nursing assistants and licensed practical nurses. Mays *et al* [22] showed that the *strongest* predictor of performance was the size of the jurisdiction population, while LHD per capita spending was the most *consistent* predictor of performance.

Suen's [3]finding of higher performance in LHDs that were both larger and centralized compared to LHDs in townships may be the best example of the difficulty in sorting performance by organizational structure: no studies examined organizational structure while at the same time controlling for both LHD and jurisdictional size. It is reasonable to surmise that LHDs serving very small jurisdictions (less than 25,000 persons) benefit from state-level resources such as staff expertise (e.g., in epidemiology), laboratory resources, and computer systems – all more expensive at a smaller scale. On the other hand, larger health departments (as noted by Mays[13]) may perform better with less direct, centralized control. The association of LHD performance with having a female head of the agency was explained in part by females being more likely than males to be full-time employees, and more likely to have a college degree (BSN). LHDs that performed better in communities with greater economic

means can be explained in part by associating higher performing LHDs in communities with higher taxes, if higher taxes translates to more funding for LHDs.

3. The association of LHD characteristics and/or LHD performance with health outcomes:

Schenck, Miller, and Richards provided the first report which attempted to link public health performance to community health status.[15] Schenck *et al* analyzed data from Miller's previous studies using the 84-indicator survey, but focused specifically on 34 LHDs serving jurisdictions with populations above 100,000. Higher performing LHDs were more likely to be associated with unfavorable health status and risks, while low performing LHDs were more likely to be associated with favorable health status and risks.

The first study reporting on the performance of LHDs using the local tool of the National Public Health Performance Standards Program (NPHPSP) was by Kennedy in a 2003 report on the initial pilot project in Texas.[8] The 47 LHDs which participated in the pilot project represented approximately 75% of the LHDs in Texas; results were reported for 37 LHDs. Performance measures were correlated with U.S. census data, community health status data from the Texas Department of Health, local agency budget and expenditures data, telephone interviews of 40 LHD directors, and a mailed survey of 550 LHD employees. Higher performing local public health *systems* (LPHSs) were correlated with larger jurisdictional populations, higher per capita income, higher educational levels, higher contribution of LHDs to system performance, and lower premature death rates, but with higher all-cause death rates. LHD contributions to overall system performance were in turn correlated with higher per capita income, higher number of employees per capita, the ability

to reward good employees, support of local elected officials, and leadership that was full-time and experienced.

In 2004 Honore´ *et al* [12]reported on a NPHPSP pilot test involving 80 LHDs in one state, and linked data to state financial and health-related data and the U.S. Economic Census for Health Care and Social Assistance. The 80 LHDs represented 70% of the LHDs in the state; data were analyzed for 50 LHDs which returned completed surveys. High performing LPHSs were positively correlated with higher taxes per capita, higher overall tax rates, having a greater percentage of total revenues from taxes, and with LHDs which were more likely to deficit-spend. Higher performing local public health systems on average served larger populations, and were also associated with higher age-adjusted mortality rates. There was no correlation between performance and LHD expenditures per capita, or between performance and hospitals per capita.

Kanarek *et al* [16]merged data from Turnock and Miller's 1998 study, with the 1996-97 NACCHO profile of LHDs, the Community Health Status Indicators database, and HRSA's Area Resource File. Principle component analysis identified four factors, with performance items related to 1) protecting the public's health; 2) evidence-based decision-making; 3) prioritizing community needs; and 4) tailoring programs to population needs. Of the explained variation in health status, 13-57% was contributed by LHD performance. Performance on items related to protecting the public's health was associated with breast cancer, motor vehicle accidents, and coronary heart disease; performance on items related to evidence-based decision-making was related to all mortality outcomes except for stroke and homicide; prioritizing community needs was associated with suicide and lung cancer; and, tailoring was associated with colon cancer.

As noted in chapter 1 of this dissertation, one unpublished study has examined the relationship between changes in LHD data derived from the multiple NACCHO surveys – specifically the financing of LHDs – and health outcomes (Mays and Smith, in press).[33] The authors' financial data went well beyond the NACCHO data on LHD expenditures, as they examined data from multiple sources, including the Area Resource File and the Consolidated Federal Funds Report. Measures of public health spending took into account state and federal expenditures that are not passed through LHDs. Analysis of data included both a random effects model as well as a fixed effects model, which considers variables that are correlated within the model (e.g., the correlation between high poverty communities and communities with low educational attainment). The authors also attempted to address the methodological complications that occur when spending is related to community characteristics which also effect health status, by using an instrumental variables model. Data analyzed across three NACCHO surveys showed that local public health spending changed very little between 1993-2005 – less than 1% per year – reaching $29.57 per capita in 2005. The authors note that the strongest associations between changes in public health spending and health outcomes were for infant mortality and cardiovascular disease, with the former falling by 6.9% and the latter by 3.8% with each 10% increase in spending. Diabetes and cancer mortality also fell, though more modestly, at 1.4% and 1.1%, respectively, for each 10% increase in public health spending.

Summary of the literature review on LHD performance and health outcomes

The published studies relating LHD performance to health outcomes were all cross-sectional in nature, which allows for two seemingly contradictory explanations to hold:

higher performing LHDs may result in improved community health status, and LHDs may be performing at a higher level in attempts to address the needs of lower health status-communities. As Schenck described, LHD performance may *appropriately* differ: in a healthy community a LHD may be judged as low-performing because there is less need for LHD services, while in a lower health status community, the LHD may be performing at a higher level in response to community need.[15] The inability to sort out cause and effect in these studies is a primary impetus for this dissertation project.

A chronological listing and summary of the studies reviewed above (post-1988) can be found in Appendix 2.

CHAPTER III

METHODOLOGY

Two datasets were examined to determine the extent to which changes in LHD inputs are associated with changes in health outcomes: the NACCHO Profile surveys, and *America's Health Rankings*. Independent variables (LHD inputs) were derived from the NACCHO Profiles, while the AHR served as the source for dependent variables (health outcomes). Before describing the analytical approaches used to answer the research questions, further detail on these two datasets is provided below.

A. Description of data sources and variables

The NACCHO Profiles of Local Health Departments

Including the 1989 *National Profile of Local Health Departments* (hereafter referred to as the Profiles), which was produced by NACCHO's predecessor, there have been four Profiles produced to-date: 1989, 1992-93, 1996-97, and 2005.[74] Beginning in 1989, NACCHO defined a LHD as "an administrative or service unit of local or state government, concerned with health, and carrying some responsibility for the health of a jurisdiction smaller than the state." [20(p.3)] All subsequent Profiles have used this same definition in order to identify LHDs to be included in the survey. The 1989 Profile depended on three sources of information in order to identify LHDs to be included in the survey - the U.S. Conference of Local Health Officers, the National Association of County Health Officials, and state health

agencies. The number of LHDs included in each of the surveys and the corresponding response rates are shown in table 3.1 below.

Table 3.1. *Response rates for National Profiles of Local Health Departments*

Profile Year	Number of LHDs surveyed	Number of LHDs returning completed surveys	Response rate
1989	2,932	2,269	77.4%
1992-93	2,888	2,079	72.0%
1996-97	2,832	2,492	88.0%
2005	2,864	2,300	80.3%

Response rates have varied by state and by size of the LHD jurisdiction, resulting in Profiles that have underrepresented LHDs serving populations < 25,000. Additional detail regarding response rates is given in table 3.2 below. Detailed information on the 1996-97 Profile is not available, as a report on the survey was never circulated in print form.

Table 3.2. *Characteristics of Respondents to the National Profile surveys*

Profile	Number of states with ≥ 80% response rate	Number of states with < 50% response rate	Approx. Number of LHDs serving < 25,000	Response rate of LHDs serving < 25,000	Approx. Number of LHDs serving > 100,000	Response rate of LHDs serving > 100,000
1989	30	5	1,337	71%	405	92%
1992-93	23	6	1,351	68%	460	80%
2005	39	2	1,174	73%	659	91%

Note: Data for 2005 response rates are estimated from tables and graphs available through NACCHO

Although the number of LHDs serving small jurisdictions is larger than the number serving large jurisdictions, the percent of the total U.S. population served is the opposite: e.g., in the 2005 Profile, 62% of LHDs served jurisdictions of < 50,000, but this covered only 10% of

the total U.S. population, compared to the 6% of LHDs that serve jurisdictions of > 500,000, which cover 54% of the total U.S. population.[31]

Although core questions on items such as expenditures, staffing, and organizational structure have remained consistent across all surveys, other questions have been added, deleted, or modified. In addition to the core questions which were sent to all LHDs, the 2005 Profile included three modules which were each sent to a sample of LHDs. The three modules asked additional questions on LHD performance, accreditation, workforce, activities, and policy-making. The 2005 survey also differed from the earlier versions in that it was Web-based, in contrast to the mail-out/mail-in paper survey of previous Profiles.[31] All Profile surveys were addressed to the LHD Director, and responses were provided through self-reporting. There was no attempt to validate the self-reported data.

Of the four NACCHO surveys, this dissertation focuses on the 1997 and 2005 Profiles. Data from the 1989 survey have not been linked to the later three surveys. The 1993 survey used population range categories rather than requesting LHDs to report actual jurisdictional population. Thus it was not possible to determine expenditures per capita from the 1993 survey data in a manner consistent with the 1997 and 2005 survey data. The linked datasets for this dissertation were provided through Dr. Glen Mays, University of Arkansas for Medical Sciences, through a modified data-use agreement with NACCHO.

Independent Variables

Specific LHD inputs which were included in both the 1997 and 2005 NACCHO surveys were the independent variables (see Table 3.3). Included in these independent variables were those variables that have been shown to be associated with LHD performance

or health outcomes in previous studies, as described in the literature review. Table 3.3 also indicates the computed variables, by which changes from 1997 to 2005 were measured.

Table 3.3. *Independent Variables*

NACCHO Survey Variables	**Variable type**
LHD expenditures	Continuous
LHD staff, in full-time equivalents (FTE)	Continuous
(Presence of a) Governing Board of Health	Nominal
Jurisdictional population	Continuous
Computed variables	
LHD expenditures per capita	Continuous
LHD FTEs per capita	Continuous
Percent of total state jurisdictional population covered by a LHD with a governing Board of Health	Continuous

LHD expenditures

LHDs reported actual total expenditures for the most recent fiscal year; 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.[31, 3331, 31] 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 vs. medical care services.[33]

LHD staff, in full-time equivalents (FTE)

LHDs reported the total number of FTEs employed by their agency.

Governing Board of Health

LHDs reported (YES or NO) on whether a governing Board of Health was in place for their agency.

Jurisdictional population

LHDs were asked to provide their best estimate for jurisdictional population based on the most recent U.S. census data. For the 2005 Profile jurisdictional population may have been downloaded from a Web-based ESRI system (available only at the time through the web-based survey) or entered manually by the LHDs. (Personal communication, Carolyn Leep, Director of Research and Evaluation, NACCHO, December 17, 2008.)

The *America's Health Rankings*

The AHR examines multiple health determinants and health outcomes; although there are a few changes year-to-year in the specific indicators, the total number of indicators has remained constant at around 18-20.[24] For the 2008 AHR report, there are 15 health determinants and 7 health outcomes. The health determinant indicators are grouped as: personal behaviors (3), community environment (6), public and health policies (3), and clinical care (3).

There are multiple sources of data for the indicators tracked in AHR, which will be described in greater detail below. Indicators are weighted, based on input from a panel of health experts. Determinants account for 75 percent of the results, and outcomes account for

25 percent. A summary score and final ranking is determined by a summation of the weighted scores for each indicator.

This dissertation will focus primarily on the values of the indicators (e.g., mortality rates), rather than the state scores. The only use of the weighting methodology will be to assess the overall change in rankings for each state. The indicators used in the 2008 edition of AHR, and the weighting factors are shown below in table 3.4.

Table 3.4. *America's Health Rankings indicators, 2008*

Indicator	**Weight**	**Initial Year of Tracking**
HEALTH DETERMINANTS		
Personal Behaviors		
Prevalence of Smoking	10.0	1990
Prevalence of Binge Drinking	5.0	1998
Prevalence of Obesity	5.0	1990
Community and Environment		
High School Graduation	5.0	1990
Violent Crime	5.0	1990
Occupational Fatalities	2.5	1990
Infectious Diseases	5.0	1990
Children in Poverty	5.0	1990
Air Pollution	5.0	2008
Public and Health Policies		
Lack of Health Insurance	5.0	1990
Public Health Funding	2.5	2002
Immunization Coverage	5.0	1996
Clinical Care		
Adequacy of Prenatal Care	5.0	1990
Primary Care Physicians	5.0	2005
Preventable Hospitalizations	5.0	2001
HEALTH OUTCOMES		
Poor Mental Health Days	2.5	2000
Poor Physical Health Days	2.5	2000
Geographic Disparity	5.0	2008
Infant Mortality	5.0	1990
Cardiovascular Deaths	2.5	1990
Cancer Deaths	2.5	1990
Premature Death	5.0	1990

Thirteen indicators have been tracked from the first AHR report (1990) to the present; however, because of changes in methodology, it is not possible to compare changes over time for high school graduation, occupational fatalities, and prenatal care. Three of the remaining 10 indicators - lack of health insurance, violent crime, and children in poverty - are considered to be more indicative of the macro context as seen in the conceptual model for this dissertation (figure 1.1, page 5), rather than being logically associated as outputs or outcomes of LHD services, activities, or performance. While these and other social determinants of health in AHR are therefore not included as dependent variables in subsequent analyses, they will be among the indicators included as control variables in the regression models (see page 48 below for additional narrative regarding the control variables).

Dependent Variables

Seven indicators will be the dependent variables (see Table 3.5 below). Data for each of these seven indicators are continuous. The data for each indicator, by state and by year, are provided through a data use agreement with the United Health Foundation, which produces the AHR.

Table 3.5. *Dependent variables*

Smoking Prevalence
Obesity Prevalence
Infectious Diseases
Infant Mortality
Cardiovascular Disease Deaths
Cancer Deaths
Premature Death (Years of Potential Life Lost)

A brief description of each of these seven indicators is provided below. (The basis for these descriptions is the *America's Health Rankings* reports for 2005 and 2006.)

Smoking Prevalence is a measure of the percent of the population over the age of 18 years that has smoked at least 100 cigarettes and currently smokes tobacco products regularly. The source of data is the Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is based on annual surveys, conducted by states under the auspices of CDC, which gather health behavior-related data on a random sample of the adult population (> 18 years) through telephone interviews.[75] Thus, the data are self-reported.

Obesity Prevalence is a measure of the percentage of the population estimated to be obese, defined as having a body mass index (BMI) of 30.0 or higher. The source of data used for BMI calculations is the BRFSS, using self-reported data on height and weight.

Infectious Diseases includes the occurrences of Acquired Immune Deficiency Syndrome (AIDS), tuberculosis, and hepatitis (all types), as representative of all infectious diseases, per 100,000 population. The source of data is the *Morbidity and Mortality Weekly Report* (MMWR) from the CDC, which is a compilation of each state's communicable and infectious diseases reports. Laws governing reportable diseases vary by state, but most disease reporting is provided through a combination of laboratory, hospital, provider, and LHD-based reporting systems. The specific infectious diseases which are included in this indicator are reported by all states.

Infant Mortality is a measure of the rate of infant deaths per 1,000 live births in a year. The source of the data is the U.S. National Center for Health Statistics, which compiles state vital statistics on infant mortality based on death certificates, and births based on birth certificates (through the National Vital Statistics System).[76] Both death and birth certificates require a physician signature, and are usually submitted to the state through the hospital where the death or birth was documented.

Cardiovascular Deaths is measured using a three-year average, age and race-adjusted death rate (per 100,000 population) due to heart disease, strokes, and other cardiovascular disease. The source of data is the CDC, based on data reported through the National Vital Statistics System of the National Center for Health Statistics.

Cancer Deaths is measured using a three-year average, age- and race-adjusted death rate (per 100,000 population) due to cancer. The source of the data is the CDC, based on data reported through the National Vital Statistics System of the National Center for Health Statistics.

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Years of Potential Life Lost measures the loss of productive life due to death before age 75 (YPLL-75). The source of the data is the CDC. The National Center for Health Statistics calculates YPLL-75 using the following eight age groups: under 1 year, 1-14 years, 15-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, and 65-74 years. The number of deaths for each age group is multiplied by the years of life lost, calculated as the difference between age 75 years and the midpoint of the age group. For the eight age groups the

midpoints are 0.5, 7.5, 19.5, 29.5, 39.5, 49.5, 59.5, and 69.5. Years of potential life lost is derived by summing years of life lost over all age groups.[77, 78] All-cause YPLL in 1998 totaled 19,201,229, with a range among the top ten specific causes from 1,983,771 (17.9%) for unintentional injuries (the cause of death with the highest YPLL) to 220,249 (2.0%) for liver disease.

Nomenclature and abbreviations which will be used throughout the results section are shown in Table 3.6 below.

Table 3.6. *Nomenclature for Independent and Dependent Variables*

LHD Inputs	**Abbreviation**
Governing Board of Health	BOH
Expenditures per capita [a]	ExpCap
FTEs per capita [a]	FTECap
Health Outcomes	
Smoking Prevalence	Smoking
Obesity Prevalence	Obesity
Infectious Disease Cases	ID
Infant Deaths	IMR
Cardiovascular Disease Deaths	CVD
Cancer Deaths	Cancer
Years of Potential Life Lost	YPLL

[a] based on reported LHD jurisdictional population

B. Data Management and Analysis

Independent Variables

The independent variables are: changes in expenditures per capita, changes in FTEs per capita, and changes in the percentage of the population covered by a LHD with a governing Board of Health. Methods for defining and calculating these independent variables are described below.

In order to correlate changes in LHD inputs with changes in state-level health outcomes, it was first necessary to aggregate the independent variables from the NACCHO dataset – representing individual LHDs – to state-level independent variables. Efforts were made to maintain a high degree of matching between LHDs which reported in both the 1997 and 2005 surveys in order to produce accurate estimates of change between the two surveys. The steps for aggregating LHD inputs were as follows:

1. From the original dataset, data were confined to LHDs which reported in both surveys.
2. The data were further limited to those LHDs which actually reported expenditure, FTE, and jurisdictional population data.
3. Expenditure, FTE, and jurisdictional populations were aggregated by state.
4. State level calculations were made for each survey year, 1997 and 2005, for:
    a. Expenditures per Capita (ExpCap) - total LHD expenditures for a given state divided by the total jurisdictional population represented by the LHDs in the final dataset. Expenditures for 1997 were adjusted to 2005 dollars.
    b. FTEs per Capita (FTECap) – total FTEs for a given state divided by the total jurisdictional population represented by the LHDs in the final dataset.

5. Changes in expenditures per capita and FTEs per capita between 1997 and 2005 for each state were determined by two methods:

    a. Relative (percent) change = $\frac{\text{(2005 figure – 1997 figure)}}{\text{1997 figure}} \times 100$

    b. Absolute change = 2005 figure – 1997 figure

6. Finally, in order to assess external validity vis-à-vis the state as a whole, the total jurisdictional population represented by the LHDs which reported was divided by the actual state population, using U.S. census data for 1997 and 2005.

For presence of a governing Board of Health (BOH):

1. Jurisdictional populations were aggregated to the state-level for LHDs which reported either YES or NO to having a governing BOH (= BOHYN), and separately for LHDs which reported YES to having a governing BOH (=BOHY).
2. The percentage of the reporting LHDs' total jurisdictional population covered by a LHD with a governing BOH was calculated by taking BOHY and dividing by BOHYN, expressed as a percentage, by state.
3. As in step 5 above with expenditure-related variables, changes between 1997 and 2005 were determined by calculating relative change and absolute change.

Dependent Variables

The dependent variables are: changes in smoking prevalence, obesity prevalence, infectious diseases morbidity, infant mortality, cardiovascular disease deaths, cancer deaths, and premature death (years of potential life lost). Data on health outcomes from AHR were available for each state for the entire 1990-2008 timeframe. Data were selected from the

AHR reports by most closely matching the source years of the data for both AHR reports and NACCHO surveys. Because data for each dependent variable are collected by different methods, the source year for the variables in AHR may differ by one or two years from the NACCHO surveys. For the 1997 NACCHO survey, LHDs reported most often on fiscal year 1996; this matched most closely with the source year for the data included in the 1998 AHR report. For the 2005 NACCHO survey, most LHDs reported on the 2004 fiscal year; this matched most closely with the source year for the data included in the 2008 AHR report. Thus the two years of data for determining changes in health outcomes came from the 1998 and 2008 AHR reports.

