2016

Local Health Department Choice in the Provision of Cancer and Cardiovascular Disease Screening

Georgianne Tiu
University of Kentucky

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Georgianne Tiu, Student

Glen Mays, PhD, MPH, Committee Chair

Wayne Sanderson, PhD, MS, Director of Graduate Studies

ABSTRACT OF CAPSTONE

Georgianne F. Tiu

The College of Public Health

University of Kentucky

2016

LOCAL HEALTH DEPARTMENT CHOICE IN THE PROVISION OF CANCER AND CARDIOVASCULAR DISEASE SCREENING

ABSTRACT OF CAPSTONE

A Capstone project submitted in partial fulfillment of the requirements for the degree of Doctor of Public Health in the College of Public Health
at the University of Kentucky
By:

Georgianne F. Tiu

Lexington, Kentucky

Director: (Glen P. Mays, MPH, PhD)
Lexington, Kentucky
Co-Directors: (F. Douglas Scutchfield, MD, Julia F. Costich, PhD, JD, & Tyrone F. Borders, PhD, MS, MA)
Lexington, Kentucky

ABSTRACT OF CAPSTONE

LOCAL HEALTH DEPARTMENT CHOICE IN THE PROVISION OF CANCER AND CARDIOVASCULAR DISEASE SCREENING

Clinical preventive services, such as cancer and cardiovascular (CVD) disease screenings are critical components essential for reaching optimal population health outcomes. Although clinical preventive services are recognized to save lives, roughly three-fourths of adults between the ages of 50 and 64 and over 50% of adults aged 65 years and older forego clinical preventive services. Private medical practitioners can provide such services. However, public sector entities, such as local health departments (LHDs), can also deliver them in addition to population based activities. Because of a possible substitution effect among health systems, we hypothesized that a LHD's choice to be involved with providing cancer or CVD screenings, is contingent on the availability and capacity of other providers in the community. We merged the 2013 NACCHO Profile Survey with the Area Health Resource Files (AHRF) and used maximum likelihood estimation. Results revealed a LHD's choice to be involved in performing CVD screening directly in a LHD is statistically associated with the availability and supply of private providers in the community, whereas involvement with cancer screening did not reach statistical significance. Other key organizational and sociodemographic variables were strongly associated. The interplay between health systems and its impact on population health outcomes further illustrates the need to support public health practice and policy.

KEYWORDS: (local health departments, clinical preventive services, cancer screening, cardiovascular disease screening, discrete choice)

(Student's Signature) Georgianne J. Tiu

(Date) 06/06/2016

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By

Georgianne F. Tiu

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Glen P. Mays, MPH, PhD (Capstone Director)

Richard C. Ingram, DrPH (Director of Doctoral Studies)

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Georgianne F. Tiu

College of Public Health

University of Kentucky

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This dissertation is dedicated to the memory of my best friend, my mother, as she was the inspiration for ever dreaming of pursuing a doctorate…and the inspiration for finishing it.

CHAPTER 1
INTRODUCTION

Background

The delivery of clinical preventive services has gained political spotlight in the past years. Private practices and clinics have been the traditional health system to deliver clinical care, but they are not the sole community providers. Other health systems such as local health departments (LHD) are unique in that they can provide both personal healthcare services such as clinical preventive, medical treatment, and specialty care services and implement activities for improving population health. Often, uninsured residents seek out clinical preventive services from LHDs and other entities such as community health centers that contribute to the "safety-net" to fill unmet health care needs. As part of the assurance function of public health, LHDs can implement personal healthcare services directly or by linking patients to other health care providers in the community by contracting out services. LHDs can also choose to be uninvolved in the provision of personal healthcare services, letting the community rely on the other healthcare providers to deliver care. Despite the assurance function, however, who should "assure conditions in which people can be healthy" is subject to debate, and disagreement on what role public health should play in directly providing personal healthcare services is on-going.

The Institute of Medicine (IOM) defined public health as "[a] coordinated effort at the local, state, and federal levels whose mission is fulfilling society's interest in assuring conditions in which people can be healthy."[1] Some LHD directors believe that offering clinical services is a part of the overall mission of public health.[2,3] Others follow the IOM recommendations on the future of public health, which advise LHDs to shy away from offering clinical services and focus on the core public health functions of assessment, assurance, and policy development.[4,5] In the early 2000s, Keane *et al.* conducted a series of studies on LHD directors' personal beliefs concerning privatizing public health services, not offering clinical services, and discontinuing direct provision of these services.[2,3,6–10] More recent research by Hsuan and Rodriguez found that 198 large LHDs discontinued approximately 5.6 clinical services per LHD from 1997 to 2008; however, more than 20% of LHDs adopted new services.[11] These findings suggest that despite declining trends in direct provision of clinical preventive services, some LHDs still realize the value of offering them directly.

Other recent research suggests trends within the wide variation in the provision of personal healthcare delivery and its dependence on organizational, institutional, or environmental factors. Luo *et al* revealed a positive association between clinical preventive health services' share of revenue and per capita expenditures.[12] Recent research conducted by Wright and Nice provides evidence that variation in the provision of primary care services in LHDs is a function of health center availability in the county.[13] Furthermore, Beatty and colleagues identified major differences in direct clinical service provision in small and large rural LHDs as well as urban LHDs.[14]

Statement of the Problem

Despite the evidence base on privatization and discontinuation of clinical preventive health services, not much is known about the drivers behind an LHD's decision to be involved with clinical preventive healthcare services such as cancer and cardiovascular disease screening. Understanding more about these decisions is important, as LHDs exhibited higher levels of involvement in disease screening compared to the delivery of primary care services in 2013.[13] In a 2013 survey, approximately 83% of LHDs screened for breast cancer, 88% screened for cervical cancer, and about 41% screened for colon cancer.[15] Some LHDs (19%) provide prostate cancer screening activities as a component of primary prevention.[16] For cardiovascular disease, 27% of all LHDs surveyed provided preventive screening services in 2013.[15]

The Affordable Care Act (ACA), Medicaid expansion, and rising rates of insured individuals have increased the demand for health care services and has simultaneously created challenges for health care providers.[17] Safety-net providers such as LHDs and community health centers that offer clinical preventive health services will continue to play an important role in filling unmet needs.[17] This is especially important since, as Ku *et al* discovered, most safety-net patients do not see these systems as a last resort; instead, they actually prefer the types of care they receive there.[17] In addition, since the implementation of the ACA, the demand for primary care services has outpaced the supply.[18] In many remote regions of the United States, clinical preventive health services are simply not available. Healthcare providers are either absent, unaffordable, or not accessible because of special health care needs, insurance status or type, distance, or cultural barriers.[18] Residents of these communities depend on neighboring LHDs or community health centers for their healthcare needs.

Purpose of the Study

Through early detection, chronic disease screening activities could have appreciable implications on population health indicators as well as healthcare expenditures. On the contrary, however, LHDs could also explore the possibility on focusing more on traditional public health activities, since more people are increasingly obtaining health insurance through the Medicaid expansions and state and federal health exchanges.[19] These newly insured individuals may seek other providers besides the LHD for healthcare needs. Moreover, some believe that the decision to provide primary care services is contingent on the availability and capacity of other safety-net providers in the area, such as FQHCs.[13] Because of a possible substitution effect, we hypothesize that a LHD's choice to provide clinical preventive services such as cancer and cardiovascular disease screening are dependent on the availability and supply of other healthcare providers in the community.

Conceptual Framework

The conceptual framework for our study draws from economic, organizational, and management theories. Organizational theories of human service organizations[20] (i.e., political-economy and institutional theories) are used to explain how the environment can influence organizational structure, and hence decision making in the provision of service delivery. The economic random utility theory provides a framework for LHD delivery choice.

Organizational theories emerged more than 50 years ago in the public administration literature. Some organizational theories are more applicable to human service organizations than others because of the distinct characteristic that separates human services from others — human services work on people to transform them.[20] This attribute contributes to the complexity of the nature of human service organizations. Thus, work from the 1970s by Wamsley & Zald[21] on political economy and Meyer & Rowan[22] on institutional theory provide salient frameworks for human service organizations,[20] including public health services and systems.[11,23–27]

The political-economy theory has several notable attributes that can be applied to public health systems. First, it acknowledges that two fundamental types of resources must be obtained by an organization in order to survive and yield services: (1) legitimacy and power (i.e., political) and (2) production resources (i.e., economic).[21] Wamsley & Zald proposed that "just as nation-states vary in their political economies — their structure of rule authority, succession to high office, power and authority distribution, division of labor, incentive systems and modes of allocation of resources — so, too, do organizations."[21] Second, this theory stresses the importance of environments, especially the task environment, composed of stakeholders that can be governmental or non-governmental organizations or interest groups who are relevant because they have control of resources needed by the organization or they have a stake so they can advance their own agendas. Third, a key feature is the idea of resource dependence.[28] Pfeffer and Salancik suggest that as the dependence on resources controlled by an external entity increases, so does the influence of that entity on the organization. Fourth, since an organization needs to possess stability in the flow of external resources while simultaneously preserving independence and autonomy, it can participate in strategies that range from competition to co-optation to survive among members of the external environment.[29] Fifth, within the organization, power and economic relations regulate how service technology is applied and how decision-making units are disseminated among the organizational divisions. However, important attributes of the institution are lacking with the political-economy theory. Therefore, institutional theory offers constructs that alleviates this limitation.

Institutional theory emphasizes societal and organizational values and norms, and contends that the structure of certain types of organizations, namely human service organizations, is determined not by technology but by rules originating from the institutional environment.[20] Public opinion from important constituencies, knowledge legitimated by the educational system, by social prestige, by laws, and by the courts[22] are examples of rules from the institutionalized environment.

In addition to political-economy and institutional theories, economic theories such as the random utility theory provides a framework for rational decision making and discrete choices. Discrete choice random utility theory has three main assumptions: (1) choice is a discrete event (0,1); (2) attraction or utility towards a service provision choice varies across individual LHDs as a random variable; (3) the LHD chooses the service provision choice with the highest utility. When a LHD chooses an option that produces the highest utility, it can be best described as the degree of "want-satisfaction" provided by a product or service. It is important to note, however, that utility and predicting choices cannot be measured exactly since choices vary (and are random) across individuals LHDs. A LHD in our study can choose between three discrete choices: (1) the choice to remain uninvolved and allow others in the community independent of LHD funding provide the service; (2) contract out the service; or (3) perform the service directly.

Organizational, Institutional, and Environmental characteristics

Drawing upon the attributes of political-economy and institutional theories, previous empirical studies indicate that organizational, financial, and institutional characteristics influence the public health system.[11,23–26] These organizational and institutional attributes likely influence service delivery arrangements among LHDs.

LHD workforce and staff may influence service delivery of personal health care services. The presence of a clinician executive director (MD or DO) may play a role in the decision to provide primary care services that include the clinical preventive services of disease screening. By contrast, the presence of an executive director with a public health education (MPH or DrPH) may also play a role.[13]

Funding affects the amount and types of resources consumed, workforce personnel employed, and public health activities offered.[23] It is not surprising that LHDs that face financial constraints are more likely to share resources.[26] Local tax bases and other sources of revenue are used to fund public health services and activities.[30] Economically disadvantaged communities may have limited tax bases and face competition for resources which can create difficulties in supporting the full array of public health activities.[31,32]

Political dynamics can influence an organization.[26] Recent evidence revealed that political dynamics such as the presence or absence of a local board of health influences public health spending,[24,33–35] performance,[23] adoption and discontinuation of clinical services among LHDs,[11] and local health department collaborative capacity.[25] Therefore, investigating the effect of a local board of health is included in our study.