For each of the seven dependent variables (see Table 3.5), the changes between 1998 and 2008 reports were determined as described above for the independent variables:

a. Relative (percent) change = $\frac{\text{(2008 figure – 1998 figure)}}{\text{1998 figure}} \times 100$

b. Absolute change = 2008 figure – 1998 figure

Correlation of Changes in Dependent and Independent Variables

Relative change and absolute change for all dependent variables (between 1998 and 2008 AHR reports) and independent variables (between 1997 and 2005 NACCHO surveys) were calculated and assessed for normality. Data were fully described by assessing mean, median, inter-quartile range (IQR), plotting histograms, and using standard tests for normality. The association between the changes in specific dependent variables with the changes in independent variables was assessed at three different levels:

1. Creating dichotomous categories of (1) an increase or (2) a decrease in value over time, and determining the strength of association with chi-square testing. Fisher's

exact test was used when any of the four cells had an expected frequency of five or less.

2. Calculating pairwise correlations between each dependent and independent variable, using Spearman's rank correlation.
3. Multiple linear regression to examine the effect of multiple independent variables simultaneously. While changes in the dependent variables over time are the primary outcomes of interests, the *context* of change within each state – the factors that influence the manner and extent of possible change in outcomes – must also be considered. Thus, in addition to the independent and dependent variables as described above, five additional variables were included in the regression models to control for community characteristics that are known to be associated with health. Those variables include three indicators that are actually included in the AHR reports as determinants of health – high school graduation, health insurance, and poverty – as well as racial composition and percent of the population over age 65 years. The inclusion of these control variables again focuses attention on the importance of the macro context in influencing how public health systems may operate and perform. The age and race composition variables were included not only because they are among the most important characteristics that affect mortality, but also because of the age and race-related health disparities that exist between populations.

Data were analyzed using Stata version 10 (copyright 1984-2208, StataCorp, College Station, TX). Consultation on data analysis was provided primarily by Dr. Glen Mays and Dr. Tom Ricketts from the dissertation committee, and by Dr. Mary Evans, Assistant Professor of

Economics at the University of Tennessee. I carried out all aspects of the data analysis and I am solely responsible for the results as presented.

C. Data Use Agreements, Institutional Review Board, and Confidentiality Issues

The data use agreement through NACCHO was approved by the NACCHO Executive Director on April 7, 2008. The linked NACCHO datasets were provided by Dr. Glen Mays, University of Arkansas for Medical Sciences. The data use agreement for the AHR data was approved by the President of United Health Foundation on May 9, 2008. Institutional Review Board (IRB) approval for use of the NACCHO and AHR secondary data for purposes described in this dissertation was provided by the University of North Carolina/Chapel Hill on May 20, 2008, with a determination that this study did not entail human subjects research.

I am the only individual with access to both the office and the computer in the office where the data are stored. Both NACCHO and AHR data will be maintained on this personal computer, with back-up files copied to flash drives. Data will be shared with the dissertation committee members, and with Dr. Mary Evans, Assistant Professor of Economics at the University of Tennessee, who is assisting with data analysis on a companion project using the same datasets. For data presentation, no county identifiers (from the NACCHO data) will be used – this is a condition of the data-use agreement with NACCHO. State identifiers for the AHR data are already in the public domain. Both NACCHO and AHR data will be retained indefinitely.

CHAPTER IV

RESULTS

Results are presented in three sections below, as well as in Appendices 3-7. Section A includes the changes in independent variables between the 1997 and 2005 NACCHO surveys. Section B presents the changes in dependent variables between the 1998 and 2008 AHR reports. Section C provides three levels of association between the changes in independent and changes in dependent variables: chi-square for dichotomous categories for over-arching variables; correlation coefficients for all pairwise correlations; and linear regression to control for multiple independent variables simultaneously.

A. Calculation and description of changes in independent variables between the 1997 and 2005 NACCHO surveys

The initial steps in data analysis involved a sequential process of identifying LHDs that reported in both the 1997 and 2005 surveys, aggregating LHD data to the state level, and then calculating both relative change and absolute change over time. The original NACCHO dataset includes surveys from 2,492 LHDs in 1997 and 2,300 LHDs in 2005; 1,924 LHDs reported in both surveys. After removing LHDs which did not report expenditure data for both years, the dataset was reduced to 1,852 LHDs in 1997 and 1,856 LHDs in 2005.

A review of these data resulted in the exclusion of four states. Rhode Island was excluded because it has no LHDs. Hawaii and Alaska both had only one LHD report expenditures for 2005, and none to report expenditures for 1997; thus they were excluded from further analyses. Mississippi was also excluded because the state reported as county-level LHDs in 1997 and multi-county districts in 2005.

The next step for creating a final dataset involved aggregating the LHDs' jurisdictional populations by state and determining the representativeness of the state's actual total population. For subsequent data analysis, a determination was made to exclude states which had <40% of the state's actual total population represented, for either 1997 or 2005. This excluded an additional four states: Maine, New Hampshire, New Mexico, and South Dakota. Thus the final dataset for analysis included data from 1,843 LHDs in 1997 and 1,845 LHDs in 2005, covering 42 states. For the final LHD count, there was a 97% match for LHDs with usable data for both 1997 and 2005.

Table 4.1 summarizes the sequential paring down of LHDs to create the final dataset, while table 4.2 shows the aggregated jurisdictional population as a percent of actual state population, after the initial exclusion of Alaska, Hawaii, Mississippi, and Rhode Island.

Table 4.1. *Number of LHDs surveyed, completing surveys, and in the final dataset, by survey year*

Year	LHDs surveyed	LHDs completing surveys	LHDs completing surveys both years	LHDs with expenditure data	LHDs in the final dataset, after excluding 8 states
1997	2,832	2,492	1.924	1,852	1,843
2005	2,864	2,300	1,924	1,856	1,845

Table 4.2. *Aggregated LHD jurisdictional population (juris. pop.) as a percent of actual (US census) population, 1997 and 2005; excluding Alaska, Hawaii, Mississippi, and Rhode Island*

State	LHD Juris. pop. as % of actual pop., 1997	LHD Juris. pop. as % of actual pop., 2005	State	LHD Juris. pop. as % of actual pop., 1997	LHD Juris. pop. as % of actual pop., 2005
Alabama	71.6	74.4	Nebraska	46.6	55.9
Arizona	90.2	79.5	Nevada	75.9	88.4
Arkansas	63.1	96.0	New Hampshire	15.1	15.4
California	92.0	93.7	New Jersey	72.4	77.1
Colorado	73.0	78.6	New Mexico	20.4	53.1
Connecticut	60.8	67.4	New York	96.5	100.3
Delaware	94.6	100.9	North Carolina	91.5	97.0
Florida	87.0	99.6	North Dakota	83.6	84.6
Georgia	79.6	85.3	Ohio	73.7	73.5
Idaho	94.2	99.9	Oklahoma	89.0	96.6
Illinois	94.5	100.3	Oregon	95.9	97.9
Indiana	69.5	72.8	Pennsylvania	40.8	40.6
Iowa	76.6	83.2	South Carolina	79.6	91.0
Kansas	94.9	93.6	South Dakota	15.7	18.3
Kentucky	76.6	78.9	Tennessee	62.0	58.7
Louisiana	50.4	55.4	Texas	78.8	82.6
Maine	7.9	21.4	Utah	71.2	76.9
Maryland	82.9	86.5	Vermont	90.2	100.7
Massachusetts	47.2	55.0	Virginia	96.0	102.5
Michigan	89.5	97.6	Washington	92.1	94.9
Minnesota	93.7	97.8	West Virginia	86.7	81.1
Missouri	89.2	97.5	Wisconsin	96.5	97.9
Montana	65.3	69.1	Wyoming	51.4	55.1

As can be seen in table 4.2, several states had total LHD jurisdictional populations greater than the actual state population. Attempts were made to verify accuracy of these data with NACCHO – it is possible that population estimates through ESRI were different from U.S. Census estimates, and it is also possible that there was some degree of misreporting of jurisdictional populations in completing the NACCHO surveys. (Personal communication, Carolyn Leep, Director of Research and Evaluation, NACCHO, December 22, 2008.)

Table 4.3 compares expenditures, FTEs, and jurisdictional population for the LHDs in the 42-state final dataset with the complete datasets for the two surveys. LHDs in the matched 42-state dataset had somewhat higher expenditures, a larger number of FTEs, and larger jurisdictional populations compared to the complete set of LHDs reporting.

Table 4.3. *Expenditures, FTEs, and Jurisdictional Population of all LHDs reporting in 1997 and 2005 vs. 42-state dataset*

Dataset	No. LHDs	Expenditures ($'s) [a]		FTEs		Jurisdictional Population	
		Mean	Median	Mean	Median	Mean	Median
1997 Complete	2492	6,862,106	879,337	75.1	16	99,979	30,000
1997 Matched, 42 states	1843	7,305,015	1,068,550	81.6	21	115,312	34,000
2005 Complete	2300	6,395,336	1,002,108	60.2	15.4	131,310	34,453
2005 Matched, 42 states	1845	7,063,227	1,185,115	68.7	20	132,237	38,583

[a] Adjusted to 2005 dollars

Total aggregated data for the 42 states are summarized in Table 4.4., which shows that 78.4% of the US population was represented in the final 42-state dataset for 1997, while 82.9% of the US population was represented in 2005.

Table 4.4. *Total Aggregated Expenditure and FTE-related data*

Variables	Total Aggregated Data for 42 States [a]
Jurisdictional Population 1997	212,520,729
Jurisdictional Population 2005	243,977,746
% of total US Population 1997	78.4
% of total US Population 2005	82.9
Expenditures 1997	$13,463,142,020
Expenditures 2005	$13,031,653,734
FTEs 1997	147,902
FTEs 2005	123,826
LHDs 1997	1,843
LHDs 2005	1,845
Expenditures per Capita 1997 [b]	$63.35
Expenditures per Capita 2005 [b]	$53.41
FTEs per Capita 1997 (x10,000) [b]	6.96
FTEs per Capita 2005 (x10,000) [b]	5.07

[a] excluding AK, HI, RI, ME, MS, NH, NM, SD
[b] based on total jurisdictional populations

FTE per capita data are reported as FTEs per 10,000 jurisdictional population. Table 4.4 shows that total expenditures and FTEs aggregated across all states decreased between 1997 and 2005.

Table 4.5 shows that the state-level mean expenditures per capita and FTEs per capita fell between 1997 and 2005. Table 4.6 includes the overall relative change and absolute change in expenditures per capita and FTEs per capita between 1997 and 2005. These data are shown by state in Table 4.7. Detailed tables, which show expenditures per capita and FTEs per capita by year and state are included in Appendix 3. These relative and absolute change data have a non-normal distribution.

Table 4.5. *State-level Mean and Median Expenditures per Capita and FTEs per Capita (x10,000) for 1997 and 2005, for 42 States*

	LHD Inputs	
	ExpCap	FTECap (x10,000)
1997		
Mean	$44.13	6.12
Median	$34.24	5.73
SD	29.80	2.66
2005		
Mean	$42.17	5.12
Median	$34.30	4.66
SD	23.92	1.97

Table 4.6. *Descriptive statistics for State-level Relative and Absolute Changes in Expenditures per Capita and, FTEs per Capita (x10,000), between 1997 and 2005*

Variable	Mean	Median	SD [a]	Min.	Max.	IQR [b]
Expenditures per Capita						
Relative 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						
Relative Change (%)	-11.48	-16.47	26.66	-64.22	83.76	28.02
Absolute Change	- 1.00	-.80	2.01	-8.12	3.95	1.74

[a] SD: Standard Deviation
[b] IQR: Inter-quartile range

Table 4.7. *Changes in Expenditures per Capita (ExpCap) and FTEs per Capita (FTECap), between 1997 and 2005, by State*

	ExpCap		FTECap (x10,000)	
State	**Relative Change (%)**	**Absolute Change ($)**	**Relative Change (%)**	**Absolute Change**
Alabama	-37.94	-29.57	-44.77	-5.99
Arizona	-10.77	-2.49	-51.88	-1.65
Arkansas	-28.63	-9.80	-37.08	-2.91
California	-50.14	-84.87	-64.22	-8.12
Colorado	5.10	1.36	-17.45	-0.82
Connecticut	25.65	6.57	27.23	0.91
Delaware	-16.26	-3.39	-11.48	-0.51
Florida	-5.20	-2.09	-22.17	-1.58
Georgia	-2.48	-0.85	-13.37	-0.84
Idaho	-10.32	-4.10	-24.05	-1.67
Illinois	11.15	4.24	-12.49	-0.75
Indiana	2.36	0.43	5.95	0.20
Iowa	3.82	1.12	-6.19	-0.35
Kansas	-3.28	-0.94	-23.19	-1.34
Kentucky	-1.12	-0.63	-27.64	-2.96
Louisiana	-5.57	-2.48	-13.28	-0.61
Maryland	11.22	7.86	16.06	1.45
Massachusetts	31.95	11.61	-45.88	-4.15
Michigan	-5.59	-2.89	-13.81	-0.75
Minnesota	11.15	4.20	83.76	3.95
Missouri	-2.33	-0.80	-30.71	-1.78
Montana	47.17	23.39	8.34	0.70
Nebraska	30.52	8.03	25.40	0.85
Nevada	-2.80	-0.94	-19.04	-0.73
New Jersey	-10.52	-1.84	-16.56	-0.40
New York	71.33	59.79	5.16	0.33
North Carolina	-10.69	-7.32	-16.39	-1.94
North Dakota	59.35	15.08	35.32	1.67
Ohio	28.74	7.11	0.69	0.03
Oklahoma	11.39	2.51	-19.41	-0.97
Oregon	22.07	14.73	1.11	0.07
Pennsylvania	-57.28	-73.37	-17.35	-0.78
South Carolina	-37.22	-23.61	-31.77	-3.14
Tennessee	21.36	8.42	-13.25	-0.97
Texas	-7.60	-2.00	-26.91	-1.14
Utah	2.87	0.96	-22.00	-1.10
Vermont	14.48	1.94	15.72	0.36
Virginia	-14.81	-5.46	-31.62	-2.14
Washington	-0.53	-0.38	-11.55	-0.72
West Virginia	-25.69	-8.32	-32.40	-2.11
Wisconsin	-16.10	-5.39	-20.68	-0.83
Wyoming	59.20	11.87	31.79	1.37

As detailed in Appendix 3, expenditures per capita varied widely, from a low in 1997 of $13.40 in Vermont to a high of $169.30 in California, and in 2005 from a low of $15.60 in New Jersey to a high of $143.60 in New York. Of the 42 states included in the analysis, 23 experienced a decline in expenditures per capita between 1997 and 2000, with several states showing over a 10% (relative) decline. Nineteen states had an increase in expenditures per capita, with the majority of these states experiencing over a 10% (relative) increase. While the overall mean relative change for these 42 states was a positive 2.17%, the total sum of LHD expenditures per capita across all states was 15.8% lower in 2005 than in 1997.

FTEs per capita ranged from a low in 1997 of 2.31 (per 10,000 population) in Vermont to a high of 13.38 in Alabama, and in 2005 from a low of 1.53 in Arizona to a high of 10.46 in Maryland. Only 12 states experienced an increase in FTEs per capita between 1997 and 2005. Many states experienced a large decline in FTEs per capita, with 16 states experiencing over a 20% (relative) decline.

Changes in the presence of a governing BOH were problematic: several states which had a very low number (<5) of Boards of Health in 1997 increased or decreased by one or two in 2005, resulting in extreme values for relative change. Table 4.8 shows the descriptive statistics for absolute change in the percentage of the population covered by a LHD with a governing BOH. Table 4.9 shows the relative and absolute change by state. As with change values for LHD inputs, the absolute change values for the presence of a governing BOH had a non-normal distribution. Additional detail for determining these change values is provided in Appendix 4. Overall, 48.4% of LHDs in the 42-state dataset reported having a governing BOH in 1997, increasing to 56.8% in 2005.

Table 4.8. *Absolute change in the percentage of the population covered by a Local Health Department with a governing Board of Health, 1997 to 2005*

Variable	Mean	Median	SD	Min.	Max.	IQR
BOH	6.47	4.44	14.29	-27.50	41.10	18.72

Table 4.9. *Relative and Absolute Change in the percentage of the population covered by a Local Health Department with a governing Board of Health, 1997 to 2005, by State*

State	Relative change in % population with BOH, 1997-2005	Absolute change in % population with BOH, 1997-2005	State	Relative change in % population with BOH, 1997-2005	Absolute change in % population with BOH, 1997-2005
Alabama	-27.3	-13.4	Montana	30.7	22.2
Arizona	undefined	2.9	Nebraska	-64.6	-27.5
Arkansas	-80.0	-1.3	Nevada	0.0	0.0
California	718.7	7.9	New Jersey	0.1	0.0
Colorado	30.1	21.6	New York	52.7	7.9
Connecticut	-35.7	-15.2	North Carolina	50.1	26.2
Delaware	0.0	0.0	North Dakota	9.1	5.8
Florida	undefined	0.1	Ohio	14.7	11.7
Georgia	16.8	11.5	Oklahoma	98.0	26.3
Idaho	53.3	26.2	Oregon	100.0	29.0
Illinois	-5.8	-3.8	Pennsylvania	72.2	11.2
Indiana	36.7	18.7	South Carolina	-100.0	-7.8
Iowa	-5.9	-4.6	Tennessee	26.6	5.6
Kansas	29.5	19.5	Texas	62.5	2.8
Kentucky	3.1	2.2	Utah	99.9	13.9
Louisiana	-100.0	-25.5	Vermont	0.0	0.0
Maryland	10.8	4.6	Virginia	0.0	0.0
Massachusetts	-3.3	-2.0	Washington	36.3	22.6
Michigan	-15.9	-4.2	West Virginia	5.0	4.2
Minnesota	71.6	41.1	Wisconsin	24.9	9.7
Missouri	0.7	0.2	Wyoming	40.4	21.7

Note: undefined: states which had no LHDs reporting with a governing BOH in 1997

Local Health Department Services

While it would have been preferable to include an analysis of changes in LHD outputs (i.e., services), this was not possible due to the wording differences in the 1997 and 2005 surveys with respect to determining service provision. Although no further analysis of changes in LHD services was done, it was still useful to examine the data that are available. For this purpose, data from the 1993 NACCHO survey were also included, because the wording of the question regarding LHD service provision is a very close match to the 2005 survey. The data in Table 4.10 are for all LHDs reporting from the group of 42 states for which data on expenditures and FTEs have been described above. Given 1993 and 2005 data, it appears that 1997 data are likely overstated – as would be expected by the wording of the survey question – as there is no reasonable explanation for why most services would have increased between 1993 and 1997, but then decreased between 1997 and 2005. The general trend which these data highlight is that overall LHD outputs as measured by these specific services have decreased. Two notable exceptions to this trend include epidemiologic investigations, which has steadily increased, and tobacco use prevention services, which appears to have increased, based on 1993 and 2005 data.