Local governmental public health agencies can function as centralized administrative units of a state health agency or as decentralized, autonomous units of local government.[27] Districts and jurisdictions with a decentralized political structure have the ability to differentiate themselves by providing specific arrangements of public services and taxing structures.[36] Decentralized political structures tend to be more informed and responsive to local community needs[27,33,37–40] and consequently increases societal well-being.[36,40] Previous evidence illustrates that state-governed LHDs share resources most extensively, as well as LHDs that cover multiple jurisdictions, and states with centralized governance.[26]

Externalities and inequities are main concerns with decentralized units. Giving local governments the power to provide services to their communities without funding support from higher levels of government can make inequality worse if citizens self-select into jurisdictions that are based on their capacity to pay for services.[36] In other words, residents with lower incomes may be forced to gravitate toward areas that have lower tax bases, creating an unchanging cycle of decreased ability for local governments to pay for health services offered by governmental agencies, such as LHDs. Centralizing the governmental structures or coordinating decision-making across governments would internalize these externalities by addressing spillover effects and correcting inequities.[36,40]

Governmental jurisdiction type (i.e., county versus multi-county) can also influence the extent of shared organizational functions. According to Vest & Shah, shared organizational functions were higher among LHDs with county and multicounty/district jurisdictions compared to cities.[26]

Population characteristics that reflect the health needs and resources of a community and the social and economic determinants influence an organization. Employment and income, educational attainment, race and ethnicity, age, language and culture influence many aspects of the public health system.[41–48] In addition, geographic location could also be a factor. Jurisdictions located in small or rural areas with smaller populations may spend more on certain public health activities, which may lead some public health agencies to consider sharing resources through mergers and consolidations, regional alliances, or joint operating agreements[23] or privatizing and contracting out services to other health systems.

Operational Definitions

A local health department is defined 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."[49]

LHDs exhibit large variations in personal healthcare services. Out of 87 public health services surveyed in the NACCHO Profile studies, 22 services are considered personal healthcare services.[12] Luo *et al* collectively classified these 22 services, and adapted them from Mays and Smith.[24] Personal healthcare services are categorized as clinical preventive services, medical treatment services, and specialty care services.[12] We focused on the clinical preventive services of cancer and cardiovascular disease screening

Performed directly by the LHD

Some public health systems feel the pressure to assure access to medical care services, especially in smaller and rural areas that face challenges with healthcare professional shortages with large populations of low-income, uninsured, and underinsured residents. This is because many LHD leaders still believe that offering these services is an intrinsic part of the mission of public health The LHD helps to fill the gaps in the "safety net."[3] Moreover, personal health care services can produce a significant proportion of revenue from self-generated fee-for-service dollars that is used to perform core public health functions.[50] In a recent study conducted by Hsuan and Rodriguez, using panel data from 1997 and 208, 22.2% of LHDs surveyed maintained or adopted the provision of clinical services.[11] Adopter LHDs tended to offer personal healthcare services that generated revenue.[11] In a study conducted by Keane *et al* in 2001, 28% of LHD directors surveyed self-reported that LHDs were the primary provider of services to uninsured residents in their jurisdictions.[3]

Contracted Out by LHD

Besides performing personal healthcare services directly, LHDs may choose to contract out or privatize these services. Previous work by Keane *et al* conducted in the early 2000s provided insight to the beliefs as to why LHD directors blieved they should contract out or privatize personal healthcare services and discontinue direct offerings.[3,8,10,50–52] Surveys were sent to 380 LHD directors, and they obtained a completion rate of 75%. In one study, when asked to hypothetically assume that no one was uninsured, 53% of LHD directors believed that a LHD should provide personal healthcare services directly.[3] Keane *et al* also discovered that 73% of LHD directors surveyed privatized at least some public health service.[52] In another study by Keane *et al* on the same sample of directors, more than half the directors believed that privatizing services had a positive effect on their department's performance of the core public health functions.[50] Privatizing personal healthcare services was the most common with 70 percent of LHDs contracting out to other healthcare providers in the community.[50] This included maternal and child health (20%), pediatric primary care (19%), and family planning (12 %). Some communicable disease services were privatized in almost a third (27%) of LHDs, with 13% percent privatizing HIV services, 9 % for STD services other than HIV, and tuberculosis services (9%). All of these services are considered to be personal healthcare services. Despite the positive effects of privatizing personal healthcare services, privatization can also lead to the loss of revenue and result in less funding to perform essential core public health activities necessary for improving population health.[12,50] In a recent study on personal healthcare services in LHDs to date conducted by Luo *et al*,[12] fixed effect panel models revealed a positive association between personal healthcare services' share of revenue and per capita expenditures from 2008-2013. LHDs with jurisdiction sizes of <25,000 people highly depend on personal healthcare services to maintain per capita expenditures.[12]

Contracting out services can be considered a form of cross-jurisdictional sharing. In 2013, around 50% of LHDs that served populations less than 500,000 and 35% of LHDs that served more than 500,000 people shared resources such as equipment, staff, or funding with one or more LHDs on a regular basis.[15] Empirical evidence suggests that CJS can improve both efficiency (i.e., achieving maximum results for every dollar that is invested) and effectiveness (i.e., the scope and quality of services offered) of public health services.[53] This is because a greater volume of public health services would be delivered and fixed costs would be distributed over a larger population of taxpayers and beneficiaries, lowering per unit costs.[23,36] Public health agencies that serve larger jurisdictions can achieve economies of scale when performing public health activities that require high fixed costs, such as surveillance systems.[23] The sharing spectrum ranges from informal and customary agreements with looser integration to complete consolidation of LHD agencies with tighter integration.[53,54]

Provided by Others in the Community Independent of LHD Funding

Besides the LHD, private medical practices, clinics, and FQHCs can provide cancer and cardiovascular disease screening. To date, there are 126,865 Family Medicine/General Practice physicians,[55] and as of 2013, there were 1,202 federally qualified health centers.[56] Depending on the geographic location and need of the community, community and migrant health centers (C/MHC), rural health clinics (RHC), and federally qualified health centers (FQHC) can act as safety-nets and fill unmet healthcare needs. FQHCs served more than 20 million patients and operated more than 8,100 health care delivery sites in every state and US territory in 2010.[57] Furthermore, health centers provide a fourth of all primary care visits for low-income individuals.[58]

Overview of Project Processes

Investigating if a LHD's choice to be involved with the delivery of clinical preventive services is contingent on the supply and availability of other healthcare providers in the community who are independent of LHD funding, is the purpose of this dissertation. Combining the 2013 National Association for County and City Health Officials (NACCHO) Profile Data with the NACCHO Boundary Files and Area Health Resource Files (AHRF)(2013-2014, 2014-2015), we conducted secondary data analysis with discrete choice binary, multinomial, and sequential logit models using maximum likelihood estimation. We focused on the specific clinical preventive services of cancer screening and cardiovascular disease screening activities. Chapter 1 contains the overall purpose and significance, with a general overview containing literature review and theory/conceptual framework as well as operational definitions. Chapter 2 discusses the data sources and methodology used for maximum likelihood estimation. Chapter 3 focuses on the cancer screening, and Chapter 4 focuses on the cardiovascular disease screening. Lastly, Chapter 5 contains overall conclusions and discusses major implications for both public health and medical care delivery systems.

Scope and Importance of Study

In summary, the provision of clinical preventive services by LHDs is of timely health policy importance, as many Americans struggle with chronic diseases, such as cancer and cardiovascular disease. In 2012, the Institute of Medicine published a report entitled, *Primary Care and Public Health: Exploring Integration to Improve Population Health*, and prompted new attention to the need for integration and collaboration among health systems in order to achieve optimal population health outcomes. Therefore, it is crucial to re-examine the level of involvement with offering healthcare services among LHDs[12] and gain further insight to the factors that influence a LHD's choice to be involved with disease screening activities.

CHAPTER 2
METHODOLOGY

Introduction

This chapter presents an overview of the data sources, underlying utility theory, and statistical methods used in Chapters 3 and 4. Data sources and description are described first. Steps for merging the datasets are described next. Dependent and independent variables are then discussed. Lastly, statistical analysis and specification tests are presented in detail.

Data Sources and Description

We used three different data sources for our studies. The study sample included LHDs that participated in the 2013 National Association of County and City Health Officials (NACCHO) Profile of Local Health Departments (Profile Survey).[15] NACCHO conducted the survey from January to March 2013. Rhode Island and Hawaii were not included in the NACCHO Profile Survey because these states do not operate LHDs. The Profile survey instrument encompassed a core questionnaire along with two separate modules. The core questionnaire was disseminated to all local health departments in the United States. Each module was disseminated to a random sample stratified by population served without replacement. A total of 2,000 out of 2,532 LHDs completed the survey, making the overall response rate 79%.[15] For this study, we analyzed data from survey questions from the Core questionnaire, (Activities section) focusing on the cancer and cardiovascular disease screening activities.

The NACCHO Boundary Files were the second data set used for our studies. It contains five digit Federal Information Processing Standard (FIPS) county codes. This code is a unique identifier for counties and county equivalents. For example, the FIPS county code for Fayette County, Kentucky is 21067.

The third data source was the Area Health Resource File (AHRF). The AHRF contains a vast amount of data on health care supply factors such as information on healthcare professionals, health facilities, utilization, expenditures, environment, and workforce, for instance. The AHRF contains FIPS county codes that were used to link LHDs to the NACCHO Profile Survey. To obtain 2013 variables, we pulled data from the 2013-2014 AHRF and the 2014-2015 AHRF.

For each activity in the charts below and on the following pages, check whether and how your LHD provided that activity or service in your jurisdiction <u>during the past year.</u>

- Indicate whether your LHD performed the activity and/or contracted out for it. Select both boxes if your LHD both performed the activity directly and contracted out for it.
- Contract out is defined as "Pay another organization to perform this activity or service on behalf of your LHD".
- "Provided by others in community independent of LHD funding" means that other organizations provide these services and do not receive funding from the LHD to provide them. Other organizations include but are not limited to other state and local government agencies, other healthcare providers (e.g., private physicians, non-LHD clinics, hospitals), schools, and community organizations.
- If a service is provided by the LHD and others in the community, select both choices.
- Do not leave any rows blank

Figure 2.1. Excerpt from the NACCHO Profile Survey. This illustrates the instructions for the survey respondent and is taken directly from the "Activities" section.

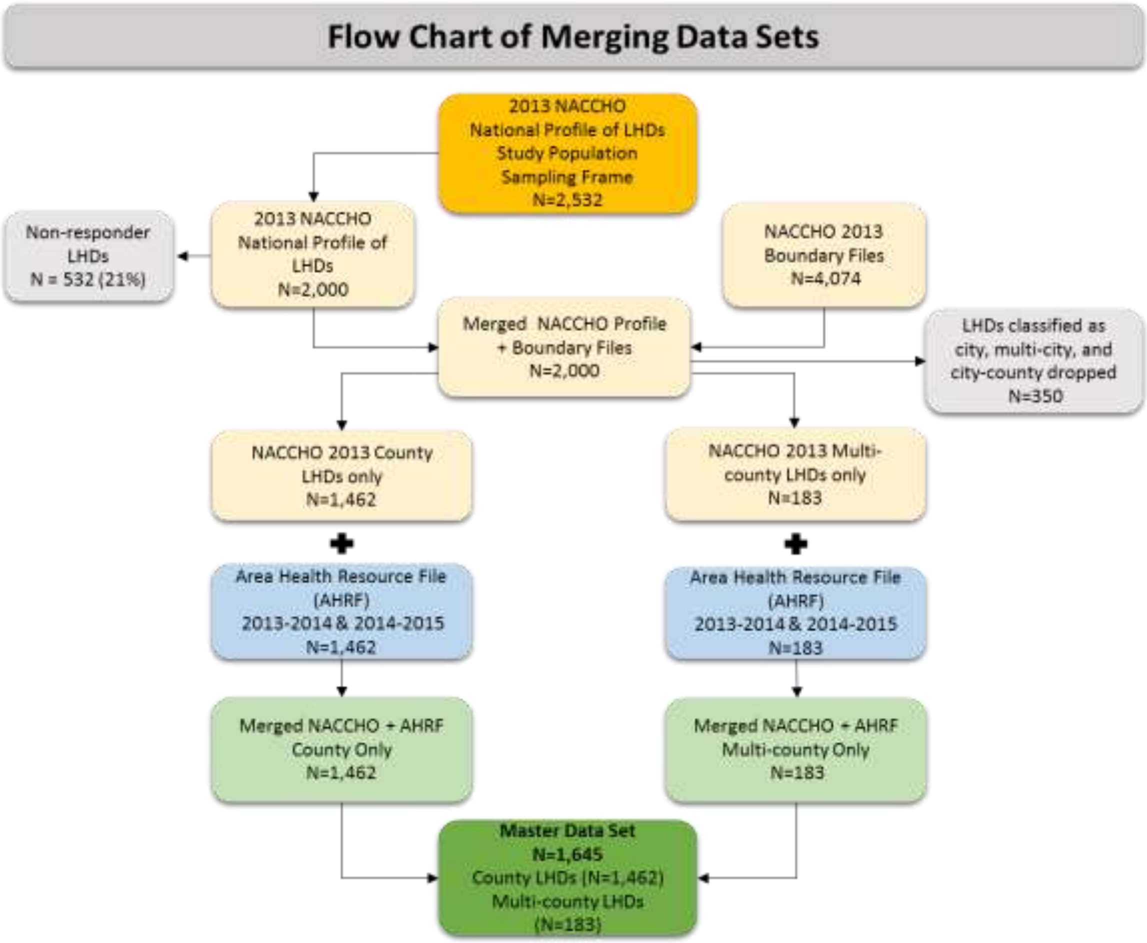

Figure 2.2. Flow Chart of Merging Datasets. This figure outlines the steps used for creating the master dataset for the statistical analysis conducted in Chapters 3 and 4.

We obtained the NACCHO Profile Survey upon approval of an application from the *Interuniversity Consortium for Political and Social Research* (*ICPSR*). The NACCHO Boundary files were obtained from the NACCHO website. Likewise, the last dataset used for our study, the Area Health Resource Files (AHRF), were obtained from their website as well.

After obtaining all datasets, we merged them. Figure 1 illustrates the flow chart for the steps taken to merge the datasets. We first merged the NACCHO Profile Survey dataset with the NACCHO Boundary Files using the common variable, "nacchoid." Each LHD is designated a unique nacchoid. LHDs classified as, "city," "multi-city," and "city-county" were dropped from the merged NACCHO dataset. Next we separated this dataset into "county only" and "multi-county only." For each separate dataset, we merged them with the AHRF, using the "FIPS county code" as the merging variable. Since the AHRF contains more FIPS county codes than NACCHO, several FIPS county codes without a matching LHD were deleted. Next, we merged the county and multi-county LHDs together. Because multi-county LHDs are comprised of several counties (with multiple FIPS county codes), independent variables for the multi-county LHDs were summated if the variable was a count or created into population weighted averages. Multi-county variables were then collapsed, with one nacchoid per LHD. The final study sample consisted of 1,645 matched LHDs.

Variables

Dependent variable

Because we hypothesized that choosing to be involved with the delivery of clinical preventive services (i.e., by contracting out or performing the service directly) is dependent on the availability and supply of other healthcare professionals and systems in the community, our dependent variable is a discrete choice (0,1). The first model we constructed was a simple binary logit, in which whether or not a LHD was involved in delivering a screening service. The choices of performing service directly or contracting out was aggregated into the singular choice, "involved." It is important to note that the survey respondent from the NACCHO Profile was allowed to select more than one answer choice. For discrete choice models, however, it is crucial that only one observation select one choice. Therefore, we coded the variable to reflect only one answer choice, always keeping in mind the most logical choice. For instance, if a LHD selected that it implemented cancer screening directly and others in the community provide it, then the dependent variable was coded as performed cancer screening directly.

Subsequently, we expanded the choice set in the multinomial model, since a LHD could choose between three options: (1) stay uninvolved and let others in the community provide the service (base); (2) contract out; or (3) directly perform the service. We used a multinomial logit model to discern if the three choices (as opposed to only two in the binary logit model) are dependent on the availability and supply of other healthcare providers in the community, while controlling for other covariates.

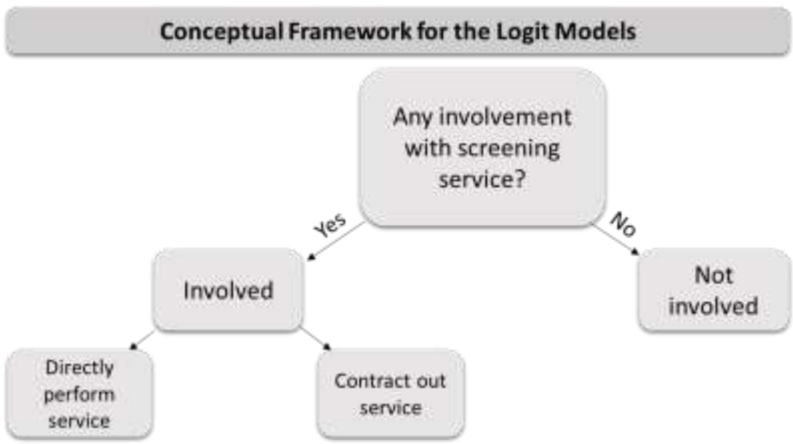

Figure 2.3 Conceptual Framework for the Discrete Choice Models. A LHD is first faced with the choice to become involved with the delivery of a personal healthcare service such as cancer or cardiovascular disease screening. By contrast, a LHD could also choose to be uninvolved in the screening activities, letting others (i.e., private practices, hospitals, FQHCs) independent of LHD funding provide the service to the community. If the LHD does choose to be involved, then it has two options: (1) directly perform the service or (2) contract out the service to other healthcare professionals in the community.

The binary and multinomial logit estimations use random utility discrete choice models. In economics, utility can be described as the degree of "want-satisfaction" provided by a product or service. In addition, choice behavior is contingent upon the assumption that individuals make rational choices. Despite this assumption, however, utility and predicting choices cannot be measured exactly. Therefore, in random utility models,

$$u_{ij} = v_{ij} + \varepsilon_{ij}$$

utility, u_{ij}, given to individual i by choice j is made up of a deterministic component, v_{ij}, and an unobserved stochastic error component, ε_{ij} . Therefore, a designated leader in a LHD makes a rational choice, choosing the option that has the highest utility. Identifying if the decision to be involved in disease screening is dependent on the availability of other providers in the community is the primary research interest. Furthermore, investigating if a LHD's decisions are sequential on a previous decision is also of interest, for reasons explained later. The sequential logit models are not random discrete utility models, for they are conventional binary logistic estimations done in sequence.

Independent variables

Because we hypothesized that choosing to be involved with the delivery of personal healthcare services (i.e., by contracting out or performing the service directly), such as cancer and cardiovascular disease screening activities, are dependent on the availability and supply of healthcare providers in the community, our main independent variables of interest are primary care physicians and midlevels (i.e., physician assistants, nurse practitioners, and advanced practice nurses), who are the other healthcare providers independent of LHD funding. We also controlled for institutional, financial, and community variables consistent with previous public health services and systems research and organizational and institutional theories.[23,26]

In terms of other healthcare supply factors, we controlled for the presence of a federally qualified health center (FQHC) and total hospital beds per 10,000 population.

For demographic factors, we controlled for the percentages of non-white race, Hispanic ethnicity, in poverty, and uninsured.

LHD staffing and leadership variables were LHD staff per 10,000 population, percentage of LHDs with a clinician (MD, DO) executive director, and percentage of LHDs with a public health (MPH, DrPH) executive director.

Variables for LHD governance characteristics included the presence of a local board of health (LBOH) to measure LHD autonomy. To measure the state-local administrative relationship, we categorized the variable into shared (omitted), local, or state governance.

For geographic location, we created three dummy variables of rural (omitted), urban (nonmetro), and metro, using the classification system established by the 2013 Rural Urban Commuting Area codes. RUCA categories 1–3 were coded as metro, categories 4–7 were coded as urban (nonmetro), and categories 8-9 were coded as rural.[59]

For LHD jurisdiction type, we included only county (omitted) or multi-county variables.

Lastly, for LHD jurisdiction population size served, we categorized this variables into 5 categories: population size served <25,000; 25,000-49,999; 50,000-99,999, 100,00 – 499,999 and >500,000.

2013 Rural-Urban Continuum Codes
Metro counties
1 Counties in metro areas of 1 million population or more
2 Counties in metro areas of 250,000 to 1 million population
3 Counties in metro areas of fewer than 250,000 population
Nonmetro counties
4 Urban population of 20,000 or more, adjacent to a metro area
5 Urban population of 20,000 or more, not adjacent to a metro area
6 Urban population of 2,500 to 19,999, adjacent to a metro area
7 Urban population of 2,500 to 19,999, not adjacent to a metro area
Completely rural
8 Completely rural or less than 2,500 urban population, adjacent to a metro area
9 Completely rural or less than 2,500 urban population, not adjacent to a metro area

Figure 2.4 2013 Rural-Urban Continuum Codes. Contains the code description of the geographic categories.

There are several ways to define urban, suburban, and rural geographic regions of the US.[60] According to NACCHO, a LHD is defined 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."[61] In the 2005 NACCHO Profile, NACCHO classified urban, suburban, and rural LHDs based on Rural-Urban Commuting Area (RUCA) codes developed by the Economic Research Service of the US Department of Agriculture. The codes classify census tracts using population density, daily commuting, and urbanization.[59,60,62] The 2013 NACCHO Profile did not classify LHDs using the RUCA codes. However, RUCA codes are contained in the AHRF. Therefore, we determined which geographic regions the LHDs belonged to by matching FIPS county codes from the AHRF. We used the most recent RUCA codes from 2013.[59] Using census tract demographic and work commuting data, RUCA created 9 major categories. A RUCA code of 1.0, for instance, signifies a metro county in which residents commute mostly within the area. RUCA categories 1-3 were coded "metro," categories 4–7 were coded "urban (nonmetro)," and categories 8-9 were coded "rural."