Table 4.10. *Percentage of all LHDs providing specific Services, 1993, 1997 and 2005, for 42 States* [a]

LHD Service	% LHDs providing, 1993	% LHDs providing, 1997	% LHDs providing, 2005
Child immunization	96.0	96.1	90.1
HIV screening	67.1	74.5	63.5
HIV treatment	29.6	31.2	26.4
STD screening	69.4	75.5	65.0
STD treatment	63.6	68.1	61.9
TB screening	85.1	93.4	85.3
TB treatment	85.1	81.4	75.3
Cancer screening	51.9	72.1	47.5
Cardiovascular disease	56.5	59.3	37.6
Diabetes	58.9	68.3	51.2
High blood pressure	84.5	89.9	72.5
Family planning	66.5	70.6	58.2
Prenatal care	62.5	62.2	41.4
Obstetrics	30.2	35.0	16.0
WIC	77.4	80.6	67.2
EPSDT	71.0	77.5	46.2
Oral Health	42.0	50.5	31.4
Primary care	31.8	24.5	14.3
Home health	52.8	48.3	28.7
Tobacco use prevention	46.5	74.3	69.5
Injury prevention	38.0	56.9	40.3
School based clinics	25.1	38.4	25.1
Epidemiological investigation	89.5	91.6	94.5
Swimming Pools Regulation	71.9	62.4	69.8
Food and Milk Regulation	55.3	71.4	31.6
Food Services Regulation	80.7	83.9	78.8
Public Water Regulation	43.7	52.2	31.5
Private Water Regulation	67.8	72.0	59.6

[a] excluding AK, HI, RI, ME, MS, NH, NM, SD

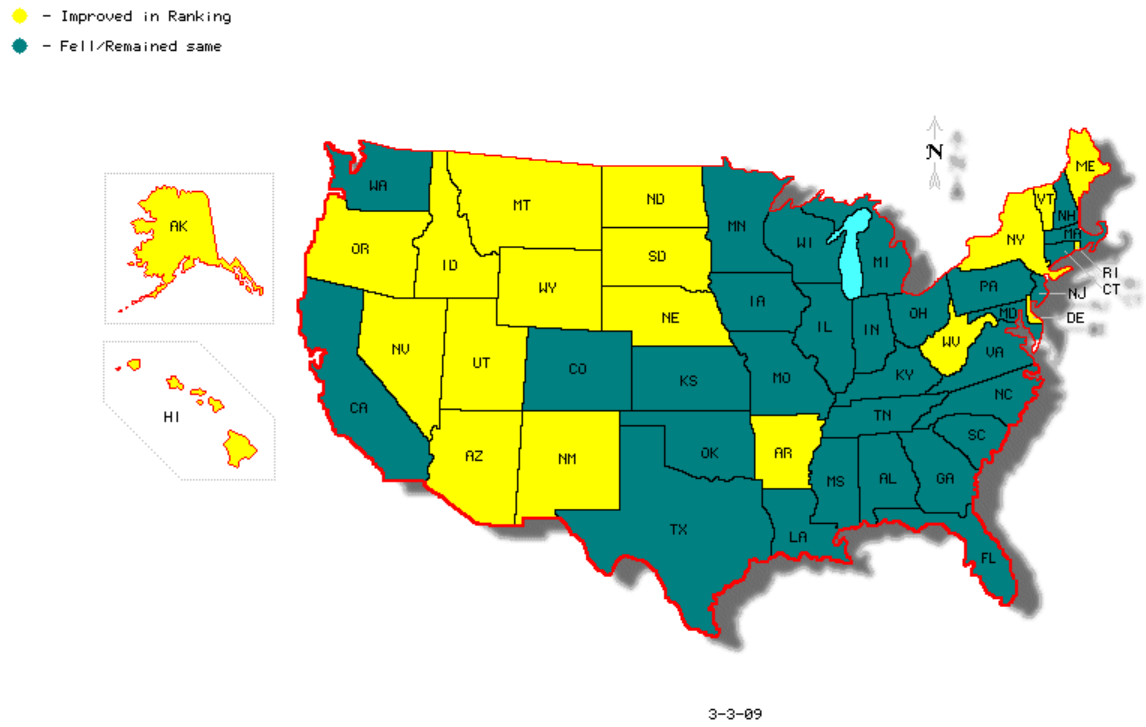
B. Calculation and description of changes in dependent variables between the 1998 and 2008 AHR reports

The broadest measure of health outcome change between the 1998 and 2008 AHR reports is the change in ranking for each state. Table 4.11 shows the 1998 and 2008 rankings by state for the 42 states in the final dataset. Figure 4.1 displays the changes in health rankings for all 50 states. Mapping these data clearly shows that, overall, the Mountain West, Southwest, and portions of New England states improved in rankings, while states in other regions – notably the South and Midwest – either fell in rankings or remained the same.

Table 4.11. *State Rankings in America's Health Rankings, 1998 and 2008, for 42 states.*

State	Rank 1998	Rank 2008
Alabama	39	40
Arizona	40	33
Arkansas	48	43
California	22	24
Colorado	4	19
Connecticut	5	7
Delaware	43	35
Florida	38	45
Georgia	33	41
Idaho	28	8
Illinois	27	31
Indiana	24	34
Iowa	10	15
Kansas	12	22
Kentucky	37	37
Louisiana	50	50
Maryland	26	26
Massachusetts	6	6
Michigan	19	27
Minnesota	1	4
Missouri	31	38
Montana	30	23
Nebraska	15	13
Nevada	47	42
New Jersey	16	18
New York	36	25
North Carolina	29	36
North Dakota	17	12
Ohio	20	32
Oklahoma	42	43
Oregon	25	16
Pennsylvania	11	27
South Carolina	44	48
Tennessee	45	47
Texas	32	46
Utah	8	5
Vermont	21	1
Virginia	12	20
Washington	7	10
West Virginia	41	39
Wisconsin	3	17
Wyoming	35	14

Figure 4. 1 *Changes in State Health Ranking, America's Health Ranking reports, 1998 to 2008*



Legend: Lighter shade: States which improved in ranking, 1998 to 2008

Darker shade: States which fell or remained the same in ranking

The changes in the dependent variables between the 1998 and 2008 AHR reports are shown in Table 4.12. The majority of these change values had a non-normal distribution. Detailed changes for each dependent variable by state are shown in Appendix 5. Data are for the 42 states which were included in subsequent data analyses.

Table 4.12. *Changes in Dependent Variables from America's Health Rankings reports, 1998 to 2008, 42 states*

Dependent Variable	Mean	Median	SD	Min. [a]	Max. [b]	IQR
Relative 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	13.17
Cardiovascular 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	2.2
Obesity Prevalence	9.50	9.45	2.11	6.00	14.30	2.5
Infectious Diseases	-24.96	-21.02	16.60	-67.05	-4.79	26.3
Infant Mortality	-.68	-.80	.83	-2.6	1.5	1
Cardiovascular Deaths	-62.83	-62.30	14.59	-100.7	-17.9	12.8
Cancer Deaths	-14.83	-14.26	7.67	-29.09	3.91	10.29
Years of Potential Life Lost	-385.8	-370.95	684.85	-2462.7	1160.4	806.7

[a] for negative numbers, greatest decrease, 1998-2008
[b] greatest increase

Overall, rates for all dependent variables declined between 1998 and 2008, with one exception: obesity prevalence increased. As detailed in Appendix 5, all 42 states showed declines in infectious diseases and cardiovascular disease mortality, with all but one 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. Thus, in summary, the changes in these seven health behaviors and outcomes between the 1998 and 2008 AHR reports show general improvements across the majority of states, excepting obesity prevalence.

C. Association of changes in independent variables with changes in dependent variables

1. Dichotomous categories, with 2 x 2 cell arrangement.

State-level results for changes in expenditures per capita, FTEs per capita, and presence of a Board of Health were placed in dichotomous categories showing either an increase or decrease between the 1997 and 2005 NACCHO surveys. As a marker of overall change in state-level health outcomes, states were placed in dichotomous categories of better vs. worse in the overall change in state rankings between the 1998 and 2008 AHR reports.

Table 4.13 shows the 4-cell distribution of dichotomous categories. Table 4.14 shows the results of the 2 x 2 table analyses of changes in expenditures per capita, FTEs per capita, and presence of a Board of Health with changes in overall state health rankings..

Table 4.13. *Four-cell designation, changes in LHD inputs vs. changes in overall state rankings*

	Changes in LHD Inputs	
	Decrease	**Increase**
Worse/No Change	**A**	**B**
Changes in State Rankings		
Better	**C**	**D**

Table 4.14. *Four-cell distribution of 42 states, associating Better/Worse ranking change (1998-2008) vs. Increase or Decrease in LHD inputs (1997-2005)*

	Cell Designation					
LHD input	**A**	**B**	**C**	**D**	**Chi-square**	***P* value**
ExpCap	17	11	6	8	1.20	0.273
FTECap	23	5	7	7	**4.72**	**0.037**
BOH	9	19	5	9	0.0536	0.541

Changes in FTEs per capita were statistically significantly associated (at $p < 0.05$) with changes in overall state health rankings ($\chi^2=4.72$, $p=0.037$).

Additional comparisons were made between the group of 7 states which are in cell D of table 4.14 (increase in FTEs per capita and improvement in state health ranking) with the group of 23 states which comprise cell A (decrease in FTEs per capita and worse state health rankings). The purpose of this comparison was to be able to identify specific states in each cell; to explore changes in the seven dependent variables which may have accounted for the changes in overall state ranking, and to determine any other distinguishing characteristics of these two groups of states which may provide insight into the changes these states experienced. The states which comprise these two groups are listed in Table 4.15.

Table 4.15. *States comprising cells A and D from Table 4.12*

Cell A: Decrease in FTECap, Worse State Health Rankings		**Cell D: Increase in FTECap, Improvement in State Health Rankings**
Alabama	Missouri	Montana
Arkansas	New Jersey	Nebraska
California	North Carolina	New York
Colorado	Oklahoma	North Dakota
Florida	Pennsylvania	Oregon
Georgia	Tennessee	Vermont
Illinois	Texas	Wyoming
Iowa	Virginia	
Kansas	Washington	
Kentucky	West Virginia	
Massachusetts	Wisconsin	
Michigan		

Tables 4.16 and 4.17 highlight that these two groups are indeed different with respect to certain inputs and outcomes, as would be expected by the 2x2 cell distribution in Table 4.14. Mean changes in inputs and outcomes were computed for independent and dependent variables for each of the two groups and compared using Student's t-test. In addition to the expected differences in FTEs per capita, Table 4.17 shows that there were significant differences in changes in expenditures per capita (t = - 5.71, p <.0001), infectious disease cases (ID) (t = 2.48, p = .0195), and deaths from cardiovascular disease (CVD)(t = 2.18, p = .0380). There were no statistically significant differences between these two groups of states for mean changes in smoking prevalence, obesity prevalence, infant mortality, cancer deaths, or YPLL. While changes in expenditures per capita were not significantly associated with changes in overall state health rankings (Table 4.14), all seven of the states in cell D of table 4.14 experienced an increase in expenditures per capita.

Table 4.16. *Comparison of changes in inputs between states in Cell A vs. states in Cell D, from Table 4.14*

	Group of 23 states (Cell A)		Group of 7 states (Cell D)	
LHD Inputs	**Increase**	**Decrease**	**Increase**	**Decrease**
BOH	15	8	5	2
ExpCap	6	17	7	0
FTECap	0	23	7	0

Table 4.17. *Comparison of two group means for changes in LHD inputs and Health Outcomes*

LHD Inputs	**Mean percent change for group of 23 states (cell A)**	**Mean percent change for group of 7 states (cell D)**	**Student's *t***	**2-tailed p**
ExpCap	-8.5	43.4	-5.71	<0.001
FTECap	-24.6	17.6	-7.19	<0.001
Health Outcomes				
ID	-55.06	-72.79	2.68	0.0122
CVD	-16.55	-22.36	3.67	0.0010

2. Pairwise Correlations of Independent and Dependent Variables

Pairwise correlations were calculated for each independent and dependent variable. Calculations were performed separately for relative change, then by absolute change in independent and dependent variables. Results are shown in Tables 4.18 and 4.19. Statistically significant results (p <.05) are shown in bold type; borderline significance (p <.10) is shown in regular type; and results which failed to reach statistical significance otherwise are designated NS. Exact correlation coefficients and significance values are shown for all correlations in Appendix 6. As can be seen in Table 4.18 (using relative change), there were statistically significant inverse relationships between changes in expenditures per capita and infectious diseases (r = -.3407, p = .0272) and cardiovascular disease deaths (r = - .3723, p = .0152); and, between FTEs per capita and cardiovascular disease deaths (r = -.3689, p = .0162). Table 4.19 presents the results using absolute change, with a significant inverse correlation between FTEs per capita and cardiovascular disease deaths (r = -.3482, p = .0238). For the majority of these correlations, the results were consistent in direction and significance between using relative change and absolute change.

Pairwise correlations were also calculated to assess the association between changes in the presence of a governing Board of Health and changes in LHD inputs, and separately with changes in health outcomes, using absolute change only. There were no statistically significant findings at p <.05.

Table 4.18. *Correlations of changes in LHD Inputs (1997-2005) with changes in Health Outcomes (1998-2008), using relative change*

	LHD Inputs	
Health Outcomes	ExpCap	FTECap
Smoking	NS	NS
Obesity	NS	NS
ID	**r = – 0.3407**	NS
	***p* = 0.0272**	
IMR	NS	r = – 0.2735
		p = 0.0797
CVD	**r = – 0.3723**	**r = – 0.3689**
	***p* = 0.0152**	***p* = 0.0162**
Cancer	NS	NS
YPLL	NS	NS

All correlations Spearman rank

Table 4.19. *Correlations of changes in LHD Inputs (1997-2005) with changes in Health Outcomes (1998-2008), using absolute change*

	LHD Inputs	
Health Outcomes	ExpCap	FTECap
Smoking	NS	NS
Obesity	NS	NS
ID	NS	NS
IMR	NS	NS
CVD	NS	**r = – 0.3482**
		***p* = 0.0238**
Cancer	NS	NS
YPLL	NS	NS

All correlations Spearman rank

3. Multiple linear regression

For each health outcome, regression equations were computed with both input measures (ExpCap and FTECap). Regressions were computed using relative change as well as absolute change values. Variables included in the regression models included high school graduation (%), health insurance (% with health insurance), poverty (% below Federal poverty line), racial composition (% of population nonwhite) and age structure (percent of the population over age 65 years). Data for these control variables were all for 1996 only, the primary source year of data for variables in the 1997 NACCHO Profile and the 1998 AHR report.

Statistically significant (p <.05) results are shown in Tables 4.20 and 4.21. Detailed results for all regression equations are provided in Appendix 7. Using relative change values, an increase in expenditures per capita was statistically significantly associated with a decrease in infectious diseases (t = -2.17, p = 0.037). 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 cardiovascular disease mortality (t = -2.59, p=0.014). For each 10 percentage point increase in FTEs per capita, cardiovascular disease mortality declined by 0.65 percentage points.

Based on these regression models, in states which showed 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. This is a 7.0% reduction in infectious diseases in these states attributable to the increase in LHD spending. For the states which showed an increase in FTEs per capita, staffing increased an average of 21.4%, which would have resulted in a decrease in cardiovascular disease mortality by 1.39 percentage

points. This is a 6.6% reduction in cardiovascular disease mortality in these states attributable to the increase in LHD staffing.

Although several of the variables – both independent and dependent – had a non-normal distribution, regression diagnostics showed that the residuals (error terms) for these significant model estimates were normally distributed. Tests to detect multicollinearity across all independent variables – including between expenditures per capita and FTEs per capita – did not reveal any significant findings. There were no statistically significant findings for regressions using absolute change values.

Table 4.20. *Multiple linear regression results for changes in Infectious Diseases with changes in Expenditures per capita*

Variable	Coefficient	Std. Err.	t	*p*	95% Conf. Interval	
Expenditures per capita	-0.18226	0.08384	-2.17	0.037	-0.3524	-0.01206
Percent below poverty	0.50311	1.04527	0.48	0.633	-1.6189	2.62513
Percent High School graduation	-0.19455	0.35776	-0.54	0.590	-0.9208	0.53174
Percent with Health Insurance	-1.78781	0.86184	-2.07	0.045	-3.5374	-0.03818
Percent population nonwhite	1.02721	0.33689	3.05	0.004	0.3433	1.711123
Percent 65+ years old	1.98099	1.29705	1.53	0.136	-0.6521	4.614139
_cons	-64.7542	38.90601	-1.66	0.105	-143.74	14.2292

Adjusted $R^2 = 0.3873$, $F(6,35) = 5.32$, $p = 0.0005$

Table 4.21. *Multiple linear regression results for changes in Cardiovascular Disease deaths with changes in FTEs per capita*

Variable	Coefficient	Std. Err.	t	*p*	95% Conf. Interval	
FTEs per capita	-0.06504	0.02515	-2.59	0.014	-0.1161	-0.01398
Percent below poverty	0.23334	0.27323	0.85	0.399	-0.32134	0.788029
Percent High School graduation	-0.10356	0.09573	-1.08	0.287	-0.2979	0.090787
Percent with Health Insurance	-0.32472	0.23022	-1.41	0.167	-0.79209	0.142652
Percent population nonwhite	0.15676	0.08747	1.79	0.082	-0.02082	0.334347
Percent 65+ years old	-0.28767	0.33950	-0.85	0.403	-0.97689	0.401557
_cons	-7.84291	10.23874	-0.77	0.449	-28.6287	12.94283

Adjusted $R^2 = 0.3612$, $F(6,35) = 4.86$, $p = 0.0010$

CHAPTER V

DISCUSSION

The primary research question in this dissertation is whether (and how) changes in LHD characteristics, inputs, and outputs are associated with changes in health outcomes at the state level. Covering the timeframe of 1996-2007 (source years for data), the results can be summarized as follows:

1. When data were combined across all states, there was an overall decline in LHD expenditures and FTEs, while there were general improvements in health outcomes, with the exception of obesity prevalence.
2. When changes in LHD inputs and state health outcomes were compared between states, significant associations were found between specific LHD inputs and both overall and specific health outcomes.
3. While these results point to an association between certain LHD inputs and state health outcomes, it is only possible to infer a pathway through LHD outputs (services or activities) which might explain this association.

In particular this study revealed that an increase in expenditures per capita was associated with a decrease in infectious disease cases, and an increase in FTEs per capita was associated with a decrease in cardiovascular disease deaths. These associations were statistically significant and consistent across three levels of analysis – in dichotomous

categories, in pairwise correlations, and in the multivariate regressions when controlling for other factors known to influence health. This study also showed that LHDs are increasingly governed by a Board of Health (BOH), although no impact of the changes in the presence of a governing BOH was seen on expenditures, FTEs, or health outcomes.

The overall decline in LHD expenditures and FTEs (when data for all states were combined), during the time when health outcomes were generally improving, was unexpected, and on one level, not intuitive. These declines were particularly surprising given the increase in funding to state health departments to strengthen emergency preparedness in the wake of 9/11. Further exploration of this funding stream is provided below. The counter-intuitive aspect of these findings is an interpretation which leads one to surmise that the less that is spent on public health across the country, the better off we are, health wise. What these broad findings obscure, though, are the changes which took place at the state level: while total expenditures and FTEs for the 42 states declined between 1997 and 2005, 19 of the 42 states showed an increase in expenditures per capita, and 12 showed an increase in FTEs per capita. This reinforces the importance of exploring data beneath the broad surface measures that can lead one to ecologic fallacy and other erroneous interpretations. At the same time, this also lends a cautionary note in interpreting the present results: just as national-level data can obscure state differences, the process of aggregating LHD data to the state can obscure real differences between LHDs. It is in this aggregation, though, that the sum "force" of LHD efforts can be compared across states: when LHDs themselves vary so greatly – even within the same state – it can be extremely challenging to produce comparisons which equate "oranges to oranges" rather than "oranges to grocery stores". This

present study is the first known attempt to aggregate LHD data to the state level for the purpose of making state-to-state comparisons.

I was surprised by the pattern of the change in state health rankings (1998-2008) as shown in Figure 4.1. (p. 63). Mapping these changes revealed patterns that were not immediately obvious to my eye when examining the list of changes in state health rankings in Table 4.11. I do not have a ready explanation for the particular patterns, i.e., for why a large portion of the Mountain West improved in state health rankings during this time period beyond the findings summarized above. Do these changes simply reflect a common regional approach to health and healthcare problems? Or, do these changes represent migration of healthier populations to the west or unhealthier populations to the East and South, or do they suggest environmental degradation in large portions of the Midwest and South? Further exploration of these questions was beyond the scope of this dissertation, but such questions certainly suggest topics for additional research.

In the categorical analysis, changes in expenditures per capita were not significantly associated with overall changes in state health rankings; however, all seven states that had higher FTEs per capita and had improved in the rankings also had increases in expenditures per capita. Those seven states also differed significantly compared to 23 states that fell in the rankings and had losses in FTEs per capita in regards to changes in infectious diseases morbidity. Expenditures per capita remained significantly associated with changes in infectious diseases in both the pairwise correlations and in the multiple regression model. The finding of an association between changes in expenditures and changes in health outcomes is consistent with the majority of cross-sectional studies which have identified positive correlations between absolute LHD expenditures[3, 4, 9] as well as expenditures per

capita[7, 11, 13, 22] with LHD performance or effectiveness. A smaller number of other studies, though, have failed to find a significant association between expenditures and LHD performance, most notably in the Scutchfield *et al* study which correlated LHD data from the 1997 NACCHO survey with the National Public Health Performance Standards. [79] Although that study found a significant relationship between expenditures per capita and LHD performance in bivariate correlations, the relationship did not remain significant when controlling for other variables. Mays and Smith provide the only evidence to-date that changes in expenditures per capita are positively correlated with changes in health outcomes.[33] The strongest associations between changes in LHD spending and health outcomes in that study were for infant mortality and cardiovascular disease deaths; mortality from influenza changed in the expected direction, but did not reach statistical significance. The findings at present are at least consistent with the Mays and Smith study conclusion that changes in public health resources may contribute to changes in health outcomes. This dissertation, though, examined only direct LHD expenditures, whereas Mays and Smith included measures of residual state and federal expenditures that may not be reflected in LHD expenditure data.