Statistical Analysis

Our research questions of interest are, "Is the decision to be involved with delivering cancer or cardiovascular disease screening dependent on the availability or supply of other healthcare professionals (health systems) in the community?" and "What factors lead communities to lean on public versus private providers?"

After we successfully merged the datasets, we conducted specification tests. Descriptive statistics were then generated to examine the distribution of responses. Sample summary statistics are presented in Table 1 in Chapters 3 (cancer screening) and 4 (cardiovascular disease screening).

Specification tests to finding the preferred model

To account for the possibility of interactions, we created a model without interaction terms (parsimonious) as well as a model with interaction terms. We conducted specification tests to determine which the preferred model. To test for multi-collinearity, we employed pairwise correlation tests for multicollinearity using the "correlate" command and the "collin" command. The variance inflation factor (VIFs) illustrated that all covariates were acceptable for estimation. All covariates were between values of approximately 1.12-2.53, signifying only mild correlation. Tolerance for all covariates were above 0.4 (As a rule of thumb, a tolerance of 0.1 or less (equivalent to VIF of 10 or greater) is a cause for concern.) It is important to note that some degree of collinearity is to be expected. Three covariates had very mild collinearity and were the percent of people in poverty (VIF = 2.17), metro location (VIF = 2.27) and jurisdiction population size (VIF = 2.53). Because of previously published work and theory, we decided to keep the covariates in the model. Furthermore, newer versions of Stata detect the presence of perfect collinearity and will drop variables that are too collinear after estimation is executed. No covariates were dropped from our models.

Both the parsimonious model and model with interaction terms were analyzed with binary logit estimation. Binary logit estimation was used because of the discrete choice dependent variable, and estimates are obtained through the use of maximum likelihood estimation. For a study sample with N independent observations, the maximum likelihood estimator (MLE), $\hat{\beta}$, maximizes the associated log-likelihood function

$$\ln L(\beta) = \sum_{i=1}^{N} [y_i \ln F(x_i'\beta) + (1 - y_i) \ln\{1 - F(x_i'\beta)\}]$$

Accordingly, the MLE is produced by iterative methods. Furthermore, it is asymptotically normally distributed. For each screening service, we conducted a binary logit estimation and obtained beta values and average marginal effects (AME). The marginal effects are the outcomes of interest because in non-linear models, they are more informative than beta values.[63] The standard errors for the marginal effects were obtained using the delta method, in which Stata generated the output.

Furthermore, we used log likelihood ratio tests (LR test) to determine the preferred model. Log likelihood ratios are provided in the output post-estimation. A manual LR test revealed that the parsimonious model (without the interaction terms) was indeed the preferred model. The p-value for the chi square statistic was determined to be insignificant after computation in Excel using the "CHI.DIST" function. The insignificant p-value suggested that the model with interaction terms is not better than the parsimonious model. Therefore, we chose to perform estimations with the parsimonious model.

Specification test between binomial and multinomial logit models

After estimation with the binary logit models, we also executed multinomial logit estimation and obtained the maximum likelihood estimates of betas with standard errors and average marginal effects (AME) predicted at each outcome (except the base of "not involved") with standard errors. For multinomial models, the maximum likelihood estimator (MLE), $\hat{\theta}$, maximizes the log-likelihood function:

$$\ln L(\theta) = \sum_{i=1}^{N} \sum_{j=1}^{m} y_{ij} \ln F_j(x_i, \theta)$$

It is important to note that the signs of the beta values may not have the same sign as the MEs. We therefore conducted another manual LR test to determine if the binary or multinomial model was the preferred model. The results revealed that the chi square statistic was significant (p<.001), illustrating that the multinomial model is preferred over the binary logit model.

Specification tests between multinomial and sequential logit models

After the completion of the multinomial estimations, we used the Hausman test to determine if the multinomial model violated the independence of irrelevant alternative assumption (IIA). The IIA is a part of the discrete choice theory and assumes that the relative odds of selecting between two or more choices are independent of other choices being considered at the same time. For example, based on this assumption, a voter would have the same odds of choosing between Trump and Clinton compared to choosing between Trump, Clinton, and a third candidate running for Presidency. In essence, the IIA assumption is based on the premise that when individuals have the opportunity to choose among a set of alternatives, the odds of choosing A over B should not depend if another alternative, C, were introduced as a choice.

The Hausman-McFadden[64] and the Small-Hsiao[65] test are the two most notable tests for the IIA in multinomial models. Therefore, we conducted the Hausman test to determine if our multinomial models adhered or violated the IIA assumption. After performing the Hausman test on both the cancer and cardiovascular disease screening multinomial models, the chi square statistic was not significant and negative, meaning the multinomial models violated the IIA assumption. The results of this test suggest that the choices are nested within one another. It is important to note two important attributes of the tests: (1) this assumption is more applicable to conditional, nested logit models and (2) more recent work conducted by Fry and Harris[66,67] and Cheng and Long[68], illustrate that both the Hausman-McFadden and Small-Hsiao test perform poorly, despite large sample sizes. Cheng and Long even concluded that, "tests of the IIA assumption that are based on the estimation of a restricted choice set are unsatisfactory for applied work." [68]

Because the multinomial models failed the Hausman test (see Appendix I), we constructed a sequential logit model, also known as hierarchical logit (see Appendix I). The sequential logit estimation was used because of the nature of our research questions and the lack of what is known as alternative specific covariates. The sequential logit model, in simpler terms, is two separate conventional binary logit estimations, completed right after another. It is called this because the model proceeds in a sequential fashion, where the individual enters transitions, one after the other, depending on the previous decision made. We followed the procedure outlined by Rodriguez.[69] For our research questions, we created two transition phases, following the conceptual model illustrated in Figure 2.3. Transition 1 consists of whether or not a LHD is involved in performing a screening service. If the answer is "yes," then the LHD enters Transition 2. Focusing only on LHDs that chose to be "involved," Transition 2 consists of whether or not the LHD directly performs the service or contracts it out. Each transition represents two separate binary logit estimations, with the base for Transition 1 as "not involved" and the base for Transition 2 as "performed directly." Each sequential logit model produces a separate log likelihood value. The log likelihood values from each binary logit estimation were then added together. That value was compared against the log likelihood value of the multinomial estimation. Using a manual log likelihood ratio test, the chi square statistic was not significant, providing further evidence that the log likelihood values of the sequential logit models and the multinomial model were not statistically different. The cancer multinomial model's log likelihood value, for example, was -1117.2108, and the combined log likelihoods of the two sequential logits added up to -1118.4908. These values are almost identical. In fact, the multinomial model is actually slightly better than the sequential logit models. The less negative the log likelihood, the better.

Furthermore, a deviance test was also conducted. The chi square statistic was not large and insignificant. If the null hypothesis, H_0, has an insignificant p-value, then H_0 cannot be rejected. Therefore, it can be safely concluded that "the fitting of the model of interest is substantially similar to that of the most completed model that can be built."[70] In other words, this means that the two transitions of the sequential logit models put together are almost identical to the most completed model that can be built, which is the multinomial model. Hence, the multinomial model is not statistically different from the sequential logit models, and the sequential logit model is not superior. The results of the sequential logit estimations, as well as the deviance specification tests, provide further evidence that the Hausman test of the IIA assumption is indeed more than likely unsatisfactory for applied work.

Limitations

There are limitations of this study that should be noted. First, the study design is cross-sectional. Associations can only be inferred, and a cause-effect relationship should not be considered. Future studies could involve longitudinal data analysis. The 2016 NACCHO Profile Survey is expected to be released in the near future, and the AHRF is expected to have 2016 data released as well. Future studies could also consider our research question in respect to identifying trends over time. Furthermore, these results are only generalizable to county and multi-county LHDs. City, city-county, and multi-city LHDs were excluded from this study, and therefore the results cannot be generalized to all LHDs. However, most LHDs are on the county level and therefore, generalizability still carries considerable weight.

Conclusion

This chapter provides an overview of the methods, tests, and models that we employed in Chapters 3 and 4. Specification tests helped to identify model fit. Discrete choice models of binomial logit and multinomial logit provide maximum likelihood estimation for our research questions.

CHAPTER 3

CANCER SCREENING

Introduction

Clinical preventive services, such as guideline recommended cancer screenings for cervical, breast, and colorectal cancers are crucial elements necessary for reaching national health targets. Although clinical preventive services, such as cancer screening, are established to save lives, many individuals do not utilitze these life-saving services. Approximately 75% of adults between 50 and 64 years old and more than 50% of adults 65 years and older forego clinical preventive services.[71] The health consequences from under-utilization of cancer screening are extensive. Cancer is the second leading cause of death in the United States, and approximately 1 in 4 individuals will fatally succumb to some form of the disease.[72]

Disparities in cancer screening rates are widely apparent. Rural-urban differences in breast and cervical cancer screening exist. According to recent research, despite a 10% increase in the overall participation in mammography, a rural-urban differences remain. Women in remote rural area have the highest likelihood of not receiving a timely mammogram.[73] Furthermore, the same study illustrated that Pap smear testing did not improve over an eleven year interval. Major factors that were significantly associated with the lack of breast and cervical cancer screening among women regardless of geographic area, included low socioeconomic status (SES), advanced age, and minority race/ethnicity.[73] In 2010, approximately 49% of all US counties lacked an OB-GYN physician.[74] The highest ratios of OB-GYNs per 10,000 women were found in metropolitan areas, and the ratio declined as an area become more rural.[74] In many rural areas, the family practice physicians provided 100% of the obstetrical and gynecologic care, and a large majority of women in rural areas do not receive recommended breast and cervical cancer screening services as part of preventative care.[74] Rural-urban disparities are apparent in colorectal cancer screening services as well. Gastroenterologists, general surgeons, and radiation oncologists traditionally provide colorectal cancer screening services, but many rural areas do not have these specialists. Approminately19% of LHDs provided this service in 2013, most likely because there is a lack of providers who can provide it.[75,76]

The economic ramifications are as equally as considerable. Medical expenditures for cancer treatment rose sharply within the past decade, increasing from $56.8 billion in the year 2001 (in 2011 USD) to $88.3 billion in 2011.[77] National cost projections for cancer care for the year 2020 are as high as $206.59 billion.[78]

Because of the significant health, equity, and economic effects caused by cancer, health systems must think of innovative solutions in order to mitigate the cancer burden. Local health departments could be a part of the solution, since many entities are involved with providing cancer screening. Recent evidence illustrates that LHDs exhibit higher levels of involvement in disease screening compared to the delivery of comprehensive primary care services.[13] In 2013, a majority of LHDs screened for cervical (88%) and breast cancer (83%).[15] Less than half of LHDs surveyed screened for colon cancer (41%).[15] However, other practitioners in the community can also provide cancer screening services. In the private sector, obstetricians and gynecologists (OB-GYNs), family medicine/general practice physicians, internal medicine physicians, as well as mid-levels such as physician assistants (PAs), nurse practitioners (NPs), and advanced practice registered nurses (APRNs) can provide them. Currently, there are approximately 48,610 OB-GYNs, 126,865 family medicine/general practice physicians, and 177,779 internal medicine physicians in the United States.[55] The total primary care physician workforce is 432,726. In the past decade, the trend in the number of PAs practicing has more than doubled[79] and currently PAs total 91,982.[80] Nurse practitioners totaled 174,918[81] and approximately 162,179 advanced practice registered nurses were active in 2012.[82] Furthermore, providers in FQHCs can also provide cancer screening services. In fact as of 2013, approximately 1,202 federally qualified health centers operated across the United States.[56]

Through early cancer detection, screening activities could have sizeable impacts on morbidity, mortality, life expectancy, and contribute to bending the cost curve. Local health departments can have the ability to be involved in performing cancer screenings directly or by contracting this service out to other providers. A third option is to simply stay uninvolved and let others in the community who are independent of LHD funding provide the service. More people are now insured through the health insurance exchanges and Medicaid expansions, and some LHDs may reconsider focusing resources on more traditional public health activities,[19] since these newly insured individuals may seek other providers in the community for healthcare needs. Because of a possible substitution effect, we hypothesize that a LHD's choice to provide clinical preventive services such as cancer screening is contingent on the availability and supply of other healthcare providers in the community.