Changes in FTEs per capita were significantly associated with both overall improvements in health outcomes – as measured by the change in state rankings - and specifically with changes in cardiovascular disease deaths. This finding is consistent with the numerous cross-sectional studies which have found positive correlations between the number of LHD FTEs and LHD performance and effectiveness[4, 5, 9, 80] and with studies which have specifically examined FTEs per capita. [7] For example, Freund and Liu reported that higher performing LHDs in New Jersey were more likely to have higher FTEs per capita. [7] Results

from other studies provide mixed and sometimes conflicting results pertaining to FTEs per capita. Kennedy found that LHDs which made high contributions to local public health systems performance had almost twice the number of FTEs per capita compared to LHDs which were judged to make low contributions to systems performance; however, higher systems performance was associated with higher overall age-adjusted death rates in this cross-sectional study. [8] Scutchfield *et al* found a negative association between FTEs per capita and system performance for two Essential Public Health Services (EPHS 1, Monitor health status, and EPHS 2, Diagnose and investigate health problems), while total FTEs were positively associated with LHD performance on EPHS 7 (Linking people to needed health services). [79] Mays *et al* found just the opposite – a negative association between FTEs per capita and performance in EPHS 7, and a positive association with EPHS 3 (Informing and educating the public).[10, 22] None of these studies measured longitudinal changes in FTEs per capita, and no study directly correlates FTEs per capita with health outcomes.

Changes in the presence of a governing Board of Health were not associated with changes in either LHD inputs or health outcomes in this study. Scutchfield *et al* found a positive correlation between the presence of a governing BOH and performance scores, although this association did not remain significant when controlling for other variables.[79] Mays *et al* reported that, for a sample of LHDs serving populations greater than 100,000, approximately 10% more activities were performed in LHDs which had a policymaking BOH compared to those without one.[13] Mays and Smith noted that the presence of a governing BOH was one of the strongest correlates of local public health spending, with spending 14% higher in communities served by a BOH compared to communities without such boards.[33]One can infer from the combination of these results a link between a BOH,

LHD spending, activities, and health outcomes: communities with a BOH had higher LHD spending, and higher LHD spending was in turn associated with improved health outcomes.

One of the research sub-questions regarding this dissertation related to the degree to which LHD characteristics identified as significant would be amenable to local, or even state, control. The vast majority of LHDs do not function as stand-alone, separate entities, and decisions on the number of LHD staff or the amount of expenditures may be in part or wholly out of the hands of the LHD Director. Boards of Health may successfully advocate in support of LHDs; they may in turn hold LHDs more accountable, which may impact performance. Finding that a higher percentage of LHDs reported the presence of a governing BOH in 2005 compared to 1997 (56.8% vs. 48.4%) may thus bode well for increasing local public health resources.

If the results of this dissertation suggest that increases in LHD inputs – such as expenditures per capita or FTEs per capita - may contribute to improvements in health outcomes, what are the possible pathways? Does, for example, an increase in expenditures per capita result in changes in LHD services or activities that relate to infectious diseases? Does an increase in FTEs per capita result in changes in LHD services or activities that relate to cardiovascular diseases? Because of changes in the wording of the NACCHO survey regarding services, it was not possible to fully explore the potential pathway through changes in LHD services or activities between 1997 and 2005. In the 2005 Profile, NACCHO provided a comparison between LHD activities reported in the1993 survey with responses to similar questions in the 2005 survey. That analysis showed that most clinical services and certain regulatory-related functions declined, but that participation in population-based activities such as behavioral risk factor surveillance and injury surveillance had increased.

The comparison of LHD services across the 1993, 1997, and 2005 surveys in this dissertation (Table 4.10) – while recognizing the data may not be fully comparable - provides further evidence of a decline in most LHD clinical services. Relevant to this dissertation, the comparison of LHD activities across time 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 one area for which there has been a substantial increase in public health resources over the past several years: emergency preparedness. The Public Health Improvement Act, sponsored by Senators Bill Frist and Ted Kennedy, was signed into law on November 13, 2000 as P.L. 106-505. Title I of the Act, known as the "Public Health Threat and Emergencies Act" was intended to "strengthen the nation's capacity to detect and respond to serious public health threats, including antimicrobial resistance and bioterrorist attacks".[81] Funding to support the act, however, only came following the terrorist attacks of 9/11 and the anthrax deaths which followed soon after. Since then, funding has been made available through CDC, which has provided $800 million-$1 billion annually to strengthen public health infrastructure and capacity to respond to public health emergencies, including bioterrorism.[82] 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 the 2005 Profile, 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 $35,000 per LHD. Fifty-one percent of LHDs reported hiring additional FTEs using funding from the CDC cooperative agreement. Responding to one of the sample modules in the 2005 Profile, LHDs generally reported that both emergency preparedness-related and unrelated functions had been strengthened by

efforts to improve emergency preparedness – only 6% reported that any function or service had been made weaker.[31]

The funding support that has come though the Public Health Threats and Emergencies Act can have dual-use, for example, in supporting epidemiology staff who may establish syndromic surveillance for bioterrorism as well as conduct routine epidemiologic investigations and strengthen routine communicable disease surveillance. This would provide a possible pathway between increases in LHD expenditures per capita and decreases in infectious disease morbidity. A personal experience with how LHDs have changed post 9/11 might provide at least anecdotal information to further support this pathway. Prior to 9/11 the only formally trained higher-level epidemiology staff in the Tennessee Department of Health were located in the central (state) office and in the larger metropolitan health departments such as Memphis-Shelby County and Nashville-Davidson County. None of the seven rural regional offices – which support LHDs - had epidemiology staff beyond a Master in Public Health level of training. With the approximately $15 million the state of Tennessee received in the first year of funding through the Public Health Threats and Emergencies Act, a substantial portion was dedicated to funding epidemiology positions at all regional offices. By the third year of funding, the state had hired several PhD-level epidemiologists at the regional office level. In the East Tennessee Regional Health Office, the additions included a PhD epidemiologist, a second PhD environmental epidemiologist, a public health physician specializing in communicable disease control, additional field investigation staff, as well as several other emergency preparedness staff (for an overall approximately 10% increase in FTEs at the regional level). Similar increases in staffing at the regional level across the state, as well as additional dedicated positions in the state central office, may account for

Tennessee's high ranking in emergency preparedness, as assessed by the Trust For America's Health.[83], and may in part account for the 66.5% reduction in infectious diseases morbidity in Tennessee as measured in AHR (see Appendix 5, table A5.3).

There is not, however, uniformity of opinion on the positive impact of the Public Health Threats and Emergencies Act. Based on a survey of 46 LHDs, Bashir *et al* found that less than 50% of the total costs of LHDs' preparedness efforts were defrayed by federal funding for one-third of those surveyed.[84] If LHDs are spending more on emergency preparedness, there may be less to spend on traditional LHD services, a concern expressed by some LHD leaders themselves.[85] There may be the opportunity to further determine the impact of the Public Health Threats and Emergencies Act through natural experiments: since 2005 Federal funding for state and local preparedness has been cut more than 25 percent, and states are no longer receiving any supplemental funding for pandemic flu preparedness, despite increased responsibilities. 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 empirical evidence of both the association between LHD inputs and health outcomes as well as the possible pathway.

In contrast to LHD expenditures and infectious diseases, the evidence supporting a pathway between LHD inputs and improvements in cardiovascular disease deaths that goes through LHD services or activities is limited and indirect at best. Cardiovascular diseases remain the leading cause of death in the U.S., even though overall heart disease death rates have been declining since 1968.[86] Since 1980 alone, the coronary heart disease death rate has declined 50%. 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 due to improved medical therapies, while 44% of the decline was due to risk factor modifications – including reductions in total cholesterol, systolic blood pressure, smoking prevalence, and physical inactivity.[87]

LHDs may influence risk factor modifications through both clinical preventive services as well as population-directed activities. A primary risk factor for cardiovascular disease is tobacco use, and the comparison of LHD services and activities over time shows that tobacco use prevention activities increased; however, it appears that chronic disease surveillance remained static, screening for high blood pressure and diabetes fell, and the provision of comprehensive primary care decreased by over 50%. This study failed to find any significant associations between changes in LHD inputs and changes in the prevalence of smoking.

A LHD's impact on cardiovascular disease could potentially be through other population-focused activities – such as through health assessment, planning, and policy-making – but there is no direct or indirect evidence to support this hypothesis. Over half of LHDs participate in community health improvement planning, but it was not possible in this dissertation to explore changes in these functions between 1997 and 2005. If the general movement away from clinical service provision was met with a concomitant increase in these broader population health activities, then the potential pathways between LHD inputs and health outcomes that go through LHD services and activities may still exist; however, identifying such pathways might require a different conceptual framework. Thus in summary, the weight of evidence linking an increase in LHD staffing to a decrease in

cardiovascular disease mortality that goes through LHD services or activities is weaker and more exploratory than the connection between LHD expenditures and infectious diseases.

Another personal experience with recent changes in LHD inputs might provide additional anecdotal information germane to the link between FTEs per capita and cardiovascular disease. Beginning in the latter half of the 1990's, regional offices in the Tennessee Department of Health initiated a community-based health assessment and planning process known as "Community Diagnosis". Regional offices were provided with new staff positions to facilitate this process through local volunteer groups concerned about health and health care, known as County Health Councils. Over the next several years, County Health Councils conducted assessments, identified leading health issues, then helped to develop and implement activities to address specific needs. Thirty-seven counties made cardiovascular disease – or primary risk factors for cardiovascular disease – their number one priority.[88] Activities which were implemented to address cardiovascular diseases included establishing community wellness activities and programs, (e.g. community-wide campaigns to improve and enhance physical activity and healthy eating, including worksite wellness), supporting cardiovascular disease screening, and providing direct support to low income persons on Medicare to receive needed medications to treat cardiovascular disease. The link to the finding regarding FTEs per capita in this dissertation is that in order to support and help facilitate this work, regional and local health departments added many new staff – in the East Tennessee Regional Health Office alone, eight new field staff were added, including doctoral and master's level prepared. Despite the general positive sense of accomplishments of such community-based activities, there is no empirical evidence that they have made a difference in Tennessee. In general, though, the *Guide to Community Preventive Services*

indicates that there is strong evidence to support community-wide campaigns related to physical activity, including creating or enhancing access to places for physical activity, combined with informational outreach activities.[17] During this same time period, however, obesity prevalence in Tennessee increased by 73.4% (see Appendix 5, table A5.2), with the state ranking 47th in obesity prevalence in 2008. With obesity being a risk factor for cardiovascular disease, it is difficult to square the association between community-based activities targeting physical activities with changes in cardiovascular disease mortality. As with funding cuts and infectious diseases, there is yet another opportunity for a natural experiment to explore a potential pathway between LHD inputs and health outcomes through community-based activities: with the recent economic downturn, the state of Tennessee has scaled back support of County Health Councils – exploring whether this decrease in support impedes further progress in cardiovascular disease reduction can be an opportunity to strengthen the evidence-base for public health practice.

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 cannot be ruled out; however, the rationale for a decrease in cardiovascular disease deaths or infectious disease morbidity to lead to an increase in LHD expenditures or FTEs per capita is less tenable. Reverse causation, or simultaneity, is just one form of endogeneity that is a limitation – another is through possible omitted variables that may act as confounders.[89] The issue of endogeneity could have been addressed in part by using time-lagged data – when the data for dependent variables follows data for independent variables

for a pre-determined time period. The actual use of time-lagged data in this study was mixed; for example, in the 1998 AHR report, data for cardiovascular disease deaths are from 1993-95, while data for infectious diseases are from 1995-97 and for obesity and smoking prevalence data are from 1997 – these data are correlated with LHD inputs that are based primarily on fiscal year 1996. In the 2008 AHR report, data for cardiovascular disease deaths is from 2003-05, while data for infectious diseases is from 2005-07, and for smoking and obesity prevalence data are from 2007 – these outcomes are correlated with LHD inputs that are based primarily on fiscal year 2004. The decision about which AHR report to best match up to the source years for the NACCHO profiles was made to balance the different source years for the variables of interest. With future iterations of the AHR report it will be possible to obtain mortality data that are clearly time-lagged vis-à-vis both 1997 and 2005 NACCHO Profiles.

Second, this study used relative and absolute change between two points in time, and did not consider the changes that may have occurred within the time period. For LHD inputs this was not possible because the datasets represented only two points in time – the 1997 and 2005 NACCHO surveys. Health outcome data, on the other hand, were available for each year between the 1998 and 2008 AHR reports used in this study. Developing a measure such as the cumulative sum statistic – the cumulative sum of deviations from an expected or reference value – as is done in Quality Improvement studies, may have captured the changes in health outcomes within the time period studied. (Personal communication, Dr. Glen Mays, September 23, 2008.) Another method to incorporate multiple data points is a fixed effects model which examines within group variation and controls for factors that may be time-invariant (thus reducing the likelihood of having omitted variables). The fixed effects model

(FEM) asks the question, "How much does each measurement in the time series differ from the average measure for each locus?"[90] The differences from the mean measure for each variable are then regressed. Because the FEM measures variation *within* each locus, bias from omitted or unobserved variables - such as quality of care, ease of access to, and affordability of care - is reduced.[90] The challenge to using a fixed effects model in this study was in having only two data points for LHD inputs – with more accurate 1993 LHD jurisdictional populations and the possibility of having a linked dataset for the 1989 survey, applying a fixed effects model may prove to be of greater utility.

Third, there is a potential ecologic fallacy in the associations drawn in this analysis: the health outcome changes that took place may have been experienced by sub-populations other than those represented by the LHDs which were included in the analyses. While attempts to limit this problem were made by excluding states that had less than 40% of their population represented by LHDs in the final dataset, it is not possible to overcome this potential problem entirely.

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. This is especially true for cancer mortality.

Fifth, although changes in FTEs per capita were significantly associated with changes in health outcomes, only 12 states (out of 42) experienced an increase in FTEs per capita between 1997 and 2005. While statistically significant, the coefficient for FTEs per capita in the regression model (- 0.06504) indicates that the expected percent decrease in cardiovascular disease deaths given a one percent increase in FTEs per capita is relatively low. It is possible that such an association is spurious. State and local health departments are

frequently mandated by law to establish infectious disease control programs, while services to prevent or treat cardiovascular diseases 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 cardiovascular diseases is spurious in contrast to the stronger, more robust association between LHD spending and infectious diseases.

Sixth, this dissertation does not consider state and federal public health spending that does not get included in the LHD expenditures measure, yet may still impact LHD functions, performance, and health outcomes. Mays and Smith have generated measures of residual state and federal public health spending and thus provide a more comprehensive measure of total public health spending.[33]The approach, however, of this dissertation was to determine if the combined resources and efforts of many LHDs could impact state-level health outcomes apart from whatever additional state and federal efforts might trickle down.

Finally, in the absence of describing a clear pathway between LHD inputs and health outcomes, given the difficulties in comparing changes in LHD services and activities over time, this study is limited in providing empirical evidence which could serve as guidance for *what* LHDs should be funded to do.

Implications for future study

Findings from this dissertation suggest at least three avenues for next steps or further study:

Repeating the methodologies in this study using the 1993 and 2005 NACCHO Profiles. With accurate LHD jurisdictional population for the 1993 NACCHO Profile, the

timeframe for studying changes in LHD inputs could be extended. In addition, with much closer similarity in questions regarding LHD services than with the 1997 Profile, a focus on the changes between 1993 and 2005 Profiles would allow for an exploration of the association between changes in LHD inputs and changes in LHD outputs, and between LHD outputs and health outcomes. This will be the focus of efforts over the next several months, through a University of Kentucky/RWJ-funded project entitled, "Association of Local Health Department Profiles with changes in *America's Health Rankings,* 1990-2006". (Paul Erwin, Principal Investigator)

Exploring statewide initiatives that 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 – if states which improved in rankings and had increases in FTEs per capita (the seven states mentioned in Table 4.15) implemented specific activities in response to early AHR reports. It may be equally instructive to study a sample of states from each of the four cells in Table 4.14 to better understand the relationship between changes in FTEs per capita and changes in state health rankings. This, in fact, will be the focus of a project recently funded by RWJ, entitled, "Improvements in State Health Outcomes: State Public Health Systems Performance and State Health Department responses to America's Health Rankings" (Paul Erwin, Principal Investigator). Findings from this dissertation can help guide specific areas of inquiry, for example, exploring state health department expenditures and infectious disease-related programs, and staffing changes related to the prevention or early detection of cardiovascular diseases. In addition, a focus on state public health spending – in contrast to the LHD spending in this dissertation – might further identify

state-to-state variations in public health resources and may provide additional insights into the changes states may have made in response to AHR.

NACCHO has just completed a 2008 *Profile* which will be available for study in the fall of 2009. (Personal communication, Carolyn Leep, Director of Research and Evaluation, NACCHO, February 9, 2009.) As with bringing in the 1993 *Profile* data mentioned above, the ability to extend the time period for study may allow for better exploration of the pathways by which we might expect, for example, that an increase in LHD staffing will lead to a decrease in cardiovascular disease mortality.

Taking advantage of opportunities to carry out natural experiments. As noted above, funding reductions from CDC through the Public Health Threats and Emergencies Act will likely force cutbacks in state and local level bioterrorism and emergency preparedness-related staff and activities. The extent to which this may impact changes in infectious disease morbidity should be studied and documented. Likewise, in Tennessee, funding reductions for community-based initiatives provide the opportunity to study more closely the impact that such activities have on community health outcomes.

Conclusion

The purpose of this study, in keeping with what Turnock and Handler suggested, 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".[25(p.279)] The findings of this study suggest that improvements in public health resources at the local level may contribute to improved health outcomes at the state level. While it was not possible to identify changes in

LHD outputs which 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.

CHAPTER VI

POLICY IMPLICATIONS AND A PLAN FOR CHANGE

There are at least three broad areas of policy implications for this dissertation, as briefly described in the introductory chapter:

1. County, state, and national support for public health
2. Development of public health accreditation standards
3. Surveillance of LHDs and tracking changes in health outcomes

Further elaboration on each of these, along with provisional plans for change, is provided below.

County, State, and National support for public health

"Show me the money", quips Rod Tidwell (Cuba Gooding, Jr.) in the movie, "Jerry Maguire". What he actually meant was "show me the money, and I'll show you what you get for the money" – a common attribute of many – athletes and non-athletes alike. The potential for increasing support for local public health may improve when the efforts of LHDs produce visible "added value" to the community's health and quality of life – when it can be shown what communities get for their money. As alluded to in the introductory chapter, for all the programs and activities which LHDs implement, the evidence for what works – what actually results in improved community health – is sorely lacking. And, while several studies have linked LHD characteristics to performance, there is a paucity of information on the

linkages between LHD characteristics and performance and community health improvement. The public health share of the healthcare dollar is getting squeezed, even in the context of reports which indicate that the largest portion of the health burden is attributable to preventable behaviors: tobacco use, physical inactivity, and inattention to good nutrition.[91, 92] Yet, the leap from identifying attributable causes of ill health to funding and otherwise supporting LHDs to do something about these preventable behaviors is across a chasm too wide, because, for much of what LHDs do, it is a leap of faith. Although many in local public health practice believe indeed that they are doing "the Lord's work", support on faith alone polarizes the resource base for LHDs between "believers" and "non-believers".

The results from this dissertation should add to the small but growing body of literature which provides evidence that public health resources matter, and that the totality of such local public health efforts can impact health and well-being at the community and state level. This dissertation provides empirical information that an increase in LHD funding is associated with a decrease in infectious disease morbidity and, conversely, that a decrease in funding is associated with an increase in infectious disease morbidity. Given the recent funding reductions from the CDC to address public health threats and emergencies – a 25% reduction in Federal funding for state and local preparedness since 2005 - having such empirical information that can be used to advocate for a reinstatement of federal funding can be critical in maximizing the benefits of public health activities.

Although the pathway between increases in LHD FTEs per capita and decreasing cardiovascular disease mortality remains unclear, the fact that almost half of the reduction in coronary heart disease death rates since 1980 is due to risk factor modifications, provides yet another point of focus for advocating on behalf of LHD resources. It takes people to provide

clinical preventive services, just as it takes people to implement community-based heart disease prevention programs. This dissertation provides empirical evidence that having such people may matter.

As mentioned in the discussion section, having a Board of Health that can advocate in support of LHDs and that can translate the message of "public health matters" to those who control funds at the local level may lead to a stronger public health resource-base. Such advocacy is made all the more relevant when LHDs can provide empirical evidence that an increase in resources to the LHD can result in improved community health.

Planning for change: Findings from this dissertation will be provided to NACCHO, ASTHO, and NALBOH through a brief written report, and to the extent possible, through oral presentations (e.g., at the annual NACCHO conference). The purpose will be for these major national-level public health organizations, which represent local and state public health practice – to use the results of this dissertation to further advocate for public health resources. In addition, results of this dissertation will be presented at the second annual Keeneland Conference on Public Health Systems and Services Research, where further discussions can take place with leadership from agencies and foundations (e.g., RWJ and CDC) which support public health.