Conceptual framework

The conceptual framework for our study uses theories from the economic and organizational and management literature. Political-economy theories explain how the political and economic environments can influence organizational structure. Discrete choice and random utility maximization (RUT) provide theoretical foundation for a LHD's choice to be involved with cancer screening.

Political-economy theories have several attributes applicable to public systems such as LHDs. Two fundamental resources of (1) legitimacy and power (i.e., political) and (2) production resources (i.e., economic)[21] must be obtained by an organization in order to survive and yield services. Secondly, this theory stresses the importance of the task environment. The task environment is composed of governmental and non-governmental organizations or interest groups who have a stake in the interest and agenda because they have control of resources needed by the organization. Furthermore, another attribute is resource dependence.[28] As an organization becomes more dependent on resources controlled by an external entity, the influence of that entity on the organization increases as well. In addition, because an organization wants to achieve stability in the flow of external resources but also remain autonomous, the organization can strategize through competition or co-optation to survive.[29] Lastly, within an organization, power and economic relations regulate how service technology is applied and how decision-making units are distributed among the organizational divisions.

Furthermore, an organization such as a LHD may choose an option that produces the highest utility. In economics, utility can be described as the degree of "want-satisfaction" provided by a product or service. Choice behavior is contingent upon the assumption that individuals make rational choices, but utility and choice prediction are not measured with complete accuracy. Hence, in random utility models,

$$u_{ij} = v_{ij} + \varepsilon_{ij}$$

where utility, u_{ij}, given to individual i by choice j is made up of a deterministic component, v_{ij}, and an unobserved stochastic error component, ε_{ij} .

Methods

We hypothesized that a LHD's choice to be involved in cancer screening activities is contingent on the availability and supply of other healthcare providers in the community independent of LHD funding. Although OB-GYNs can perform breast and cervical cancer screening, and gastroenterologists, for instance, can perform colon cancer screening, specialists were excluded from our study. They were excluded because these preventive services can be frequently performed by primary care physicians and midlevels. We assumed that if screening results are suspicious or pre-cancerous, then a specialist is referred. Therefore, we made the assumption that the cancer screening activity conducted in the LHD and other primary care settings practice primary prevention. Secondary and tertiary prevention would be conducted by specialists, and therefore, they were excluded.

We used data from three sources. The primary dataset of interest was the National Association of County and City Officials (NACCHO) Profile Survey 2013. Hawaii and Rhode Island were not included in the survey because these states do not operate LHDs. We merged the NACCHO Profile with the NACCHO Boundary Files, which contains Federal Information Processing Standard (FIPS) County codes. We obtained the FIPS County codes in order to merge the NACCHO datasets with the Area Health Resource File (AHRF). Since our study was cross-sectional in nature, focusing on 2013, we pulled data from the 2013-2014 and 2014-2015 AHRF. We excluded LHDs classified as city, city-county, or multi-city because we wanted to focus on county and multi-county level LHDs only. Most LHDs in the US operate on the county level. Variables that contained count data were aggregated and population weighted averages for multi-city jurisdictions were calculated. All three datasets were merged into one master dataset, used for the analyses. A total of 1,645 LHDs were contained in the master dataset.

We used specification tests to first find the preferred model, comparing a binary logit estimation model with interaction terms and one without. We also conducted pairwise correlation tests. We also used multicollinearity tests and determined that all covariates should be kept in the model, for none of them were severely collinear, according to the variance of inflation factor (VIF). An insignificant LR test revealed that the parsimonious model without interaction terms is the preferred model over the model with interaction terms. A binary logit estimation with the parsimonious model was estimated, with the dependent variable as, "not involved =0" and "involved=1." Not involved was defined as, "the LHD is not involved in the provision of cancer screening, since others in the community independent of LHD funding already provides the service."

A multinomial logit model was then estimated with the three choices in the dependent variable. In our study, the choices a LHD would face would be to (1) remain uninvolved and let others in the community independent of LHD funding provide the service; (2) contract out the service; or (3) perform cancer screening directly. To test the independence of irrelevant alternative assumption (IIA), we implemented a Hausman test. It is important to point out, however, that research reveals that the Hausman tests performs poorly, even in large sample sizes.[68] Because of the failed results, we then estimated the sequential logit models.

A sequential logit model can be described as if decisions were made in a sequence of stages or transitions. We followed the procedure outlined by Rodriguez.[69] To answer our specific research question, we assumed that a LHD experiences two transition phases (see Figure 1). Transition 1 consists of whether a LHD is involved in performing a screening service. If it is involved, then the LHD enters Transition 2. Among only those LHDs that selected it is involved with the provision of cancer screening, it then enters the Transition 2. Transition 2 consists of whether the LHD directly performs the service or contracts it out.

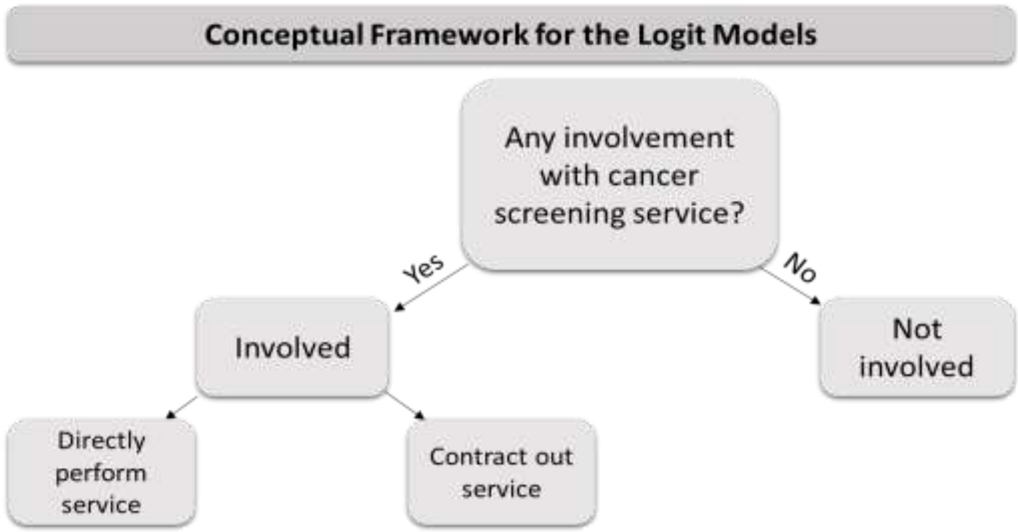

Figure 3.1 Conceptual Framework for the Discrete Choice Cancer Models. A LHD is first faced with the choice to become involved with the provision of cancer screening. By contrast, a LHD could also choose to be uninvolved in the screening activities since others (i.e., private practices, hospitals, FQHCs) independent of LHD funding provide the service to the community. If the LHD does choose to be involved, then it has two options: (1) directly perform the service or (2) contract it out to other healthcare professionals in the community.

Each transition represents two separate binary logit estimations. The base (omitted reference group) for Transition 1 is "not involved," and for Transition 2, it was "perform directly." Each sequential logit model produces separate log likelihood values that are then added together to get an overall sequential logit model log likelihood value. That value was manually compared against the log likelihood value of the multinomial estimation, using the LR test in Excel. It was determined that the log likelihood values of the sequential logit models and the multinomial model were almost identical, and it was not better than the multinomial model. The log likelihood of the cancer multinomial model was -1117.2108, and the summed log likelihoods of the two sequential logits added up to -1118.4908. The log likelihood values from the multinomial and the sequential logits are almost identical. Moreover, the multinomial model's log likelihood is actually slightly better than the sequential logit models. In addition, a deviance test was carried out. The chi square statistic was small and insignificant, meaning that the multinomial model is not statistically different from the sequential logit models. Because the multinomial model is actually slightly better than the sequential logit model (less negative log likelihood value), this provides further evidence that "tests of the IIA assumption that are based on the estimation of a restricted choice set are unsatisfactory for applied work."[68]

Because we hypothesized that the choice to be involved in cancer screening activities is contingent on the availability and supply of other healthcare providers in the community, the dependent variable is a discrete choice (0,1). For the multinomial logit estimation, we extended the choice set to three options: (1) stay uninvolved and let others in the community provide the service (base); (2) contract out; or (3) directly perform the service. It is important to note that since the LHDs that participated in the NACCHO Profile Survey were allowed to select more than one option, we coded the dependent variables to account for only on choice per LHD. We also reflected the most logical choice. For example, if a LHD survey respondent selected that his or her agency performs the cancer screening activity directly and others in the community also provide the service, the code would generate a "1" for the choice of "performing directly." Because of the inherent nature of the discrete choice models, only one choice per observation is required for the discrete choice models we employed.

Our primary independent variables of interest are the other providers independent of LHD funding, which are primary care physicians and midlevels (i.e., physician assistants, nurse practitioners, and advanced practice nurses). We also controlled for institutional, financial, and community covariates that are consistent with previous public health services and systems research.[11,23,26]

For healthcare supply factors, we controlled for primary care physicians per 10,000 population, midlevels per 10,000 population, the presence of a federally qualified health center (FQHC), and total hospital beds per 100,000 population. Recent research illustrates that primary care provision in LHDs is a function of the presence of a FQHC.[13] Total hospitals beds per 100,000 is used to reflect capacity, and is therefore a better measure for the potential substitution effect, as opposed to the total number of short term general hospitals.

Sociodemographic factors are known to play roles in the provision of clinical or personal healthcare services, as low income, indigent, or uninsured populations rely on safety-nets for their healthcare needs. Therefore, we controlled for the percentages of non-white race, Hispanic ethnicity, people in poverty, and uninsured.

LHD staffing and leadership variables were LHD staff per 10,000 population, percentage of LHDs with a clinician (MD, DO) executive director, and percentage of LHDs with a public health (MPH, DrPH) executive director. Previous research sheds light on the role of a clinician executive director on the provision of certain clinical preventive services.[13]

Political-economy theories suggest that the political and economic environment can influence an organization's agendas and choices. We included the presence of a local board of health (LBOH) to measure LHD autonomy and controlled for measurements for the state-local administrative relationship. The variable was categorized into shared (omitted), local, or state governance.

For LHD geographic location, we created three dummy variables of rural (omitted), urban (nonmetropolitan), and metropolitan, using the classification system established by the 2013 Rural Urban Commuting Area (RUCA) codes. RUCA categories 1–3 were coded as metro, categories 4–7 were coded as urban (nonmetro), and categories 8-9 were coded as rural.[59]

For LHD jurisdiction type, we included only county (omitted) or multi-county variables. Lastly, LHD jurisdiction population size served may play a role in the decision to become involved in cancer screening care, as smaller LHDs may be more likely contract out or share resources across jurisdictions; or, larger LHDs may have the capacity to offer services beyond the traditional public health activities. We categorized this variables into 5 classifications based on population size served: < 25,000; 25,000-49,999; 50,000-99,999, 100,000 – 499,999 and >500,000.

Results

Summary statistics for the study sample are presented in Table 3.1. Around 41% of LHDs provide cancer screening services. In terms of healthcare supply factors, on average, there are 5.8 primary care physicians and 11.7 midlevels per 10,000 population. There are 8.9 LHD staff per 10,000 population. Almost a fifth of LHDs surveyed (19.3%) have a public health executive director, and only 11.9% have a clinician director. Furthermore, 70.3% of LHDs have a local board of health (LBOH). More than half (66.8%) of LHDs have a local governance classification, while 22.4% and 10.8% have a state and shared governance, respectively. The majority of the sample is composed of single county LHDs (88.9%). Jurisdiction population size served varies, with 36% of LHDs in our sample serving populations less than 25,000 and only 7% of LHDs serving population sizes larger than 500,000. The number of FQHCs delivery sites average 3.6 per 100,000 population. The percent of individuals in poverty and who are uninsured both average around 16%, while 15.2% of the sample are classified as non-white. Geographic region is divided into 38.9% of LHDs being located in metro areas, 38.6% in urban (nonmetro) areas, and only 13.9% in rural regions.

Table 3.1 - Sample Summary Statistics

Variable	Mean (SD)	Range
Health care supply factors		
Primary care physicians per 10000 population	5.8 (3.2)	0-24.5
Midlevels (PAs, NPs, APRNs) per 10000 population	11.7 (7.6)	0-100.9
FQHC present in counties, %	58.6	0-128
FQHC delivery sites per 100000 population	3.6 (8.8)	0-208.2
Total hospital beds per 100000 population	324.9 (430.06)	0-7815.9
General hospitals per 100000 population	4.63 (7.4)	0-86.2
Demographic factors		
% White race	84.8 (14.6)	15.5-99
% Non-white race	15.2 (14.6)	.99-84.5

% Hispanic ethnicity	7.1 (10.3)	.22-95.7
% In poverty	16.6 (5.7)	3.8-41.1
% Uninsured	16.5 (4.8)	6-36.8
LHD service provision		
% LHDs providing cancer screening	41.3	0-100
LHD staffing and leadership		
LHD staff per 10000 LHD population	8.9 (10.8)	0-195.8
% LHDs with clinician (MD, DO) executive director	11.9	0-100
% LHDs with public health (MPH, DrPH) executive director	19.3	0-100
LHD governance characteristics		
Local board of health (LBOH) present	70.3	0-100
State governance	22.4	0-100
Local governance	66.8	0-100
Shared governance	10.8	0-100
LHDs by location		
% Metro	38.9	0-100
% Urban (nonmetro)	38.6	0-100
% Rural	13.9	0-100
LHDs by jurisdiction		
% County	88.9	0-100
% Multi-county	11.1	0-100
LHD jurisdiction population size served		
Population size served < 25,000	36.0	0-100
Population size served 25,000 - 49,999	20.1	0-100
Population size served 50,000 - 99,999	15.8	0-100
Population size served 100,000 - 499,999	21.0	0-100
Population size served > 500,000	7.0	0-100
N = 1,645 Local Health Departments		

Abbreviations: FQHC, federally qualified health center; LHD, local health department

The results of the binary logit estimation are illustrated in Table 3.2, and the results of the multinomial model are presented in Table 3.3. The results of the sequential logit model for cancer screening are in Appendix II. The multinomial model proved to be a superior model to the sequential logit. Beta values and standard errors, as well as marginal effects (ME) along with standard errors are reported in the tables. It is crucial to point out that the signs of beta values may not have the same sign as the MEs. Primary interest is in how probabilities change as the covariates change, and MEs will provide that information.[63] Therefore, interpretation from the estimations refer to the statistically significant MEs. Primary care physicians and midlevels per 10,000 population did not have significant beta values or MEs. The type of LHD director was not statistically significant either.

However, other variables had statistically significant MEs. A unit increase in the percentage of the people in poverty increases a LHD's probability to choose to be in involved in the delivery of cancer screening activity by 1.3% ($p<.001$). Furthermore, a LHD's location in a metro area increases the probability of choosing to be involved in the delivery of this activity by 10.2% ($p<.05$). Serving a jurisdiction population size between 50,000 to 99,999 and 99,999 - 499,999 people increases the probability of delivering this activity by 14.4% ($p<.001$) and 11.7% ($p<.05$), respectively. By contrast, having a state or local governance decreases the probability of being involved with cancer screening by 30.6% ($p<.001$) and 43.6% ($p<.001$), respectively.

Table 3.2 - Results of the Binary Logit Estimation of Whether or Not a LHD is Involved in Delivering Cancer Screening Activity

Variable	β	SE	ME	SE
Primary care physicians per 10000 population	0.009	0.024	0.002	0.005
Midlevels (PAs, NPs, APRNs) per 10000 population	-0.002	0.010	-0.000	0.002
FQHC present in counties	0.074	0.137	0.016	0.029
Total hospital beds per 100000 population	0.000	0.000	-0.000	0.000
% Non-white race	-0.005	0.005	-0.001	0.001
% Hispanic ethnicity	-0.013	0.007	-0.003	0.001
% In poverty	0.060[a]	0.015	0.013[a]	0.003
% Uninsured	0.032	0.017	0.007	0.004
LHD staff per 10000 LHD population	0.019	0.007	0.004	0.001
LHD with clinician (MD, DO) executive director	-0.204	0.190	-0.042	0.039
LHD has a public health (MPH, DrPH) executive director	0.256	0.145	0.055	0.031
Local board of health (LBOH) present	0.189	0.137	0.039	0.028
Centralization (shared is omitted reference group)				
State governance	-1.519[a]	0.252	-0.306[a]	0.043
Local governance	-2.084[a]	0.237	-0.436[a]	0.038
LHD location (Rural is omitted reference group)				
Metro	0.481[b]	0.216	0.102[b]	0.045
Urban (nonmetro)	0.128	0.191	0.027	0.040
LHD jurisdiction population size served (<25,000 is omitted reference group)				
Population size served 25,000 - 49,999	0.258	0.173	0.053	0.036
Population size served 50,000 - 99,999	0.683[a]	0.194	0.144[a]	0.041

Population size served 100,000 - 499,999	0.559[b]	0.228	0.117[b]	0.048
Population size served > 500,000	0.608	0.327	0.128	0.070
LHD jurisdiction (county is omitted reference group)	0.139	0.233	0.029	0.050
Log likelihood = -950.282778				
N = 1,565 Local Health Departments				

Abbreviations: ME, marginal effect; FQHC, federally qualified health center; LHD, local health department

[a]P<.001

[b]P <.05

Contract Out

For the multinomial models, we first examined the choice of contracting out the cancer screening service to others in the community. The presence of a FQHC increases the probability of a LHD contracting out cancer screening services by 2% (p<.05), as opposed to staying uninvolved (base) because other healthcare providers already deliver the service. A unit increase in the percentage of uninsured individuals decreases the probability of contracting out by .38% (p<.05). Having a local or state governance decreases the probability of contracting out by 9% (p<.01), and 7% (p<.05), respectively. Furthermore, a multi-county jurisdiction decreases the probability of contracting out by 2.96% (p<.01).

Perform Directly

A unit increase in the percentage of the people in poverty decreases a LHD's probability to choose to directly perform cancer screening service activity by 1.25% (p<.001), as opposed to staying uninvolved. Furthermore, a unit increase in the percentage of uninsured individuals increases the probability to directly perform cancer screening by 1.05% (p<.01). As the LHD staff per 10,000 LHD population increases, the probability increases by .34% (p<.05). Having a public health executive director increases the probability of performing cancer screening services directly by 6.59% (p<.05). Furthermore, having a local or state governance decreases the probability of performing cancer services directly by 22% (p<.001) and 35.9% (p<.001), respectively. LHD location in a metro area increases the probability of performing this service directly by 10.56%

(p<.05). Serving jurisdiction population sizes of 50,000 – 99,999 and 100,000 – 499,999 increases the probability of directly performing cancer screening activities by 13.1% (p<.01) and 9.8% (p<.05), respectively.

Table 3.3 - Results of the Multinomial Logit Estimation of Cancer Screening Delivery Choice

Variable	Contract out				Perform Directly			
	β	SE	ME	SE	β	SE	ME	SE
Primary care physicians per 10000 population	-0.0239	0.0587	-0.0009	0.0018	0.0105	0.0247	0.0025	0.0051
Midlevels (PAs, NPs, APRNs) per 10000 population	0.0103	0.0208	0.0004	0.0007	-0.0034	0.0099	-0.0009	0.0020
FQHC present in counties	0.7141	0.3809	0.0209[c]	0.0105	0.0182	0.1398	-0.0060	0.0286
Total hospital beds per 100000 population	0.0002	0.0003	0.0000	0.0000	-0.0002	0.0002	0.0000	0.0000
% Non-white race	0.0083	0.0126	0.0004	0.0004	-0.0066	0.0051	-0.0015	0.0010
% Hispanic ethnicity	-0.0046	0.0213	0.0001	0.0007	-0.0132	0.0071	-0.0027	0.0015
% In poverty	0.0415	0.0365	0.0004	0.0011	0.0630[a]	0.0148	0.0125[a]	0.0029
% Uninsured	-0.0994[c]	0.0486	-0.0038[c]	0.0016	0.0429[c]	0.0173	0.0105[b]	0.0035
LHD staff per 10000 LHD population	0.0238[c]	0.0118	0.0005	0.0003	0.0179[b]	0.0067	0.0034[c]	0.0013
LHD with clinician (MD, DO) executive director	-0.0623	0.4449	0.0013	0.0141	-0.2241	0.1950	-0.0450	0.0383
LHD has a public health (MPH, DrPH) executive director	-0.2504	0.3901	-0.0116	0.0103	0.2938[c]	0.1474	0.0659[c]	0.0310
Local board of health (LBOH) present	0.6065	0.4013	0.0152	0.0101	0.1529	0.1393	0.0233	0.0280
Centralization (shared is omitted reference group)								
State governance	-2.9913[a]	0.6445	-0.0915[b]	0.0298	-1.4272[a]	0.2543	-0.2200[a]	0.0478
Local governance	-2.5481[a]	0.4231	-0.0762[c]	0.0299	-2.0289[a]	0.2407	-0.3594[a]	0.0432
LHD location (Rural is omitted reference group)								
Metro	0.0751	0.6800	-0.0052	0.0217	0.5101[b]	0.2196	0.1056[c]	0.0451
Urban (nonmetro)	-0.1389	0.6174	-0.0065	0.0186	0.1438	0.1939	0.0321	0.0402
LHD jurisdiction population size served (<25,000 is omitted reference group)								
Population size served 25,000 - 49,999	0.6259	0.5176	0.0143	0.0142	0.2352	0.1760	0.0401	0.0351
Population size served 50,000 - 99,999	0.8478	0.5757	0.0146	0.0159	0.6770[a]	0.1981	0.1309[b]	0.0406
Population size served 100,000 -	0.8923	0.6496	0.0189	0.0190	0.5302[b]	0.2331	0.0982[c]	0.0476