<u>Development of public health accreditation standards</u>

A second policy implication of this dissertation is on its potential to provide a stronger empirical base for the development of standards for public health accreditation. The movement towards accreditation has been propelled by many factors – including a growing focus on LHD accountability and performance improvement – but also through the efforts to

better define what should be expected of LHDs.[18] The development of accreditation standards that can be applied to all LHDs - given the great variability in LHD size, structure, and capacities - will pose enormous challenges. The timing for focused attention on accreditation vis-à-vis this dissertation is important: the new Public Health Accreditation Board (PHAB) will be developing standards through 2009, testing tools and processes 2009-10, and is expected to accept applications for accreditation beginning in 2011. (Personal communication, Dr. Albert Gray, Executive Director, Public Health Accreditation Board; July 2007.) The relevance of the independent variables in this dissertation to potential accreditation standards is further explored below.

The standards for public health accreditation will be partly based on the standards described in NACCHO's Operational Definition of a Functioning Local Health Department.[93] (Personal communication; initial meeting of the Research and Evaluation Committee, Public Health Accreditation Board, Dr. William Riley, Chair; Washington, DC, March 12-14, 2008.) The Operational Definition standards closely parallel the 10 EPHS, and describe "what everyone, no matter where they live, should reasonably expect the local health department to meet".[93] More recently NACCHO has adopted a tool developed by Lenihan *et al* for assessing accreditation preparedness known as the Operational Definition Prototype Metrics (ODPM).[94] Based on the Operational Definition standards, the ODPM describes capacity, process, and output indicators that will be indicative of meeting the standards.

Identifying what LHDs should do can be based on what is mandated by law as well as what is supported by the empirical evidence. With the inability to fully assess changes in LHD outputs (services), it is not possible to identify the impact that changes in these

functions have on health outcomes. This limits the direct utility of the dissertation results for the broad standards that could be empirically-based. Nonetheless, the results related to LHD inputs still have relevance to the development of accreditation standards, as shown in Table 6.1. PHAB may be able to use the results of this dissertation to develop more explicit LHD input criteria for what an accredited LHD should have. For example, results from this dissertation, in concert with related studies on public health systems and services, can help build the foundation for evidence-based resourcing of LHDs, such as specifying the expenditure and FTE floor, below which no accredited LHD should find themselves.

Table 6.1. *Association of Independent Variables with the Standards from the Operational Definition of a Functioning Local Health Department*

Independent Variable	**Operational Definition Standard Number**	**Operational Definition Standard Description**
LHD expenditures per capita	8e	8e. Provide the public health workforce with adequate resources to do their jobs.
LHD staff FTE per capita	8a	8a. Recruit, train, develop, and retain a diverse staff.
Governing Board of Health	6a	6a. Review existing laws and regulations and work with governing bodies and policymakers to update them as needed

As described above in the discussion chapter, a critical limitation of this dissertation is the inability to specify a pathway between LHD inputs and health outcomes. With the capacity to track changes in LHD functions and activities over time, NACCHO is in the best position to provide the longitudinal data needed in order to build a stronger evidence-base for *what* LHDs should be doing in order to improve the community's health. The degree to which such evidence links LHD inputs with LHD functions can only make accreditation standards stronger. Table 6.2 provides additional potential linkages between LHD services and

functions which NACCHO can track through future Profiles. With more accurate jurisdictional population data for LHDs in the 1993 survey, it will be possible to explore changes in LHD services and functions between 1993 and 2005. This will provide further useful information that can lead to empirically-based accreditation standards, beginning with the standards described in Table 6.2.

Table 6.2. *Potential Associations of LHD functions and services in future NACCHO Profiles with the Standards from the Operational Definition of a Functioning Local Health Department*

LHD Functions or Services tracked by NACCHO	**Operational Definition Standard Number**	**Operational Definition Standard Description**
LHD Services – Surveillance	1a, 2a	1a. Obtain and maintain data that provide information on the community's health. 2a. Investigate health problems and environmental health hazards.
LHD Services – Prevention and Control	2b, 7b	2b. Prevent, minimize, and contain adverse health events and conditions. 7b. Support and implement strategies to increase access to care and establish systems of personal health services, including preventive and health promotion services
LHD Services – Personal	7b, 7c	7c. Link individuals to available, accessible personal health care providers (i.e., a medical home).
Health Planning	1c, 4a, 5c	1c. Conduct or contribute expertise to periodic community health assessments. 4a. Engage the local public health system in an ongoing, strategic, community-driven, comprehensive planning process. 5c. Engage in LHD strategic planning.
Partnerships with Universities	4d, 8c, 10a	4d. Develop partnerships to generate interest in and support for improved community health status, including new and emerging public health issues. 8c. Provide practice- and competency based educational experiences for the future public health workforce, and provide expertise in developing and teaching public health curricula, through partnerships with academia. 10a. When researchers approach the LHD to engage in research activities that benefit the health of the community, **i.** Identify appropriate populations, geographic areas, and partners; **ii.** Work with them to actively involve the community in all phases of research; **iii.** Provide data and expertise to support research; and, **iv.** Facilitate their efforts to share research findings with the community, governing bodies, and policymakers.

Planning for change: Results of this dissertation will be presented to and discussed at meetings of the Research and Evaluation Committee of the Public Health Accreditation Board, of which I am a member. The work of this committee can additionally inform the work of the Standards Committee of PHAB, which is primarily tasked with developing accreditation standards. The intent is to generate further discussion about public health systems and services research that can serve to establish a solid empirical base for standards, rather than depending on standards that just appear to be right.

Surveillance of LHDs and tracking changes in health outcomes

One of the limiting factors in public health systems and services research has been the inattention to collecting and analyzing longitudinal data on LHDs. The NACCHO Profiles are the closest datasets we have to a national surveillance system of and for LHDs. Providing evidence of the utility of the Profiles in public health systems research will add value and provide support for not only continuing the Profiles, but also highlighting the potential it has for a national surveillance system of LHDs.

Finally, the sponsors and Scientific Advisory Committee of the *America's Health Ranking* have substantial interest in understanding how the annual reports can be used, the value they provide, and the actions taken to address the issues which surface. Indeed, a primary impetus for this dissertation was in pondering the question about why some states have improved in the rankings over time, while other states have not. The AHR, since it is produced annually, also has the potential to serve as a tracking or surveillance mechanism focusing on both health outcomes as well as the underlying social determinants of health.

Understanding why states improve or fall in their rankings will increase the potential for the AHR findings to become actionable.

Planning for change: The Scientific Advisory Committee to AHR, of which I am a member, is aware of this dissertation, and I anticipate providing a report and presentation to the committee at its annual meeting in the spring of 2009.

Coda: The Dissertation and Leadership

> *If we forget how much we cannot know we become insensitive to many things of very great importance.* Bertrand Russell[95]

In musical notation, the *coda* is meant to indicate a concluding section, although it may also function as a means to integrate and bring balance to various themes within a piece. I prefer this sense of an ending over the literal Latin root – *cauda* – for "tail".[96] This DrPH program is the Health Policy and Management Doctoral Program in Health Leadership, and as such it is appropriate to consider the following leadership-focused questions:

1. How does the dissertation process make one a better leader?
2. What do leaders need to learn from this experience?

My immediate response to the first question is that the dissertation process gives me a greater appreciation as a leader for what it takes to produce scholarly work that is meant to inform and be applicable to public health practice. A presentation at a NACCHO or APHA

conference, or a published article in a peer-reviewed journal is just the tip of the iceberg: the mass below the surface is full of complexities, challenges, contradictions, and limitations. The environment in which this dissertation gets carried out – in a distance learning program where students are fully employed and have full family lives – reinforces the need for self-mastery. This is particularly so following two years of steady and rigorous coursework during which there is extensive contact – when such contact and support is withdrawn so abruptly the leader's self-discipline must shift into high gear. If, as Yukl contends, leadership is the "process of influencing others"[97], then certainly standing before an audience of faculty and peers and defending your ideas, while at the same time knowing that your faults are exposed, is a leadership-strengthening experience. The dissertation process also reinforces the notion that fundamental to good leadership is the ability to collaborate – although the dissertation has to be completed by the student, it is not done – indeed cannot be done - as a solo flying experience. The camaraderie with fellow DrPH students concerning the dissertation process can also lend itself to opportunities to inspire – who has learned a new method, who has made it to the next milestone, who inspires me to inspire others as a leader? The dissertation experience reinforces for the leader that listening is an effective communication skill.

A leader needs to take from this experience not just the end product – which we know is important – but the entire journey. To alter a phrase from Peter Senge: it's not what the dissertation <u>is</u>, it's what the dissertation <u>does</u> that matters.[98] The leader needs to appreciate how difficult it is to ask a clear, singular question – a question that is simply stated, but not simple, straightforward, but one that communicates depth of understanding. The student can formulate a question, but the leader needs to take in new perspectives on old questions, and

ask new questions on accepted knowledge - and to know that the answer to the question is in the asking of the question. The student can learn new skills - a new software program or a new analytical method – but the leader must learn when it is appropriate to apply such skills or methods, and when it is not. The student can produce findings that reach statistical significance, but the leader must be able to distinguish statistical significance from importance – all things that are statistically significant aren't necessarily important, and there may be great importance in that which is not statistically significant. A leader must learn the value and limitations of information – perfect information may be desirable, but practically unattainable. How much is enough information, and how does one make the best use, the best judgments about whatever information one has? These are important leadership lessons that are applicable in settings as variable as an office meeting, a policy briefing with the President, and a research project. Finally, the dissertation experience teaches – for the leaders who open themselves to it – humility. Knowledge is power, yes, but so is humility, in saying "I don't know".

APPENDIX 1

20 Public Health Measures (Miller and Turnock)[6]

1. For the jurisdiction served by your local health department, is there a community needs assessment process that systematically describes the prevailing health status in the community?
2. In the past three years in your jurisdiction, has the local public health agency surveyed the population for behavioral risk factors?
3. For the jurisdiction served by your local health agency, are timely investigations of adverse health events, including communicable disease outbreaks and environmental health hazards, conducted on an ongoing basis?
4. Are the necessary laboratory services available to the local public health agency to support investigations of adverse health events and that meet routine diagnostic and surveillance needs?
5. For the jurisdiction served by your local public health agency, has an analysis been completed of the determinants and contributing factors of priority health needs, adequacy of existing health resources, and the population groups most impacted?
6. In the past three years in your jurisdiction, has the local public health agency conducted an analysis of age-specific participation in preventive and screening services?
7. For the jurisdiction served by your local public health agency, is there a network of support and communication relationships that includes health-related organizations, the media, and the general public?

8. In the past year in your jurisdiction, has there been a formal attempt by the local public health agency at informing elected officials about the potential public health impact of decisions under their consideration?
9. For the jurisdiction served by your local public health agency, has there been a prioritization of the community health needs that have been identified from a community needs assessment?
10. In the past three years in your jurisdiction, has the local public health agency implemented community health initiatives consistent with established priorities?
11. For the jurisdiction served by your local public health agency, has a community health action plan been developed with community participation to address community health needs?
12. During the past three years in your jurisdiction, has the local public health agency developed plans to allocate resources in a manner consistent with community health action plans?
13. For the jurisdiction served by your local public health agency, have resources been deployed as necessary to address priority health needs identified in the community health needs assessment?
14. In the past three years in your jurisdiction, has the local public health agency conducted an organizational self-assessment?
15. For the jurisdiction served by your local public health agency, are age-specific priority health needs effectively addressed through the provision of, or linkage to appropriate services?

16. Within the past year in your jurisdiction, has the local public health agency provided reports to the media on a regular basis?
17. For the jurisdiction served by your local public health agency, have there been regular evaluations of the effects of public health services on community health status?
18. In the past three years in your jurisdiction, has the local public health agency used professionally recognized processes and outcome measures to monitor programs and to redirect resources as appropriate?
19. In your jurisdiction, is the public regularly provided with information about current health status, health care needs, positive health behaviors, and health care policy issues?
20. In the past three years in your jurisdiction, has there been an instance in which the local public health agency has failed to implement a mandated program or service?

APPENDIX 2

Performance Measurement of Local Health Departments

Appendix 2. Performance Measurement of Local Health Departments

Authors (year)	Sample Size (number of LHDs)	Performance Measures Framework	Data acquisition/sources	Dependent variable/focus	Independent variables/correlates	Positive correlates of LHD performance
Spain et al (1989)[48]	18	Model Standards	Interviews and questionnaires	Program Objectives	Local-state negotiation	LHDs which negotiated with the state met more program objectives
Miller et al (1993)[51]	14	Structured interview examining impact of 20 critical events	Interviews and questionnaires	Impact on LHD Performance	20 critical events	HIV/AIDS epidemic, changes in fee income, 1988 IOM report
Turnock et al (1994)[2]	208	10 Public Health Practices	Survey questionnaire	LHD compliance, LHD role, LHD effectiveness	LHD jurisdiction size and organizational type	City, LHDs serving > 50,000
Turnock et al (1995)[70]	42	26 Indicators/10 Public Health Practices	Survey questionnaire	LHD Performance	7 capacity-building influences; LHD jurisdiction size	Use of IPLAN and APEXPH; LHDs serving populations 25,000-100,000
Richards et al (1995)[68]	370	26 Indicators/10 Public Health Practices	Survey questionnaire	LHD Performance, adequacy, LHD contribution	LHD jurisdiction size and organizational type	LHDs serving larger populations, especially > 100,000; LHDs in centralized administrative structure

IPLAN: Illinois Project for Local Assessment of Needs

Authors (year)	Sample Size (number of LHDs)	Performance Measures Framework	Data acquisition/sources	Dependent variable/focus	Independent variables/correlates	Positive correlates of LHD performance
Suen et al (1995)[3]	2,079	Eight core functions	NACCHO 1992-93 Profile of LHDs	LHD Performance	LHD jurisdiction size and organizational type; expenditures; use of planning models	LHDs serving populations > 50,000; higher LHD expenditures; centralized administrative structure
Schenck et al (1995)[15]	34	84 indicators/10 Public Health Practices	Survey questionnaire; health status and risk measures	LHD Performance	Health Status and Risks	Unfavorable health status and risks
Handler and Turnock (1996)[4]	264	10 Public Health Practices	Survey questionnaire matched to NACCHO 1992-93 Profile of LHDs	LHD Effectiveness	LHD characteristics	Higher number of LHD staff; higher total expenditures; private insurance as a significant source of revenue; female head of agency
Mayer et al (1997)[5]	93	10 Public Health Practices, modified for MCH	Survey questionnaire matched to NACCHO 1992-93 Profile of LHDs	LHD Performance	LHD characteristics	LHDs serving larger jurisdictions; higher number of LHD staff; community interactions; managed care participation; urban setting

Authors (year)	Sample Size (number of LHDs)	Performance Measures Framework	Data acquisition/sources	Dependent variable/focus	Independent variables/correlates	Positive correlates of LHD performance
Turnock et al (1998)[6]	298	20 Public Health Practice measures	Survey questionnaire	LHD Performance, effectiveness	LHD jurisdiction size and organizational type	LHDs serving populations > 50,000; LHDs organized by city and county
Lovelace (2000)[73]	64	4 Public Health actions	Survey questionnaire	LHD Performance	LHD jurisdiction size; community interaction	LHDs serving larger jurisdictions; degree and productivity of community relationships
Freund and Liu (2000)[7]	102	26 Indicators/10 Public Health Practices	Survey questionnaire; demographics; budgets	LHD Performance	LHD jurisdiction size; budgets; number of LHD staff	Larger LHD staff/population; serving larger populations; larger budgets
Lovelace (2001)[14]	64	4 Public Health actions	Survey questionnaire	LHD Performance	LHD Top Management Team makeup, process	Presence of a TMT; discussions on assessment and political changes
Kennedy (2003)[8]	37	NPHPSP/10 Essential Services	Survey questionnaire; US census; community health status data; financial data; telephone interviews	Local Public Health System Performance	LHD characteristics, community health status, financial data	Larger LHD juris; higher per capita income; higher educational levels; higher contribution of LHD to system performance; lower premature death rates

Authors (year)	Sample Size (number of LHDs)	Performance Measures Framework	Data acquisition/sources	Dependent variable/focus	Independent variables/correlates	Positive correlates of LHD performance
Zahner and Vandermause (2003)[80]	93	Analysis of compliance with state statutes and rules	Site visits using an assessment tool; documented evidence of compliance	Compliance rate	LHD characteristics, expenditures, tax per capita, jurisdiction size	Larger LHD jurisdictions; staff size; total expenditures; Higher level of certification by state health department
Suen and Magruder (2004)[72]	2,007	20 Public Health Practice measures	Survey questionnaire	LHD Performance	LHD jurisdiction size and organizational type	LHDs serving larger populations; LHD type other than city/municipal
Scutchfield et al (2004)[10]	152	NPHPSP/10 Essential Services	Survey questionnaire matched with NACCHO 1996-97 profile of LHDs	Local Public Health System Performance	LHD characteristics	Total expenditures per LHD staff; LHD director with master's or bachelor's degree; relationship with universities
Mauer et al (2004)[9]	34	Washington State Performance Standards for Public Health	Self-assessment survey, followed by site visits and documentation of evidence of performance	LHD performance	LHD characteristics, jurisdiction size, expenditures	LHDs with higher budgets and larger number of staff

Authors (year)	Sample Size (number of LHDs)	Performance Measures Framework	Data acquisition/sources	Dependent variable/focus	Independent variables/correlates	Positive correlates of LHD performance
Mays et al (2004)[11]	285	NPHPSP/10 Essential Services	Survey questionnaire matched with NACCHO profile of LHDs, Area Resource File, CFFR 2000	Local Public Health System Performance	LHD characteristics	LHD and federal per capita spending;
Honore' et al (2004)[12]	50	NPHPSP/10 Essential Services	Survey questionnaire matched with health status data and US Economic Census for Health Care and Social Assistance	Local Public Health System Performance	LHD characteristics	Higher taxes per capita; higher overall tax rate; LHDs with greater percentage of revenue from taxes; LHDs which deficit-spend; higher mortality rates
Mays et al (2004)[13]	356	20 Public Health Practice measures	Survey questionnaire	Performance in availability, effectiveness	LHD and population characteristics	Higher performance in availability with larger pop., lower poverty rates, higher per capita LHD expenditures, LHDs in shared or mixed state-local relationship; Higher perf.in effectiveness with lower poverty, lower % of non-whites, presence of policymaking BOH

CFFR: Consolidated Federal Funds Report

Authors (year)	Sample Size (number of LHDs)	Performance Measures Framework	Data acquisition/sources	Dependent variable/focus	Independent variables/correlates	Positive correlates of LHD performance
Mays et al (2006)[22]	285	NPHPSP/10 Essential Services	Survey questionnaire matched with NACCHO 1996-97 profile of LHDs, Area Resource File, and CFFR 2000	Local Public Health System Performance	LHD characteristics	LHD per capita spending; LHDs in shared or mixed state-local organizations
Kanarek et al (2006)[16]	304	20 Public Health Practice measures	Survey questionnaire matched with NACCHO 1996-97 profile of LHDs, CHSI, Area Resource File	Health status	LHD Performance and characteristics	LHD performance contributed 13-57% of explained variance in health status

CHSI: Community Health Status Indicators

APPENDIX 3

Changes in Expenditures and FTEs, by year and state

Table A3.1. *Expenditures per Capita*

State	Expenditures per capita, 1997	Expenditures per capita, 2005	Relative change, 1997-2005	Absolute change, 1997-2005
Alabama	77.94	48.36	-37.94	-29.57
Arizona	23.11	20.62	-10.77	-2.49
Arkansas	34.22	24.43	-28.63	-9.80
California	169.26	84.39	-50.14	-84.87
Colorado	26.75	28.11	5.10	1.36
Connecticut	25.61	32.18	25.65	6.57
Delaware	20.83	17.44	-16.26	-3.39
Florida	40.20	38.11	-5.20	-2.09
Georgia	34.26	33.41	-2.48	-0.85
Idaho	39.76	35.66	-10.32	-4.10
Illinois	37.99	42.23	11.15	4.24
Indiana	18.33	18.76	2.36	0.43
Iowa	29.37	30.49	3.82	1.12
Kansas	28.63	27.69	-3.28	-0.94
Kentucky	56.03	55.41	-1.12	-0.63
Louisiana	44.47	41.99	-5.57	-2.48
Maryland	70.03	77.89	11.22	7.86
Massachusetts	36.32	47.93	31.95	11.61
Michigan	51.68	48.79	-5.59	-2.89
Minnesota	37.69	41.90	11.15	4.20
Missouri	34.20	33.41	-2.33	-0.80
Montana	49.58	72.97	47.17	23.39
Nebraska	26.31	34.34	30.52	8.03
Nevada	33.71	32.76	-2.80	-0.94
New Jersey	17.47	15.63	-10.52	-1.84
New York	83.82	143.61	71.33	59.79
North Carolina	68.47	61.15	-10.69	-7.32
North Dakota	25.41	40.50	59.35	15.08
Ohio	24.74	31.85	28.74	7.11
Oklahoma	22.07	24.58	11.39	2.51
Oregon	66.76	81.49	22.07	14.73
Pennsylvania	128.08	54.71	-57.28	-73.37
South Carolina	63.43	39.82	-37.22	-23.61
Tennessee	39.41	47.83	21.36	8.42
Texas	26.27	24.27	-7.60	-2.00
Utah	33.31	34.26	2.87	0.96
Vermont	13.40	15.34	14.48	1.94
Virginia	36.85	31.39	-14.81	-5.46