499,999								
Population size served > 500,000	1.1846	0.8320	0.0312	0.0321	0.5428	0.3360	0.0947	0.0696
LHD jurisdiction (county is omitted reference group)	-1.3668	0.9033	-0.0296[b]	0.0107	0.2394	0.2364	0.0641	0.0497
Log likelihood = -1117.2108								
N = 1,565 Local Health Departments								

Abbreviations: ME, marginal effect; FQHC, federally qualified health center; LHD, local health department

[a]P <.001

[b]P <.01

[c]P <.05

Discussion

The number of primary care physicians and midlevels per 10,000 population were not statistically significant in either the binary or multinomial logit estimations. This is a surprising finding, as we hypothesized that the choice to become involved in cancer screening activities in the LHD was contingent on the availability and supply of other healthcare providers in the community.

The type of LHD director was not statistically significant in the binary logit model, but in the multinomial model, having a LHD director with a public health degree (MPH, DrPH) increased the probability of performing the cancer screening activity directly. A LHD director with a public health degree may see performing cancer screening services directly as part of the mission of public health through prevention and early detection. The LHD director may have some influence on the decision to be involved with providing cancer screening directly, by choosing to perform cancer screening directly or contracting out the service.

The FQHC is known to act as a safety-net for impoverished people with low incomes. The results of both estimations provide statistically significant evidence that as the percentage of people in poverty increases, so does the LHD's probability of staying uninvolved in the delivery of cancer screening activity. The most logical explanation for this is because impoverished individuals may seek care from other providers and health systems such as FQHCs instead. In fact, this postulate is supported by results from the multinomial logit estimation. The presence of a FQHC increases the probability of contracting out cancer screening services. This may be because LHD directors may be aware of the value of contracting out this service to a FQHC because the impoverished individuals are more likely to go to the FQHC to receive the service.

In addition, as the percentage of uninsured individuals increase, the probability of a LHD contracting out or directly performing cancer screening services declines with statistical significance. In other words, as the percentage of uninsured individuals increase, the probability of a LHD being staying uninvolved and letting others in the community provide cancer screening increase. This observation may be due in part to the National Breast and Cervical Cancer Early Detection Program (NBCCEDP), as this program entails a network of various health systems and providers who already provide this service in the community. The NBCCEDP is a federal program through the Centers for Disease Control and Prevention (CDC) that "provides low-income, uninsured, and underserved women access to timely breast and cervical cancer screening and diagnostic services."[83] The NBCCEDP is composed of a network of more than 22,000 clinical providers in various health systems that include LHDs, FQHCs, private practices, safety-net hospitals, and other health systems. More recently, the CDC funded the Colorectal Cancer Control Program (CRCCP) in 2009 with goals to increase colorectal cancer screening rates in adults aged 50 to 75. These cancer screening programs entail partnerships and collaborative capacity among the various health systems. Every LHD works with this network of clinical providers to provide the services.[83]

Geographic location also plays a role in a LHD's decision. The binary logit estimation revealed that a LHD that is located in a metro area has a higher probability of choosing to be involved in the delivery of this service. The multinomial model revealed the specific choice — a LHD location in a metro area increases the probability of performing this service directly by 10.56%. This may be because LHDs that serve larger jurisdictions may have adequate resources and choose to deliver this service regardless of community need.[13]

In addition to geographic location, jurisdiction population size served also is statistically significant. The binary logit model first revealed a statistically significant association between jurisdiction population sizes served of 50,000 to 99,999 and 100,000 to 499,999 and the increasing the probability of a LHD's choice to be involved. The multinomial logit model revealed that serving jurisdictions with those population sizes increases the probability of performing cancer screening activities directly. This is perhaps because larger LHDs have the resources, staff, and capacity to perform this screening service in-house. This conjecture is supported by the fact that as the LHD staff per 10,000 LHD population increases, the probability of performing cancer screening directly increases by .34%. It is interesting to point out, however, that jurisdictions with population sizes smaller than 25,000 and greater than 500,000 were not statistically significant. Perhaps smaller, low resource communities may rely on the presence of a FQHC for cancer screening services. On the other end, LHDs that serve large jurisdictions may simply have enough resources, staff, and funding to directly perform cancer screening.

Moreover, the binomial logit estimations revealed that having a state or local governance decreases the probability of being involved with cancer screening. The results of the multinomial models revealed that a local or state governance decreases the probabilities of both contracting out and directly performing the screening activity. This implies that the LHD with a state or local governance chooses to be uninvolved. A previous study by Mays & Smith illustrated that public health spending was 24% lower in centralized state agencies, as opposed to independent local agencies.[84] It may be possible that centralized state LHDs may be more concerned with finances and budgets, and local agencies may be more knowledgeable of the specific community needs and availability of private providers compared to the state agencies.

Lastly, having a multi-county jurisdiction type decreases the probability of contracting out the service by almost 3% as opposed to staying uninvolved and allowing others independent of LHD funding provide the service to community residents. This finding could possibly be explained by the fact that multi-county LHDs may be more aware of the other healthcare providers and health systems in their jurisdiction, since their territory spans multiple counties, forcing them to communicate with other LHDs. This might also allow multi-county LHDs to make more informed decisions, partially influencing the decision to remain uninvolved.

Limitations

There are some limitations of this study to this study. First, this study is cross-sectional in nature. A cause-effect relationship should not be considered. Future studies could involve longitudinal data analysis, as the 2016 NACCHO Profile Survey is due to be released, and the AHRF is expected to have 2016 data released as well in the near future. Furthermore, these results are only generalizable to county and multi-county LHDs However, most LHDs are on the county single level. Lastly, a final limitation is that gynecologists were not included in the primary care physician variable since debate on classifying gynecologists as primary care physicians as opposed to specialists/surgeons is on-going; therefore, including gynecologists in the primary care variable in a future study may have an impact on statistical significance.

Conclusion

Although the results suggest that the decision to become involved with cancer screening activities is not dependent on the availability or supply of physicians or midlevels, we still gained valuable information. Several organizational, institutional, and environmental characteristics are associated with a LHD's decision to provide cancer screening activities either through performing it directly or contracting it out. The presence of a public health director, the number of LHD staff, metropolitan location, jurisdiction population size served, as well as jurisdiction type, are all significantly associated with the LHD's decision. An overall trend suggests that as population size increases, so does the probability of involvement with cancer screening. This study has important public health ramifications, as Mays and Smith previously revealed over a 13 year time period, that for every 10% increase in public health spending, cancer mortality fell by 1.1 percent.[84] In conclusion, these findings have viable practice and policy significance that will greatly benefit the public's health now and in the future.

CHAPTER 4

CARDIOVASCULAR DISEASE SCREENING

Introduction

Heart disease is the number one cause of death in the United States, and stroke comes in third. Approximately, 27.6 million people are currently diagnosed with CVD, and as of 2013, 611,105 individuals died from it.[85] Clinical preventive services, such as cardiovascular disease screenings, are fundamental for protecting the public's health and reaching national health targets, such as Healthy People 2020. Cardiovascular disease (CVD) screenings help detect heart conditions that have the potential to lead to a stroke or heart attack and include physical examinations and lifestyle discussion, evaluation of family history, and blood tests for cholesterol, lipid, and triglyceride levels. Despite the established effectiveness of clinical preventive services, including CVD screening, around three-fourths of adults between 50 and 64 years old and more than half of adults 65 years and older forego clinical preventive services.[71]

The economic burden from CVD on the US healthcare system is significant, as almost every 6 healthcare dollars is spent on CVD. In 2011, the nation's healthcare system spent almost $1 billion a day in medical costs, and by the year 2030, yearly direct medical costs for CVD and lost productivity costs could increase to over $818 billion and $275 billion dollars, respectively.[86]

In addition to a large economic burden, equity issues arise, as racial and ethnic disparities with CVD mortality are higher in individuals with low educations and African American populations[87] in addition to individuals who reside in rural areas, especially those who live in the South.[88]

Despite the paramount importance of CVD screening, many individuals do not have access to such services. Disparities in the capacity and distribution of private providers who provide CVD screening are apparent. Evidence illustrates that CVD screening in rural areas is suboptimal.[89] The suboptimal rates are also due in part to primary care workforce shortages that plague many rural areas and other medically underserved areas. Lack of insurance is also a factor that contributes to suboptimal CVD screening rates. Low CVD rates have profound effects on population health, as the lack of detection of CVD increases the amount of people who are at risk for fatal heart attacks and strokes.

In the private medical sector, several primary care physicians and midlevels can provide CVD screening. Family medicine/general practice physicians, internal medicine physicians, as well as mid-levels such as physician assistants (PAs), nurse practitioners (NPs), and advanced practice registered nurses (APRNs) can provide CVD screening services. As of 2012, there were 27,076 cardiologists[90], 126,865 family medicine/general practice physicians, and 177,779 internal medicine physicians in the United States.[55] The primary care physician workforce totals 432,726 practitioners. In addition, the trend in the number of PAs practicing has more than doubled in the last decade[79] and currently PAs total 91,982.[80] Nurse practitioners total 174,918[81] and nearly 162,179 advanced practice registered nurses were active in 2012.[82] Furthermore, practitioners in FQHCs can also provide CVD screening services. In 2013, roughly 1,202 federally qualified health centers operated across the United States.[56]

At present, policies from the ACA are pushing to reduce excessive emergency department usage and hospital readmissions. Cardiovascular related events, such as congestive heart failure among adults, are cited as common conditions for the emergency department[91] as well as hospital readmissions.[92] LHDs that offer clinical preventive screening activities, such as CVD screening, could possibly play a role in mitigating excessive ED visits and hospital readmissions, especially in low resourced urban and rural communities. Cardiovascular screening, done in the early stages, can slow the progression of disease.

Exploring innovative and cost-effective ways to ensure access to CVD screening will take efforts from both private healthcare and public health systems, and LHDs may play a major role in finding the solution. Low resource communities and uninsured individuals who do not have access to a FQHC could rely on LHDs for this service. On the contrary, since more people are now becoming insured through the health insurance exchanges and Medicaid expansions, LHDs may reconsider the role of offering clinical preventive services and let others in the community provide them instead.