State	Expenditures per capita, 1997	Expenditures per capita, 2005	Relative change, 1997-2005	Absolute change, 1997-2005
Washington	71.68	71.30	-0.53	-0.38
West Virginia	32.38	24.06	-25.69	-8.32
Wisconsin	33.48	28.09	-16.10	-5.39
Wyoming	20.05	31.92	59.20	11.87

Table A3.2. *FTEs per Capita (x 10,000)*

State	FTEs per capita, 1997	FTEs per capita, 2005	Relative change, 1997-2005	Absolute change, 1997-2005
Alabama	13.38	7.39	-44.77	-5.99
Arizona	3.18	1.53	-51.88	-1.65
Arkansas	7.85	4.94	-37.08	-2.91
California	12.65	4.53	-64.22	-8.12
Colorado	4.68	3.86	-17.45	-0.82
Connecticut	3.35	4.26	27.23	0.91
Delaware	4.46	3.95	-11.48	-0.51
Florida	7.14	5.56	-22.17	-1.58
Georgia	6.26	5.42	-13.37	-0.84
Idaho	6.95	5.28	-24.05	-1.67
Illinois	6.04	5.28	-12.49	-0.75
Indiana	3.37	3.57	5.95	0.20
Iowa	5.70	5.34	-6.19	-0.35
Kansas	5.77	4.43	-23.19	-1.34
Kentucky	10.70	7.74	-27.64	-2.96
Louisiana	4.62	4.00	-13.28	-0.61
Maryland	9.01	10.46	16.06	1.45
Massachusetts	9.05	4.90	-45.88	-4.15
Michigan	5.45	4.70	-13.81	-0.75
Minnesota	4.72	8.66	83.76	3.95
Missouri	5.81	4.03	-30.71	-1.78
Montana	8.34	9.03	8.34	0.70
Nebraska	3.36	4.21	25.40	0.85
Nevada	3.86	3.12	-19.04	-0.73
New Jersey	2.43	2.02	-16.56	-0.40
New York	6.31	6.63	5.16	0.33
North Carolina	11.82	9.88	-16.39	-1.94
North Dakota	4.74	6.41	35.32	1.67
Ohio	3.76	3.78	0.69	0.03
Oklahoma	5.02	4.05	-19.41	-0.97
Oregon	6.12	6.19	1.11	0.07
Pennsylvania	4.52	3.74	-17.35	-0.78
South Carolina	9.90	6.75	-31.77	-3.14
Tennessee	7.33	6.36	-13.25	-0.97
Texas	4.22	3.08	-26.91	-1.14
Utah	5.02	3.92	-22.00	-1.10
Vermont	2.31	2.68	15.72	0.36
Virginia	6.78	4.63	-31.62	-2.14
Washington	6.22	5.50	-11.55	-0.72
West Virginia	6.52	4.41	-32.40	-2.11
Wisconsin	4.00	3.17	-20.68	-0.83
Wyoming	4.30	5.66	31.79	1.37

APPENDIX 4

Changes in percent of jurisdictional population covered by a Local Health Department with a governing Board of Health

Guide to Tables A4.1-A4.3

Tables in Appendix 4 show data regarding a governing Board of Health (BOH).

For Tables A4.1 and A4.2, columns are defined as follows:

Column 1 – State: states were included on the basis of a cutoff of 40% in column 6

Column 2 – LHDs reporting: the number of LHDs which reported either YES or NO on the question regarding the presence of a governing BOH

Column 3 – LHDs with BOH: the number of LHDs which reported YES on the presence of a governing BOH

Column 4 - Jurisdictional population of LHDs which reported: the aggregated jurisdictional population represented by column 2

Column 5 - Jurisdictional population of LHDs which reported, with a BOH : the aggregated jurisdictional population represented by column 3

Column 6 - % Actual state population represented by reporting LHDs: column 4 divided by the actual state population, expressed as a percent

Column 7 – % Jurisdictional population with a BOH for LHDs which reported: column 5 divided by column 4, expressed as a percent

Table A4.1. *Presence of a governing Board of Health (BOH), 1997*

State	LHDs reporting	LHDs with BOH	Jurisdictional population of LHDs which reported	Jurisdictional population of LHDs which reported, with a BOH	% Actual state population represented by reporting LHDs	% Jurisdictional population with a BOH for LHDs which reported
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Alabama	48	14	3,129,508	1,540,097	71.6	49.2
Arizona	13	0	4,271,297	0	90.2	0
Arkansas	63	2	1,641,336	25,800	63.1	1.6
California	52	2	29,872,565	330,421	92.0	1.1
Colorado	36	25	2,934,362	2,100,305	73.0	71.6
Connecticut	45	11	2,037,366	868,035	60.8	42.6
Delaware	2	0	711,253	0	94.6	0
Florida	65	0	13,211,319	0	87.0	0
Georgia	123	84	6,117,135	4,169,042	79.6	68.2
Idaho	7	4	1,156,930	567,924	94.2	49.1
Illinois	85	68	11,515,697	7,456,015	94.5	64.7
Indiana	64	30	4,139,744	2,112,409	69.5	51.0
Iowa	71	55	2,213,357	1,725,665	76.6	78.0
Kansas	83	42	2,500,785	1,650,856	94.9	66.0
Kentucky	34	30	3,025,866	2,187,836	76.6	72.3
Louisiana	5	1	2,227,431	567,869	50.4	25.5
Maryland	22	15	4,275,010	1,825,468	82.9	42.7
Massachusetts	100	57	2,940,256	1,759,621	47.2	59.8
Michigan	40	18	8,775,778	2,335,235	89.5	26.6
Minnesota	44	34	4,464,439	2,561,365	93.7	57.4
Missouri	83	54	4,887,753	1,419,584	89.2	29.0
Montana	21	8	581,009	419,534	65.3	72.2
Nebraska	10	7	785,626	334,413	46.6	42.6
Nevada	2	2	1,339,688	1,339,688	75.9	100.0
New Jersey	56	32	5,948,169	3,460,380	72.4	58.2
New York	55	21	18,001,508	2,693,184	96.5	15.0
North Carolina	81	43	7,008,897	3,657,961	91.5	52.2
North Dakota	22	15	542,910	345,360	83.6	63.6
Ohio	95	71	8,314,952	6,588,411	73.7	79.2
Oklahoma	62	9	3,002,270	806,205	89.0	26.9
Oregon	32	13	3,170,293	920,450	95.9	29.0
Pennsylvania	9	2	4,993,668	772,822	40.8	15.5
South Carolina	10	1	3,073,198	240,500	79.6	7.8
Tennessee	44	5	3,409,075	711,986	62.0	20.9
Texas	39	6	15,562,058	686,076	78.8	4.4
Utah	8	2	1,510,052	209,500	71.2	13.9

Table A4.1. *(continued) Presence of a governing Board of Health (BOH), 1997*

State	LHDs reporting	LHDs with BOH	Jurisdictional population of LHDs which reported	Jurisdictional population of LHDs which reported, with a BOH	% Actual state population represented by reporting LHDs	% Jurisdictional population with a BOH for LHDs which reported
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Vermont	11	0	538,836	0	90.2	0
Virginia	35	0	6,553,359	0	96.0	0
Washington	30	24	5,226,552	3,257,096	92.1	62.3
West Virginia	38	31	1,577,173	1,335,696	86.7	84.7
Wisconsin	91	52	5,080,896	1,975,155	96.5	38.9
Wyoming	7	2	251,353	134,963	51.4	53.7

Table A4.2. *Presence of a governing Board of Health (BOH), 2005*

State	LHDs reporting	LHDs with BOH	Jurisdictional population of LHDs which reported	Jurisdictional population of LHDs which reported, with a BOH	% Actual state population represented by reporting LHDs	% Jurisdictional population with a BOH for LHDs which reported
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Alabama	47	4	3,376,771	1,208,715	74.4	35.8
Arizona	13	2	4,732,156	137,331	79.5	2.9
Arkansas	73	1	2,662,577	8,378	96.0	0.3
California	48	1	33,717,012	3,053,302	93.7	9.1
Colorado	33	23	3,673,282	3,421,045	78.6	93.1
Connecticut	45	8	2,350,958	643,711	67.4	27.4
Delaware	2	0	847,811	0	100.9	0
Florida	65	1	17,663,374	19,478	99.6	0.1
Georgia	128	108	7,773,307	6,190,211	85.3	79.6
Idaho	7	5	1,424,704	1,072,066	99.9	75.2
Illinois	85	71	12,762,200	7,781,862	100.3	61.0
Indiana	61	46	4,554,540	3,176,636	72.8	69.7
Iowa	75	65	2,458,314	1,802,992	83.2	73.3
Kansas	81	62	2,566,403	2,193,711	93.6	85.5
Kentucky	34	29	3,290,884	2,452,437	78.9	74.5
Louisiana	6	0	2,490,289	0	55.4	0
Maryland	22	10	4,820,066	2,281,130	86.5	47.3
Massachusetts	102	77	3,537,325	2,046,912	55.0	57.9
Michigan	41	20	9,864,126	2,207,729	97.6	22.4
Minnesota	43	41	5,001,402	4,924,868	97.8	98.5
Missouri	81	56	5,644,063	1,650,013	97.5	29.2
Montana	20	16	646,778	610,430	69.1	94.4
Nebraska	10	5	980,823	147,731	55.9	15.1
Nevada	2	2	2,128,399	2,128,399	88.4	100.0
New Jersey	57	37	6,676,750	3,887,058	77.1	58.2
New York	56	27	19,310,749	4,411,472	100.3	22.8
North Carolina	80	61	8,420,527	6,597,507	97.0	78.4
North Dakota	21	16	537,837	373,233	84.6	69.4
Ohio	96	85	8,428,107	7,662,061	73.5	90.9
Oklahoma	65	13	3,415,340	1,816,126	96.6	53.2
Oregon	31	16	3,554,015	2,064,146	97.9	58.1
Pennsylvania	9	2	5,020,274	1,337,828	40.6	26.6
South Carolina	10	0	3,870,627	0	91.0	0
Tennessee	40	7	3,517,991	930,367	58.7	26.4
Texas	39	6	18,874,651	1,352,188	82.6	7.2
Utah	8	6	1,926,954	534,390	76.9	27.7

Table A4.2. *(continued) Presence of a governing Board of Health (BOH), 2005*

State	LHDs reporting	LHDs with BOH	Jurisdictional population of LHDs which reported	Jurisdictional population of LHDs which reported, with a BOH	% Actual state population represented by reporting LHDs	% Jurisdictional population with a BOH for LHDs which reported
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Vermont	11	0	587,355	0	94.8	0
Virginia	35	0	7,749,274	0	102.5	0
Washington	28	25	5,952,528	5,056,824	94.9	85.0
West Virginia	37	33	1,463,575	1,301,671	81.1	88.9
Wisconsin	90	58	5,424,531	2,634,696	97.9	48.6
Wyoming	8	4	279,098	210,425	55.1	75.4

Table A4.3. *Changes in the percentage of the population covered by a Local Health Department with a governing Board of Health (BOH), 1997-2005*

Based on column 7 in Tables A2.1 and A2.2 above

Relative change = (Column 7 for 2005 – Column 7 for 1997) x 100
Column 7 for 1997

Absolute change = Column 7 for 2005 – Column 7 for 1997

State	Relative change in % population with BOH, 1997-2005	Absolute change in % population with BOH, 1997-2005	State	Relative change in % population with BOH, 1997-2005	Absolute change in % population with BOH, 1997-2005
Alabama	-27.3	-13.4	Montana	30.7	22.2
Arizona	undefined	2.9	Nebraska	-64.6	-27.5
Arkansas	-80.0	-1.3	Nevada	0.0	0.0
California	718.7	7.9	New Jersey	0.1	0.0
Colorado	30.1	21.6	New York	52.7	7.9
Connecticut	-35.7	-15.2	North Carolina	50.1	26.2
Delaware	0.0	0.0	North Dakota	9.1	5.8
Florida	undefined	0.1	Ohio	14.7	11.7
Georgia	16.8	11.5	Oklahoma	98.0	26.3
Idaho	53.3	26.2	Oregon	100.0	29.0
Illinois	-5.8	-3.8	Pennsylvania	72.2	11.2
Indiana	36.7	18.7	South Carolina	-100.0	-7.8
Iowa	-5.9	-4.6	Tennessee	26.6	5.6
Kansas	29.5	19.5	Texas	62.5	2.8
Kentucky	3.1	2.2	Utah	99.9	13.9
Louisiana	-100.0	-25.5	Vermont	0.0	0.0
Maryland	10.8	4.6	Virginia	0.0	0.0
Massachusetts	-3.3	-2.0	Washington	36.3	22.6
Michigan	-15.9	-4.2	West Virginia	5.0	4.2
Minnesota	71.6	41.1	Wisconsin	24.9	9.7
Missouri	0.7	0.2	Wyoming	40.4	21.7

Note: undefined: states which had no LHDs reporting with a governing BOH in 1997

APPENDIX 5

Changes in Dependent Variables, from the 1998 and 2008 *America's Health Rankings* reports, by state

Note: The specific source years for data for each dependent variable are designated at the bottom of each table.

Table A5.1. *Changes in Smoking Prevalence, from 1998-2008*

State	Smoking Prevalence, 1998	Smoking Prevalence, 2008	Relative change, 1998-2008	Absolute change, 1998-2008
Alabama	24.6	22.5	-8.5	-2.1
Arizona	21.1	19.8	-6.2	-1.3
Arkansas	28.4	22.4	-21.1	-6.0
California	18.4	14.3	-22.3	-4.1
Colorado	22.5	18.7	-16.9	-3.8
Connecticut	21.6	15.4	-28.7	-6.2
Delaware	26.6	18.9	-28.9	-7.7
Florida	23.6	19.3	-18.2	-4.3
Georgia	22.4	19.4	-13.4	-3.0
Idaho	19.9	19.1	-4.0	-0.8
Illinois	23.2	20.1	-13.4	-3.1
Indiana	26.4	24.1	-8.7	-2.3
Iowa	23.1	19.8	-14.3	-3.3
Kansas	22.6	17.9	-20.8	-4.7
Kentucky	30.7	28.2	-8.1	-2.5
Louisiana	24.5	22.6	-7.8	-1.9
Maryland	20.4	17.1	-16.2	-3.3
Massachusetts	20.5	16.4	-20.0	-4.1
Michigan	26.0	21.1	-18.8	-4.9
Minnesota	21.8	16.5	-24.3	-5.3
Missouri	28.6	24.5	-14.3	-4.1
Montana	20.5	19.5	-4.9	-1.0
Nebraska	22.1	19.9	-10.0	-2.2
Nevada	28.0	21.5	-23.2	-6.5
New Jersey	21.4	17.1	-20.1	-4.3
New York	23.1	18.9	-18.2	-4.2
North Carolina	25.8	22.9	-11.2	-2.9
North Dakota	22.3	20.9	-6.3	-1.4
Ohio	25.1	23.1	-8.0	-2.0
Oklahoma	24.6	25.8	4.9	1.2
Oregon	20.7	16.9	-18.4	-3.8
Pennsylvania	24.2	21.0	-13.2	-3.2
South Carolina	23.4	21.9	-6.4	-1.5
Tennessee	26.9	24.3	-9.7	-2.6
Texas	22.5	19.3	-14.2	-3.2
Utah	13.8	11.7	-15.2	-2.1
Vermont	23.3	17.6	-24.5	-5.7
Virginia	24.4	18.5	-24.2	-5.9
Washington	23.8	16.8	-29.4	-7.0
West Virginia	27.4	26.9	-1.8	-0.5
Wisconsin	23.2	19.6	-15.5	-3.6
Wyoming	24.0	22.1	-7.9	-1.9

Note: AHR 1998 are for 1997 BRFSS data, AHR 2008 are for 2007 BRFSS data

Table A5.2. *Changes in Obesity Prevalence, from 1998-2008*

State	Obesity Prevalence, 1998	Obesity Prevalence, 2008	Relative change, 1998-2008	Absolute change, 1998-2008
Alabama	18.2	30.9	69.8	12.7
Arizona	12.4	25.8	108.1	13.4
Arkansas	18.1	29.3	61.9	11.2
California	16.0	23.3	45.6	7.3
Colorado	11.8	19.3	63.6	7.5
Connecticut	14.7	21.7	47.6	7.0
Delaware	18.8	28.2	50.0	9.4
Florida	16.1	24.1	49.7	8.0
Georgia	14.4	28.7	99.3	14.3
Idaho	16.3	25.1	54.0	8.8
Illinois	17.1	25.6	49.7	8.5
Indiana	21.2	27.4	29.2	6.2
Iowa	19.4	27.7	42.8	8.3
Kansas	14.7	27.7	88.4	13.0
Kentucky	21.8	28.7	31.7	6.9
Louisiana	19.6	30.7	56.6	11.1
Maryland	17.5	26.3	50.3	8.8
Massachusetts	14.8	21.7	46.6	6.9
Michigan	19.3	28.2	46.1	8.9
Minnesota	16.5	26.0	57.6	9.5
Missouri	19.1	28.2	47.6	9.1
Montana	14.6	22.6	54.8	8.0
Nebraska	17.0	26.5	55.9	9.5
Nevada	14.1	24.6	74.5	10.5
New Jersey	16.0	24.1	50.6	8.1
New York	16.0	25.5	59.4	9.5
North Carolina	18.3	28.7	56.8	10.4
North Dakota	17.0	27.0	58.8	10.0
Ohio	17.7	28.1	58.8	10.4
Oklahoma	15.1	28.8	90.7	13.7
Oregon	19.4	26.3	35.6	6.9
Pennsylvania	17.5	27.8	58.9	10.3
South Carolina	16.9	29.0	71.6	12.1
Tennessee	17.7	30.7	73.4	13.0
Texas	18.7	28.6	52.9	9.9
Utah	15.2	22.4	47.4	7.2
Vermont	15.9	21.9	37.7	6.0
Virginia	16.4	25.3	54.3	8.9
Washington	15.2	25.9	70.4	10.7
West Virginia	20.6	30.3	47.1	9.7
Wisconsin	16.6	25.3	52.4	8.7
Wyoming	15.0	24.5	63.3	9.5

Note: AHR 1998 are for 1997 BRFSS data, AHR 2008 are for 2007 BRFSS data

Table A5.3. *Changes in Infectious Diseases morbidity, from 1998-2008*

State	Infectious Diseases morbidity, 1998	Infectious Diseases morbidity, 2008	Relative change, 1998-2008	Absolute change, 1998-2008
Alabama	29.1	17.7	-39.1	-11.4
Arizona	64.0	17.2	-73.1	-46.8
Arkansas	40.7	16.0	-60.7	-24.7
California	67.1	21.4	-68.1	-45.7
Colorado	33.0	10.6	-67.9	-22.4
Connecticut	50.5	20.4	-59.6	-30.1
Delaware	46.6	24.6	-47.2	-22.0
Florida	65.7	36.3	-44.8	-29.4
Georgia	42.7	29.4	-31.1	-13.3
Idaho	39.2	4.5	-88.5	-34.7
Illinois	33.8	19.1	-43.4	-14.7
Indiana	20.2	9.0	-55.4	-11.2
Iowa	21.0	6.2	-70.5	-14.8
Kansas	24.3	7.7	-68.3	-16.6
Kentucky	19.1	10.3	-46.2	-8.8
Louisiana	49.7	27.1	-45.4	-22.6
Maryland	59.9	37.0	-38.2	-22.9
Massachusetts	29.8	14.6	-50.9	-15.2
Michigan	28.8	12.3	-57.3	-16.5
Minnesota	14.8	10.0	-32.4	-4.8
Missouri	48.5	11.0	-77.3	-37.5
Montana	23.9	3.9	-83.7	-20.0
Nebraska	18.1	8.4	-53.6	-9.7
Nevada	64.9	17.3	-73.3	-47.6
New Jersey	63.9	22.2	-65.2	-41.7
New York	93.6	39.3	-58.0	-54.3
North Carolina	26.4	18.7	-29.2	-7.7
North Dakota	12.8	2.5	-80.5	-10.3
Ohio	21.4	10.4	-51.3	-11.0
Oklahoma	71.5	14.0	-80.4	-57.5
Oregon	62.2	11.8	-81.0	-50.4
Pennsylvania	29.5	18.5	-37.3	-11.0
South Carolina	36.4	22.8	-37.4	-13.6
Tennessee	61.9	20.7	-66.5	-41.2
Texas	57.5	23.8	-58.6	-33.7
Utah	53.1	5.3	-90.0	-47.8
Vermont	13.1	5.7	-56.4	-7.4
Virginia	29.4	14.9	-49.3	-14.5
Washington	36.8	12.4	-66.3	-24.4
West Virginia	14.4	9.5	-34.1	-4.9
Wisconsin	12.3	5.7	-53.8	-6.6
Wyoming	69.6	2.5	-96.4	-67.1

Note: AHR 1998 are for 1995-97 CDC data, AHR 2008 are for 2005-07 CDC data

Table A5.4. *Changes in Infant Mortality, from 1998-2008*

State	Infant Mortality Rate, 1998	Infant Mortality Rate, 2008	Relative change, 1998-2008	Absolute change, 1998-2008
Alabama	10.2	9.2	-9.8	-1.0
Arizona	7.6	6.5	-14.5	-1.1
Arkansas	9.0	8.1	-10.0	-0.9
California	6.1	5.3	-13.1	-0.8
Colorado	6.5	6.3	-3.1	-0.2
Connecticut	6.8	5.9	-13.2	-0.9
Delaware	7.5	9.0	20.0	1.5
Florida	7.5	7.2	-4.0	-0.3
Georgia	9.3	8.0	-14.0	-1.3
Idaho	6.7	5.9	-11.9	-0.8
Illinois	9.0	7.2	-20.0	-1.8
Indiana	8.5	7.7	-9.4	-0.8
Iowa	7.6	5.0	-34.2	-2.6
Kansas	7.7	6.8	-11.7	-0.9
Kentucky	7.6	6.5	-14.5	-1.1
Louisiana	9.4	10.3	9.6	0.9
Maryland	8.7	7.1	-18.4	-1.6
Massachusetts	5.1	5.1	0.0	0.0
Michigan	8.2	7.6	-7.3	-0.6
Minnesota	6.3	5.2	-17.5	-1.1
Missouri	7.5	8.1	8.0	0.6
Montana	7.0	6.1	-12.9	-0.9
Nebraska	8.1	5.7	-29.6	-2.4
Nevada	6.0	6.1	1.7	0.1
New Jersey	6.7	5.0	-25.4	-1.7
New York	7.3	5.7	-21.9	-1.6
North Carolina	9.2	8.5	-7.6	-0.7
North Dakota	6.2	6.1	-1.6	-0.1
Ohio	8.2	8.1	-1.2	-0.1
Oklahoma	8.4	7.9	-6.0	-0.5
Oregon	5.8	5.9	1.7	0.1
Pennsylvania	7.8	7.7	-1.3	-0.1
South Carolina	9.0	8.6	-4.4	-0.4
Tennessee	8.9	9.5	6.7	0.6
Texas	6.4	6.5	1.6	0.1
Utah	5.7	5.1	-10.5	-0.6
Vermont	6.6	5.8	-12.1	-0.8
Virginia	7.8	7.0	-10.3	-0.8
Washington	5.9	4.8	-18.6	-1.1
West Virginia	7.7	7.6	-1.3	-0.1
Wisconsin	7.3	6.5	-11.0	-0.8
Wyoming	7.0	5.1	-27.1	-1.9

Note: AHR 1998 are for 1994-96 NCHS data, AHR 2008 are for 2003-05 NCHS data

Table A5.5. *Changes in Cardiovascular Disease (CVD) Deaths, from 1998-2008*

State	CVD Deaths, 1998	CVD Deaths, 2008	Relative change, 1998-2008	Absolute change, 1998-2008
Alabama	384.1	366.2	-4.7	-17.9
Arizona	318.2	250.2	-21.4	-68.0
Arkansas	394.2	340.0	-13.7	-54.2
California	358.1	289.2	-19.2	-68.9
Colorado	299.1	247.0	-17.4	-52.1
Connecticut	330.8	258.9	-21.7	-71.9
Delaware	353.1	305.6	-13.5	-47.5
Florida	327.8	264.4	-19.3	-63.4
Georgia	383.5	325.9	-15.0	-57.6
Idaho	327.7	267.0	-18.5	-60.7
Illinois	381.9	303.2	-20.6	-78.7
Indiana	391.3	317.9	-18.8	-73.4
Iowa	353.6	277.9	-21.4	-75.7
Kansas	345.0	283.9	-17.7	-61.1
Kentucky	405.5	343.3	-15.3	-62.2
Louisiana	389.1	349.2	-10.3	-39.9
Maryland	342.8	301.6	-12.0	-41.2
Massachusetts	315.2	253.7	-19.5	-61.5
Michigan	389.8	327.0	-16.1	-62.8
Minnesota	303.8	219.4	-27.8	-84.4
Missouri	390.4	328.4	-15.9	-62.0
Montana	319.3	252.4	-21.0	-66.9
Nebraska	352.4	265.0	-24.8	-87.4
Nevada	371.1	320.3	-13.7	-50.8
New Jersey	351.0	289.1	-17.6	-61.9
New York	394.9	313.0	-20.7	-81.9
North Carolina	368.4	306.8	-16.7	-61.6
North Dakota	339.4	263.7	-22.3	-75.7
Ohio	381.6	320.3	-16.1	-61.3
Oklahoma	411.5	371.0	-9.8	-40.5
Oregon	327.5	265.1	-19.1	-62.4
Pennsylvania	375.3	308.5	-17.8	-66.8
South Carolina	389.6	316.1	-18.9	-73.5
Tennessee	404.7	353.8	-12.6	-50.9
Texas	362.6	302.8	-16.5	-59.8
Utah	284.3	243.2	-14.5	-41.1
Vermont	356.4	255.7	-28.3	-100.7
Virginia	361.4	291.0	-19.5	-70.4
Washington	326.4	263.7	-19.2	-62.7
West Virginia	414.2	353.5	-14.7	-60.7
Wisconsin	344.0	274.3	-20.3	-69.7
Wyoming	329.7	262.5	-20.4	-67.2

Note: AHR 1998 are for 1994-96 NCHS data, AHR 2008 are for 2003-05 NCHS data

Table A5.6. *Changes in Cancer Deaths, from 1998-2008*

State	Cancer Deaths, 1998	Cancer Deaths, 2008	Relative change, 1998-2008	Absolute change, 1998-2008
Alabama	213.1	211.4	-0.8	-1.7
Arizona	193.4	173.6	-10.2	-19.8
Arkansas	220.9	213.4	-3.4	-7.5
California	200.3	175.4	-12.4	-24.9
Colorado	182.4	168.3	-7.7	-14.1
Connecticut	202.8	190.1	-6.3	-12.7
Delaware	238.7	209.8	-12.1	-28.9
Florida	205.8	185.4	-9.9	-20.4
Georgia	210.1	196.6	-6.4	-13.5
Idaho	176.3	180.2	2.2	3.9
Illinois	220.0	201.2	-8.5	-18.8
Indiana	221.4	209.0	-5.6	-12.4
Iowa	206.1	191.1	-7.3	-15.0
Kansas	200.9	191.3	-4.8	-9.6
Kentucky	237.0	226.2	-4.6	-10.8
Louisiana	228.1	223.8	-1.9	-4.3
Maryland	222.2	198.9	-10.5	-23.3
Massachusetts	220.5	196.4	-10.9	-24.1
Michigan	209.5	199.3	-4.9	-10.2
Minnesota	200.0	182.8	-8.6	-17.2
Missouri	217.6	206.9	-4.9	-10.7
Montana	202.2	190.0	-6.1	-12.2
Nebraska	197.9	182.4	-7.8	-15.5
Nevada	225.8	199.0	-11.9	-26.8
New Jersey	225.7	196.6	-12.9	-29.1
New York	209.4	182.2	-13.0	-27.2
North Carolina	208.4	199.7	-4.2	-8.7
North Dakota	189.9	179.8	-5.3	-10.1
Ohio	222.7	209.0	-6.1	-13.7
Oklahoma	215.9	203.7	-5.6	-12.2
Oregon	212.9	196.2	-7.8	-16.7
Pennsylvania	220.1	204.1	-7.3	-16.0
South Carolina	207.1	204.7	-1.2	-2.4
Tennessee	220.1	216.0	-1.9	-4.1
Texas	209.3	186.3	-11.0	-23.0
Utah	168.0	145.7	-13.3	-22.3
Vermont	207.0	185.0	-10.6	-22.0
Virginia	214.7	198.0	-7.8	-16.7
Washington	203.9	189.5	-7.1	-14.4
West Virginia	229.2	219.8	-4.1	-9.4
Wisconsin	208.1	192.2	-7.6	-15.9
Wyoming	191.6	183.4	-4.3	-8.2

Note: AHR 1998 are for 1994-96 NCHS data, AHR 2008 are for 2003-05 NCHS data

Table A5.7. *Changes in Years of Potential Life Lost (YPLL), from 1998-2008*

State	YPLL, 1998	YPLL, 2008	Relative change, 1998-2008	Absolute change, 1998-2008
Alabama	10093.1	10261.0	1.7	167.9
Arizona	8816.6	7867.0	-10.8	-949.6
Arkansas	9514.4	9694.0	1.9	179.6
California	7623.7	6356.0	-16.6	-1267.7
Colorado	6954.4	6407.0	-7.9	-547.4
Connecticut	7083.1	5925.0	-16.4	-1158.1
Delaware	8231.4	7886.0	-4.2	-345.4
Florida	9009.6	8094.0	-10.2	-915.6
Georgia	9413.9	8417.0	-10.6	-996.9
Idaho	6746.5	6444.0	-4.5	-302.5
Illinois	8472.1	7145.0	-15.7	-1327.1
Indiana	7997.4	7972.0	-0.3	-25.4
Iowa	6666.5	6168.0	-7.5	-498.5
Kansas	7103.9	7277.0	2.4	173.1
Kentucky	8441.1	9059.0	7.3	617.9
Louisiana	10309.7	11125.0	7.9	815.3
Maryland	8949.7	7615.0	-14.9	-1334.7
Massachusetts	6529.7	5801.0	-11.2	-728.7
Michigan	8016.8	7642.0	-4.7	-374.8
Minnesota	6207.5	5407.0	-12.9	-800.5
Missouri	8491.0	8284.0	-2.4	-207.0
Montana	7460.6	7765.0	4.1	304.4
Nebraska	6559.9	6229.0	-5.0	-330.9
Nevada	8977.1	8610.0	-4.1	-367.1
New Jersey	7922.1	6339.0	-20.0	-1583.1
New York	8690.7	6228.0	-28.3	-2462.7
North Carolina	8898.8	8340.0	-6.3	-558.8
North Dakota	6463.6	6447.0	-0.3	-16.6
Ohio	7783.0	7861.0	1.0	78.0
Oklahoma	8990.4	9624.0	7.0	633.6
Oregon	7284.3	6678.0	-8.3	-606.3
Pennsylvania	7722.4	7635.0	-1.1	-87.4
South Carolina	9713.9	9559.0	-1.6	-154.9
Tennessee	9411.1	9647.0	2.5	235.9
Texas	7982.4	7505.0	-6.0	-477.4
Utah	6485.5	6029.0	-7.0	-456.5
Vermont	6612.4	5905.0	-10.7	-707.4
Virginia	7587.1	7104.0	-6.4	-483.1
Washington	6753.1	6131.0	-9.2	-622.1
West Virginia	8277.6	9438.0	14.0	1160.4
Wisconsin	6507.6	6496.0	-0.2	-11.6
Wyoming	7703.3	7839.0	1.8	135.7

Note: AHR 1998 are for 1994-96 NCHS data, AHR 2008 are for 2003-05 NCHS data

APPENDIX 6

Pairwise Correlations of Independent and Dependent Variables

All correlations Spearman rank

Significant findings (p <.05) for correlations of independent and dependent variables in bold

Table A6.1. Correlation of changes in Expenditures per capita and FTEs per capita with changes in Dependent Variables, using relative change

	ExpCap	FTECap	Smoke	Obese	ID	IMR	CVD	Cancer	YPLL
Expenditures per capita (ExpCap)	1								
FTEs per capita (FTECap)	0.6893 0.0000	1							
Smoking prevalence (Smoke)	0.057 0.7201	-0.0808 0.611	1						
Obesity prevalence (Obese)	-0.0536 0.7362	-0.0677 0.6703	0.2109 0.18	1					
Infectious Disease morbidity (ID)	**-0.3407** **0.0272**	-0.0521 0.7431	-0.0521 0.7431	-0.0425 0.7891	1				
Infant Mortality (IMR)	-0.2053 0.1922	-0.2735 0.0797	0.0818 0.6067	0.007 0.9647	0.0431 0.7863	1			
Cardiovascular Disease Deaths (CVD)	**-0.3723** **0.0152**	**-0.3689** **0.0162**	0.1565 0.3224	0.1887 0.2313	0.1326 0.4024	0.5009 0.0007	1		
Cancer deaths (Cancer)	-0.1492 0.3457	-0.1059 0.5044	0.544 0.0002	0.2417 0.123	0.0662 0.677	0.1813 0.2506	0.2774 0.0753	1	
Years of Potential Life Lost (YPLL)	-0.1346 0.3954	-0.1461 0.3559	0.5605 0.0001	0.2145 0.1726	-0.084 0.5968	0.4215 0.0054	0.4493 0.0028	0.7114 0	1

Key
rho
Sig. level

Table A6.2. Correlation of changes in Expenditures per capita and FTEs per capita with changes in Dependent Variables, using absolute change

	ExpCap	FTECap	Smoke	Obese	ID	IMR	CVD	Cancer	YPLL
Expenditures per capita (ExpCap)	1								
FTEs per capita (FTECap)	0.6683	1							
	0.0000								
Smoking prevalence (Smoke)	0.0807	-0.0915	1						
	0.6116	0.5643							
Obesity prevalence (Obese)	-0.2565	-0.1844	0.2313	1					
	0.1011	0.2424	0.1405						
Infectious Disease morbidity (ID)	-0.1762	0.0148	0.0751	-0.038	1				
	0.2642	0.9257	0.6362	0.811					
Infant Mortality (IMR)	-0.1735	-0.2385	0.0086	0.0696	-0.0749	1			
	0.2718	0.1282	0.957	0.6613	0.6372				
Cardiovascular Disease Deaths (CVD)	-0.2286	**-0.3482**	0.1219	0.3423	-0.315	0.4208	1		
	0.1453	**0.0238**	0.4419	0.0265	0.0422	0.0055			
Cancer deaths (Cancer)	-0.1612	-0.2215	0.4851	0.3997	0.2044	0.0687	0.1714	1	
	0.3079	0.1587	0.0011	0.0087	0.194	0.6657	0.2778		
Years of Potential Life Lost (YPLL)	-0.1385	-0.1788	0.4798	0.3323	0.1939	0.3421	0.333	0.69	1
	0.3818	0.2571	0.0013	0.0315	0.2185	0.0266	0.0312	0	

Key
rho
Sig. level

Table A6.3. Correlation of changes in the presence of a Board of Health with changes in Independent and Dependent Variables, using absolute change

	BOH	ExpCap	FTECap	Smoke	Obese	ID	IMR	CVD	Cancer	YPLL
Board of Health (BOH)	1									
Expenditures per capita (ExpCap)	0.2101	1								
	0.1817									
FTEs per capita (FTECap)	0.144	0.6683	1							
	0.363	0								
Smoking prevalence (Smoke)	0.204	0.0807	-0.0915	1						
	0.1951	0.6116	0.5643							
Obesity prevalence (Obese)	0.0335	-0.2565	-0.1844	0.2313	1					
	0.8334	0.1011	0.2424	0.1405						
Infectious Disease morbidity (ID)	-0.1282	-0.1762	0.0148	0.0751	-0.038	1				
	0.4186	0.2642	0.9257	0.6362	0.811					
Infant Mortality (IMR)	0.0113	-0.1735	-0.2385	0.0086	0.0696	-0.0749	1			
	0.9434	0.2718	0.1282	0.957	0.6613	0.6372				
Cardiovascular Disease Deaths (CVD)	0.0881	-0.2286	-0.3482	0.1219	0.3423	-0.315	0.4208	1		
	0.5789	0.1453	0.0238	0.4419	0.0265	0.0422	0.0055			

Key
rho
Sig. level

Table A6.3. (continued) Correlation of changes in the presence of a Board of Health with changes in Independent and Dependent variables, using absolute change

	BOH	ExpCap	FTECap	Smoke	Obese	ID	IMR	CVD	Cancer	YPLL
Cancer deaths (Cancer)	0.0529	-0.1612	-0.2215	0.4851	0.3997	0.2044	0.0687	0.1714	1	
	0.7392	0.3079	0.1587	0.0011	0.0087	0.194	0.6657	0.2778		
Years of Potential Life Lost (YPLL)	0.0543	-0.1385	-0.1788	0.4798	0.3323	0.1939	0.3421	0.333	0.69	1
	0.7326	0.3818	0.2571	0.0013	0.0315	0.2185	0.0266	0.0312	0	

APPENDIX 7

Multiple Linear Regression Results for Health Outcomes and LHD Inputs

Table 7.1. *Multiple linear regression for changes in Smoking Prevalence with changes in Expenditures per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	0.023177	0.043828	0.53	0.6	-0.0658	0.112153
Percent below poverty	1.811874	0.546459	3.32	0.002	0.702503	2.921244
Percent High School graduation	0.005172	0.187033	0.03	0.978	-0.37453	0.38487
Percent with Health Insurance	-0.48625	0.450562	-1.08	0.288	-1.40094	0.428444
Percent population nonwhite	-0.1474	0.176122	-0.84	0.408	-0.50495	0.210148
Percent 65+ years old	-0.27668	0.678085	-0.41	0.686	-1.65326	1.099911
_cons	-25.3359	20.33975	-1.25	0.221	-66.6278	15.956

F(6,35) = 2.37; p = 0.0500; Adj R-squared = 0.1671

Table 7.2. *Multiple linear regression for changes in Obesity Prevalence with changes in Expenditures per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	0.040267	0.100156	0.4	0.69	-0.16306	0.243595
Percent below poverty	0.463565	1.248767	0.37	0.713	-2.07157	2.998696
Percent High School graduation	-0.252	0.427408	-0.59	0.559	-1.11969	0.615683
Percent with Health Insurance	0.737486	1.029623	0.72	0.479	-1.35276	2.827732
Percent population nonwhite	0.175486	0.402474	0.44	0.666	-0.64158	0.992552
Percent 65+ years old	-0.65479	1.549559	-0.42	0.675	-3.80056	2.490981
_cons	65.07513	46.48035	1.4	0.17	-29.285	159.4353

F(6,35) = 1.18; p = 0.3397; Adj R-squared = 0.0256

Table 7.3. *Multiple linear regression for changes in Infectious Diseases with changes in Expenditures per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.18226	0.083835	-2.17	0.037	-0.35245	-0.01206
Percent below poverty	0.503114	1.04527	0.48	0.633	-1.6189	2.625125
Percent High School graduation	-0.19455	0.357759	-0.54	0.59	-0.92084	0.531739
Percent with Health Insurance	-1.78781	0.861838	-2.07	0.045	-3.53743	-0.03818
Percent population nonwhite	1.027205	0.336888	3.05	0.004	0.343287	1.711123
Percent 65+ years old	1.980995	1.297046	1.53	0.136	-0.65215	4.614139
_cons	-64.7542	38.90601	-1.66	0.105	-143.738	14.2292

F(6,35) = 5.32; p = 0.0005; Adj R-squared = 0.3873

Table 7.4. *Multiple linear regression for changes in Infant Mortality with changes in Expenditures per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.05244	0.064439	-0.81	0.421	-0.18326	0.078375
Percent below poverty	-0.11359	0.803436	-0.14	0.888	-1.74466	1.517468
Percent High School graduation	-0.64045	0.274988	-2.33	0.026	-1.19871	-0.0822
Percent with Health Insurance	-0.35001	0.662443	-0.53	0.601	-1.69484	0.994824
Percent population nonwhite	-0.18575	0.258945	-0.72	0.478	-0.71143	0.33994
Percent 65+ years old	0.294537	0.996961	0.3	0.769	-1.7294	2.318476
_cons	42.34476	29.9047	1.42	0.166	-18.365	103.0545

F(6,35) = 1.47; p = 0.2166; Adj R-squared = 0.0645

Table 7.5. *Multiple linear regression for changes in Cardiovascular Disease deaths with changes in Expenditures per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.03486	0.0233	-1.5	0.144	-0.08216	0.012443
Percent below poverty	0.303146	0.290505	1.04	0.304	-0.28661	0.892902
Percent High School graduation	-0.14171	0.099429	-1.43	0.163	-0.34356	0.060145
Percent with Health Insurance	-0.23911	0.239525	-1	0.325	-0.72537	0.247152
Percent population nonwhite	0.130012	0.093629	1.39	0.174	-0.06007	0.320088
Percent 65+ years old	-0.28567	0.360479	-0.79	0.433	-1.01748	0.44614
_cons	-6.03286	10.81287	-0.56	0.58	-27.9842	15.91844

F(6,35) = 3.72; p =.0057; Adj R-squared = 0.2849

Table 7.6. *Multiple linear regression for changes in Cancer deaths with changes in Expenditures per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.02319	0.020486	-1.13	0.265	-0.06478	0.018395
Percent below poverty	0.880501	0.255423	3.45	0.001	0.361965	1.399038
Percent High School graduation	-0.05129	0.087422	-0.59	0.561	-0.22877	0.126183
Percent with Health Insurance	-0.59661	0.2106	-2.83	0.008	-1.02415	-0.16907
Percent population nonwhite	-0.05356	0.082322	-0.65	0.52	-0.22068	0.113563
Percent 65+ years old	-0.19204	0.316947	-0.61	0.548	-0.83548	0.451398
_cons	-2.67394	9.507108	-0.28	0.78	-21.9744	16.62652

F(6,35) = 2.34; p =.0524; Adj R-squared = 0.1642

Table 7.7. *Multiple linear regression for changes in Years of Potential Life Lost with changes in Expenditures per capita, using relative change*

Variable	**Coefficient**	**Std. Err.**	**t**	***P***	**[95% Conf.**	**Interval]**
Expenditures per capita	-0.08637	0.04532	-1.91	0.065	-0.17837	0.005636
Percent below poverty	1.878858	0.565055	3.33	0.002	0.731736	3.02598
Percent High School graduation	-0.12498	0.193398	-0.65	0.522	-0.5176	0.267641
Percent with Health Insurance	-1.12535	0.465895	-2.42	0.021	-2.07117	-0.17953
Percent population nonwhite	-0.38923	0.182116	-2.14	0.04	-0.75894	-0.01951
Percent 65+ years old	-0.45326	0.70116	-0.65	0.522	-1.87669	0.970168
_cons	7.771368	21.0319	0.37	0.714	-34.9257	50.46839

F(6,35) = 2.76; p = .0267; Adj R-squared = 0.2045

Table 7.8. *Multiple linear regression for changes in Smoking Prevalence with changes in FTEs per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	0.000698	0.05026	0.01	0.989	-0.10133	0.10273
Percent below poverty	1.842331	0.545958	3.37	0.002	0.733977	2.950685
Percent High School graduation	0.014651	0.191288	0.08	0.939	-0.37368	0.402986
Percent with Health Insurance	-0.51691	0.460019	-1.12	0.269	-1.4508	0.416982
Percent population nonwhite	-0.16171	0.174789	-0.93	0.361	-0.51655	0.19313
Percent 65+ years old	-0.31494	0.678381	-0.46	0.645	-1.69212	1.062251
_cons	-25.203	20.45874	-1.23	0.226	-66.7364	16.33048

F(6,35) = 2.31; p = .0557; Adj R-squared = 0.1605

Table 7.9. *Multiple linear regression for changes in Obesity Prevalence with changes in FTEs per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	0.029608	0.114552	0.26	0.798	-0.20294	0.26216
Percent below poverty	0.527128	1.24435	0.42	0.674	-1.99904	3.053294
Percent High School graduation	-0.25879	0.435984	-0.59	0.557	-1.14388	0.626305
Percent with Health Insurance	0.742669	1.048478	0.71	0.483	-1.38586	2.871193
Percent population nonwhite	0.148303	0.39838	0.37	0.712	-0.66045	0.957057
Percent 65+ years old	-0.69484	1.546169	-0.45	0.656	-3.83373	2.444046
_cons	66.02057	46.62965	1.42	0.166	-28.6427	160.6838

F(6,35) = 1.16; p = 0.3494; Adj R-squared = 0.1605

Table 7.10. *Multiple linear regression for changes in Infectious Diseases with changes in FTEs per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	0.054071	0.101605	0.53	0.598	-0.1522	0.260341
Percent below poverty	0.285942	1.103718	0.26	0.797	-1.95473	2.526609
Percent High School graduation	-0.31787	0.38671	-0.82	0.417	-1.10293	0.467194
Percent with Health Insurance	-1.42409	0.929983	-1.53	0.135	-3.31206	0.463872
Percent population nonwhite	1.134875	0.353356	3.21	0.003	0.417524	1.852227
Percent 65+ years old	2.33728	1.371426	1.7	0.097	-0.44686	5.121423
_cons	-64.3008	41.35973	-1.55	0.129	-148.266	19.66393

F(6,35) = 4.07; p = 0.0034; Adj R-squared = 0.3102

Table 7.11. *Multiple linear regression for changes in Infant Mortality with changes in FTEs per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.06226	0.073545	-0.85	0.403	-0.21157	0.087044
Percent below poverty	-0.20527	0.798906	-0.26	0.799	-1.82713	1.416599
Percent High School graduation	-0.6122	0.279913	-2.19	0.036	-1.18046	-0.04395
Percent with Health Insurance	-0.40554	0.673151	-0.6	0.551	-1.77211	0.961025
Percent population nonwhite	-0.14841	0.255771	-0.58	0.565	-0.66765	0.370836
Percent 65+ years old	0.324651	0.992682	0.33	0.746	-1.6906	2.339902
_cons	40.51707	29.93749	1.35	0.185	-20.2593	101.2934

F(6,35) = 1.48; p = 0.2128; Adj R-squared = 0.0659

Table 7.12. *Multiple linear regression for changes in Cardiovascular Disease deaths with changes in FTEs per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.06504	0.025153	-2.59	0.014	-0.1161	-0.01398
Percent below poverty	0.233344	0.273229	0.85	0.399	-0.32134	0.788029
Percent High School graduation	-0.10356	0.095732	-1.08	0.287	-0.2979	0.090787
Percent with Health Insurance	-0.32472	0.23022	-1.41	0.167	-0.79209	0.142652
Percent population nonwhite	0.156764	0.087475	1.79	0.082	-0.02082	0.334347
Percent 65+ years old	-0.28767	0.339501	-0.85	0.403	-0.97689	0.401557
_cons	-7.84291	10.23874	-0.77	0.449	-28.6287	12.94283

F(6,35) = 4.86; $p = 0.0010$; Adj R-squared = 0.3612

Table 7.13. *Multiple linear regression for changes in Cancer deaths with changes in FTEs per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.00047	0.023823	-0.02	0.984	-0.04884	0.047892
Percent below poverty	0.850107	0.258788	3.28	0.002	0.324741	1.375474
Percent High School graduation	-0.06097	0.090672	-0.67	0.506	-0.24504	0.123108
Percent with Health Insurance	-0.56546	0.218052	-2.59	0.014	-1.00813	-0.12279
Percent population nonwhite	-0.03926	0.082851	-0.47	0.639	-0.20745	0.128939
Percent 65+ years old	-0.15354	0.321557	-0.48	0.636	-0.80634	0.499254
_cons	-2.80125	9.697567	-0.29	0.774	-22.4884	16.88586

F(6,35) = 2.05; $p = 0.0843$; Adj R-squared = 0.1336

Table 7.14. *Multiple linear regression for changes in Years of Potential Life Lost with changes in FTEs per capita, using relative change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.05693	0.053525	-1.06	0.295	-0.16559	0.051727
Percent below poverty	1.744985	0.581428	3	0.005	0.564625	2.925346
Percent High School graduation	-0.1158	0.203715	-0.57	0.573	-0.52937	0.297761
Percent with Health Insurance	-1.12294	0.489906	-2.29	0.028	-2.1175	-0.12838
Percent population nonwhite	-0.33146	0.186145	-1.78	0.084	-0.70935	0.046436
Percent 65+ years old	-0.36124	0.722453	-0.5	0.62	-1.8279	1.105418
_cons	5.908858	21.78789	0.27	0.788	-38.3229	50.14062

$F(6,35) = 2.20$; $p = 0.0662$; Adj R-squared = 0.1495

Table 7.15. *Multiple linear regression for changes in Smoking Prevalence with changes in Expenditures per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	0.003471	0.012888	0.27	0.789	-0.02269	0.029635
Percent below poverty	0.430561	0.134311	3.21	0.003	0.157896	0.703227
Percent High School graduation	0.014069	0.045979	0.31	0.761	-0.07927	0.107411
Percent with Health Insurance	-0.11392	0.110243	-1.03	0.309	-0.33772	0.109885
Percent population nonwhite	-0.03984	0.043109	-0.92	0.362	-0.12736	0.047672
Percent 65+ years old	-0.14046	0.166557	-0.84	0.405	-0.47859	0.197667
_cons	-5.86408	5.021974	-1.17	0.251	-16.0592	4.331069

F(6,35) = 2.06; $p = 0.0840$; Adj R-squared = 0.1339

Table 7.16. *Multiple linear regression for changes in Obesity Prevalence with changes in Expenditures per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	0.001592	0.014097	0.11	0.911	-0.02703	0.03021
Percent below poverty	0.22631	0.146907	1.54	0.132	-0.07193	0.524546
Percent High School graduation	-0.03304	0.050291	-0.66	0.515	-0.13514	0.069054
Percent with Health Insurance	-0.04047	0.120581	-0.34	0.739	-0.28526	0.204326
Percent population nonwhite	0.061216	0.047152	1.3	0.203	-0.03451	0.156939
Percent 65+ years old	0.002994	0.182177	0.02	0.987	-0.36684	0.372832
_cons	8.713614	5.492934	1.59	0.122	-2.43764	19.86486

F(6,35) = 2.36; $p = 0.0512$; Adj R-squared = 0.1657

Table 7.17. *Multiple linear regression for changes in Infectious Diseases with changes in Expenditures per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.13041	0.111191	-1.17	0.249	-0.35614	0.095319
Percent below poverty	1.02692	1.158756	0.89	0.382	-1.32548	3.379319
Percent High School graduation	0.21057	0.396678	0.53	0.599	-0.59473	1.01587
Percent with Health Insurance	-2.33553	0.951108	-2.46	0.019	-4.26638	-0.40468
Percent population nonwhite	0.387307	0.37192	1.04	0.305	-0.36773	1.142345
Percent 65+ years old	0.978739	1.436956	0.68	0.5	-1.93844	3.895916
_cons	-37.7008	43.32665	-0.87	0.39	-125.659	50.257

F(6,35) = 2.29; $p = 0.0576$; Adj R-squared = 0.1583

Table 7.18. *Multiple linear regression for changes in Infant Mortality with changes in Expenditures per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.00387	0.005999	-0.65	0.523	-0.01605	0.008307
Percent below poverty	-0.01756	0.062517	-0.28	0.781	-0.14447	0.109361
Percent High School graduation	-0.04703	0.021402	-2.2	0.035	-0.09047	-0.00358
Percent with Health Insurance	-0.01181	0.051314	-0.23	0.819	-0.11598	0.092367
Percent population nonwhite	-0.01775	0.020066	-0.88	0.382	-0.05849	0.022982
Percent 65+ years old	0.014706	0.077527	0.19	0.851	-0.14268	0.172094
_cons	3.140962	2.337555	1.34	0.188	-1.60453	7.886452

F(6,35) = 1.14; $p = 0.3592$; Adj R-squared = 0.0203

Table 7.19. *Multiple linear regression for changes in Cardiovascular Disease deaths with changes in Expenditures per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.05826	0.09996	-0.58	0.564	-0.26119	0.144671
Percent below poverty	0.121768	1.041715	0.12	0.908	-1.99303	2.236563
Percent High School graduation	-0.48158	0.356612	-1.35	0.186	-1.20554	0.242384
Percent with Health Insurance	-0.16869	0.855041	-0.2	0.845	-1.90451	1.567137
Percent population nonwhite	0.292035	0.334354	0.87	0.388	-0.38674	0.97081
Percent 65+ years old	-1.21348	1.291816	-0.94	0.354	-3.83601	1.409046
_cons	-16.1003	38.95043	-0.41	0.682	-95.1739	62.97326

F(6,35) = 1.93; $p = 0.1035$; Adj R-squared = 0.1196

Table 7.20. *Multiple linear regression for changes in Cancer deaths with changes in Expenditures per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.01968	0.051722	-0.38	0.706	-0.12468	0.085324
Percent below poverty	1.833734	0.53901	3.4	0.002	0.739485	2.927982
Percent High School graduation	-0.13978	0.18452	-0.76	0.454	-0.51437	0.234816
Percent with Health Insurance	-1.19439	0.44242	-2.7	0.011	-2.09255	-0.29623
Percent population nonwhite	-0.15892	0.173003	-0.92	0.365	-0.51014	0.192292
Percent 65+ years old	-0.60788	0.668419	-0.91	0.369	-1.96484	0.749082
_cons	-0.86447	20.15395	-0.04	0.966	-41.7792	40.05021

F(6,35) = 2.19; $p = .0677$; Adj R-squared = 0.1480

Table 7.21. *Multiple linear regression for changes in Years of Potential Life Lost with changes in Expenditures per capita, using absolute change*

Variable	**Coefficient**	**Std. Err.**	**t**	***P***	**[95% Conf.**	**Interval]**
Expenditures per capita	-5.39513	4.587548	-1.18	0.248	-14.7084	3.918085
Percent below poverty	141.9846	47.80834	2.97	0.005	44.9285	239.0407
Percent High School graduation	-9.74612	16.36629	-0.6	0.555	-42.9715	23.47922
Percent with Health Insurance	-81.2031	39.24114	-2.07	0.046	-160.867	-1.53933
Percent population nonwhite	-31.0747	15.34481	-2.03	0.051	-62.2263	0.076942
Percent 65+ years old	-35.864	59.28644	-0.6	0.549	-156.222	84.49386
_cons	568.6047	1787.586	0.32	0.752	-3060.39	4197.597

$F(6,35) = 2.29$; $p = .0576$; Adj R-squared = 0.1583

Table 7.22. *Multiple linear regression for changes in Smoking Prevalence with changes in FTEs per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	0.097874	0.1579	0.62	0.539	-0.22268	0.418427
Percent below poverty	0.446797	0.136639	3.27	0.002	0.169406	0.724188
Percent High School graduation	0.009112	0.046577	0.2	0.846	-0.08544	0.103668
Percent with Health Insurance	-0.11232	0.10977	-1.02	0.313	-0.33517	0.110521
Percent population nonwhite	-0.04044	0.042788	-0.95	0.351	-0.1273	0.04643
Percent 65+ years old	-0.14251	0.165708	-0.86	0.396	-0.47892	0.19389
_cons	-5.6114	5.015426	-1.12	0.271	-15.7933	4.570454

F(6,35) = 2.13; p = .0748; Adj R-squared = 0.1415

Table 7.23. *Multiple linear regression for changes in Obesity Prevalence with changes in FTEs per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	0.097874	0.1579	0.62	0.539	-0.22268	0.418427
Percent below poverty	0.446797	0.136639	3.27	0.002	0.169406	0.724188
Percent High School graduation	0.009112	0.046577	0.2	0.846	-0.08544	0.103668
Percent with Health Insurance	-0.11232	0.10977	-1.02	0.313	-0.33517	0.110521
Percent population nonwhite	-0.04044	0.042788	-0.95	0.351	-0.1273	0.04643
Percent 65+ years old	-0.14251	0.165708	-0.86	0.396	-0.47892	0.19389
_cons	-5.6114	5.015426	-1.12	0.271	-15.7933	4.570454

F(6,35) = 2.74; p = 0.0275; Adj R-squared = 0.2026

Table 7.24. *Multiple linear regression for changes in Infectious Diseases with changes in FTEs per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.96347	1.385395	-0.7	0.491	-3.77597	1.849037
Percent below poverty	0.90956	1.198853	0.76	0.453	-1.52424	3.343361
Percent High School graduation	0.245686	0.408661	0.6	0.552	-0.58394	1.075312
Percent with Health Insurance	-2.35982	0.963108	-2.45	0.019	-4.31503	-0.40461
Percent population nonwhite	0.418508	0.375422	1.11	0.273	-0.34364	1.180655
Percent 65+ years old	1.04535	1.453901	0.72	0.477	-1.90623	3.996926
_cons	-40.382	44.00487	-0.92	0.365	-129.717	48.95264

F(6,35) = 2.09; $p = 0.0799$; Adj R-squared = 0.1372

Table 7.25. *Multiple linear regression for changes in Infant Mortality with changes in FTEs per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-0.0093	0.074244	-0.13	0.901	-0.16003	0.141419
Percent below poverty	-0.01754	0.064247	-0.27	0.786	-0.14796	0.112892
Percent High School graduation	-0.04706	0.0219	-2.15	0.039	-0.09152	-0.0026
Percent with Health Insurance	-0.01227	0.051613	-0.24	0.813	-0.11705	0.092507
Percent population nonwhite	-0.01676	0.020119	-0.83	0.41	-0.05761	0.02408
Percent 65+ years old	0.016609	0.077915	0.21	0.832	-0.14157	0.174785
_cons	3.109808	2.358237	1.32	0.196	-1.67767	7.897285

F(6,35) = 1.06; $p = 0.4030$; Adj R-squared = 0.0091

Table 7.26. *Multiple linear regression for changes in Cardiovascular Disease deaths with changes in FTEs per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	-1.5757	1.207017	-1.31	0.2	-4.02607	0.874678
Percent below poverty	-0.13857	1.044493	-0.13	0.895	-2.259	1.981867
Percent High School graduation	-0.40212	0.356043	-1.13	0.266	-1.12493	0.320688
Percent with Health Insurance	-0.19461	0.839102	-0.23	0.818	-1.89808	1.508858
Percent population nonwhite	0.302187	0.327084	0.92	0.362	-0.36183	0.966202
Percent 65+ years old	-1.17929	1.266703	-0.93	0.358	-3.75083	1.392257
_cons	-20.173	38.33897	-0.53	0.602	-98.0053	57.6592

$F(6,35) = 2.23$; $p = 0.0633$; Adj R-squared = 0.1524

Table 7.27. *Multiple linear regression for changes in Cancer deaths with changes in FTEs per capita, using absolute change*

Variable	Coefficient	Std. Err.	t	*P*	[95% Conf.	Interval]
Expenditures per capita	0.023936	0.637786	0.04	0.97	-1.27084	1.318711
Percent below poverty	1.846761	0.551909	3.35	0.002	0.726326	2.967195
Percent High School graduation	-0.14391	0.188133	-0.76	0.449	-0.52584	0.238022
Percent with Health Insurance	-1.19583	0.44338	-2.7	0.011	-2.09594	-0.29572
Percent population nonwhite	-0.15366	0.172831	-0.89	0.38	-0.50452	0.197208
Percent 65+ years old	-0.59849	0.669324	-0.89	0.377	-1.95729	0.760315
_cons	-0.84402	20.25826	-0.04	0.967	-41.9705	40.28243

$F(6,35) = 2.15$; $p = 0.0714$; Adj R-squared = 0.1446

Table 7.28. *Multiple linear regression for changes in Years of Potential Life Lost with changes in FTEs per capita, using absolute change*

Variable	**Coefficient**	**Std. Err.**	**t**	***P***	**[95% Conf.**	**Interval]**
Expenditures per capita	-19.5405	57.46376	-0.34	0.736	-136.198	97.11718
Percent below poverty	140.8179	49.72631	2.83	0.008	39.86809	241.7676
Percent High School graduation	-9.42469	16.95053	-0.56	0.582	-43.8361	24.98672
Percent with Health Insurance	-81.9407	39.94802	-2.05	0.048	-163.04	-0.8419
Percent population nonwhite	-29.7167	15.57183	-1.91	0.065	-61.3292	1.895789
Percent 65+ years old	-33.187	60.30527	-0.55	0.586	-155.613	89.23917
_cons	508.6865	1825.244	0.28	0.782	-3196.76	4214.13

$F(6,35) = 2.00$; $p = 0.0917$; Adj R-squared = 0.1280

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