It is possible that a substitution effect among providers could be occurring, and it is imperative to understand this possible substitution effect. Therefore, we hypothesize that a LHD's choice to provide CVD screening is conditional on the availability and supply of private healthcare providers in the community.

Conceptual framework

This study is supported several organizational and management theories. Political-economy provides a framework on how the political and economic environments can influence organizational structure and decisions. Random utility maximization (RUT) provide theoretical foundation for a LHD's choice to be involved with CVD disease screening.

The political-economy theories have several attributes that are transferable to public agencies such as LHDs. Resources of (1) legitimacy and power (i.e., political) and (2) production resources (i.e., economic)[21] must be attained by an organization in order to survive and produce services. Furthermore, there is influence from the task environment.

The task environment is made up of governmental and non-governmental organizations, interest groups, and stakeholders who have control of resources needed by the organization. Furthermore, another attribute is resource dependence.[28] As an organization becomes more dependent on resources controlled by an external entity, the influence of that entity on the organization increases as well. Furthermore, an organization strives to achieve stability in the flow of external resources but also still have autonomy. Therefore, the organization can strategize through competition or co-optation to survive.[29] Lastly, within an organization, power and economic relations control the application of service technology and how decision-making units are distributed among the organizational divisions.

Furthermore, an organization such as a LHD may choose an option that produces the highest utility. In economics, utility can be described as the degree of "want-satisfaction" provided by a product or service. Choice behavior is contingent upon the assumption that individuals make rational choices but utility and choice prediction are not measured with complete accuracy. Hence, in random utility models,

$$u_{ij} = v_{ij} + \varepsilon_{ij}$$

where utility, u_{ij}, given to individual i by choice j is made up of a deterministic component, v_{ij}, and an unobserved stochastic error component, ε_{ij} .

Methods

We hypothesized that a LHD's choice to be involved in CVD screening activities is dependent on the availability and supply of other healthcare providers in the community independent of LHD funding. Although cardiologists can perform CVD disease screening, they were excluded from our study because this preventive services is commonly performed by primary care physicians and midlevels. We also assumed that if the screening results require specialized attention or treatment, then the cardiologist is referred. Therefore, we made the assumption that CVD screening performed in the LHD or in other primary care settings practice primary prevention. Secondary and tertiary prevention would be conducted by a cardiologist, so we excluded them from the analysis.

The final dataset was created from three sources. The primary dataset of interest was the National Association of County and City Officials (NACCHO) Profile Survey 2013. Rhode Island and Hawaii were not included in the survey because they do not have LHDs. We merged the NACCHO Profile with the NACCHO Boundary Files. The Boundary Files contain Federal Information Processing Standard (FIPS) County codes. We obtained the FIPS County codes in order to merge the NACCHO datasets with the Area Health Resource File (AHRF). Since our cross-sectional study focused on the year 2013, we pulled data from the 2013-2014 and 2014-2015 AHRF files. We only analyzed county and multi-county level LHDs and excluded LHDs classified as city, city-county, or multi-city. For multi-city jurisdictions, variables that contained count data were aggregated and population weighted averages were calculated. A total of 1,645 LHDs were contained in the master dataset.

We conducted several specification tests to determine the preferred model, We first compared a binary logit estimation model with interaction terms and one without (parsimonious). We also conducted pairwise correlation tests. We determined that all covariates should be kept in the model. No variables were severely collinear, according to the variance of inflation factor (VIF). The parsimonious model and the model with interaction terms are illustrated in Appendix I. An insignificant LR test revealed that the parsimonious model is the preferred model. A binary logit estimation with the parsimonious model was estimated, with the dependent variable as, "not involved =0" and "involved=1." Not involved is defined as the LHD is not involved in the provision of CVD screening, since others in the community independent of LHD funding already provides the service.

A multinomial logit model estimation was then conducted, with the three choices in the dependent variable. In our study, the choices a LHD might face would be to (1) remain uninvolved and let others in the community independent of LHD funding provide the service; (2) contract out the service; or (3) perform CVD screening directly. To test the independence of irrelevant alternative assumption (IIA) inherent in multinomial models, we applied a Hausman test (see Appendix I). It is important to point out, however, that recent research reveals that the Hausman tests performs poorly, even in large sample sizes.[68] Because of the failed results of the test, we executed sequential logit estimations, also known as hierarchical logit estimations.

A sequential logit model is structured with decisions made in a stages. We followed the procedure outlined by Rodriguez.[69] We assumed that a LHD experiences two transition phases (see Figure 1). Transition 1 consists of whether (or not) a LHD is involved in performing a screening service. If it is involved, then the LHD enters Transition 2. Among only those LHDs that selected "yes" it is involved with the provision of CVD screening, they then enter the next transition. Transition 2 consists of whether (or not) the LHD directly performs the service or contracts it out.

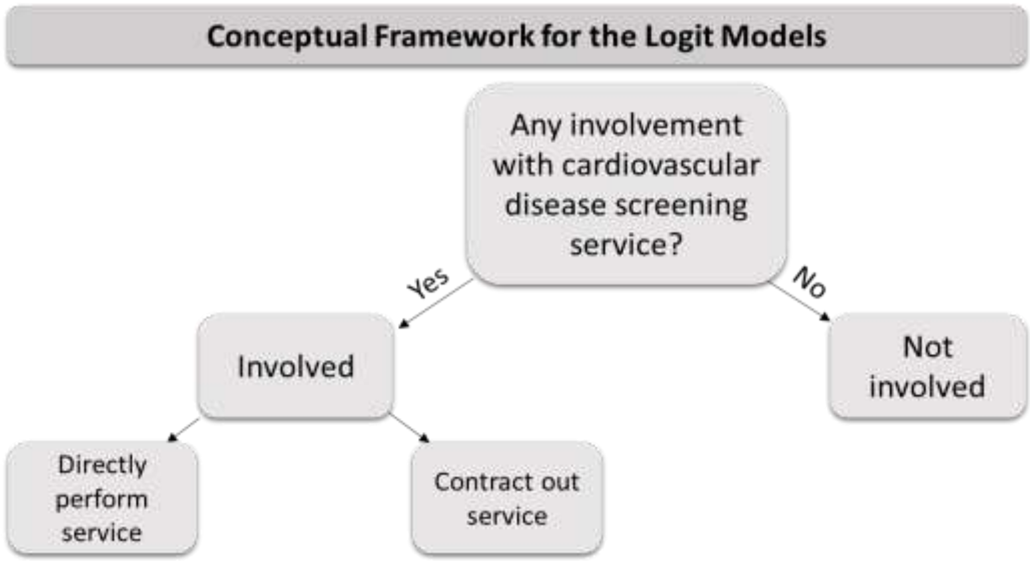

Figure 4.1 Conceptual Framework for the Discrete Choice CVD Models. A LHD is first faced with the choice to become involved with the provision of cardiovascular disease screening. By contrast, a LHD could also choose to be uninvolved in the screening activities, letting others (i.e., private practices, hospitals, FQHCs) independent of LHD funding provide the service to the community. If the LHD does choose to be involved, then it has two options: (1) directly perform the service or (2) contract out the service to other healthcare professionals in the community.

Each transition phase represents two separate binary logit estimations. Transition 1, the base (omitted reference group) is "not involved," and for Transition 2, it was "perform directly." Each sequential logit model generates its own separate log likelihood values that are then added together. The overall sequential logit model log likelihood value can then be calculated. The summed value would then be manually and computationally compared against the log likelihood value of the multinomial estimation. However, for the cardiovascular disease screening model, the sequential logit model for Transition 1 was not statistically significant, and Transition 2 could not be estimated because of too many missing values. The multinomial logit model proved to be the superior model.

Because we hypothesized that the choice to be involved in CVD screening activities is conditional on the availability and supply of other healthcare providers in the community, the dependent variable is a discrete choice (0,1). For the multinomial logit estimation, we increased the choice set to three choices: (1) stay uninvolved and let others in the community provide the service (base); (2) contract out; or (3) directly perform the service. It is important to note that the LHD survey respondent for the NACCHO Profile was allowed to select more than one option. To correct for only one choice per LHD, we coded the dependent variables to account for the most logical decision. For example, if a LHD survey respondent selected that his or her agency performs the CVD screening activity directly and selected that others in the community also provide the service, the code would generate a "1" for the choice of "directly performing." Only one choice per observation is required for the discrete choice models.

Our primary independent variables of interest are the other providers in the community independent of LHD funding. Those are primary care physicians and midlevels (i.e., physician assistants, nurse practitioners, and advanced practice nurses). Besides these providers, we also controlled for institutional, financial, and community covariates previously investigated in other public health services and systems research studies.[11,23,24]

For healthcare supply factors, we controlled for primary care physicians per 10,000 population, midlevels per 10,000 population, total hospital beds per 100,000 population, and the presence of a federally qualified health center (FQHC) since recent research illustrates that primary care provision in LHDs is a function of the presence of a FQHC.[13] The total hospitals beds per 100,000 is a reflection of capacity, and is therefore a better measure for the potential substitution effect, as opposed to the total number of short term general hospitals.

We controlled for sociodemographic factors of the percentages of non-white race, Hispanic ethnicity, in poverty, and uninsured. These variables are known to affect the provision of clinical or personal healthcare services, as low income, uninsured, and indigent populations rely on safety-nets for their healthcare needs.

LHD staffing and leadership variables were LHD staff per 10,000 population, percentage of LHDs with a clinician (MD, DO) executive director, and percentage of LHDs with a public health (MPH, DrPH) executive director. Previous research sheds light on the role of an increasing number of LHD staff per 10,000 and a clinician executive director on the provision of directly performing cardiovascular disease screening in LHDs.[13]

The political and economic environment can influence an organization's choices. Therefore, we included the presence of a local board of health (LBOH) to measure LHD autonomy and controlled for the state-local administrative relationship. Previous studies have documented the effect of governance characteristics, such as centralized governance and its association with spending decisions.[84] This variable was categorized into shared (omitted), local, or state governance.

For LHD geographic location, three dummy variables of rural (omitted), urban (nonmetro), and metro were created, following the classification system established by the 2013 Rural Urban Commuting Area (RUCA) codes. RUCA categories 1–3 were coded as metro, categories 4–7 were coded as urban (nonmetro), and categories 8-9 were coded as rural.[59]

For LHD jurisdiction type, we included only single county (omitted) or multi-county variables. The most common type of LHD in the United States is the county LHD.

LHD jurisdiction population size served may play a role in the decision to become involved in CVD screening, as smaller LHDs may be more likely contract out or share resources across jurisdictions. Furthermore, larger LHDs may have adequate capacity to offer services beyond the traditional public health activities. Thus, we categorized this variables into 5 categories: population size served < 25,000; 25,000-49,999; 50,000-99,999, 100,000 – 499,999 and >500,000.

Results

Summary statistics for the study sample are illustrated in Table 4.1. Less than half (41.3%) of LHDs provide CVD screening services. The majority of the sample is composed of single county LHDs (88.9%), in which only 11.1% are multi-county LHDs. A FQHC is present in 58.6% of the counties sampled. The number of total hospital beds per 100,000 population average around 325 beds, and there are 5.8 primary care physicians and 11.7 midlevels per 10,000 population. The majority of the sample is composed of individuals who are classified as "white race" (84.8%), while 15.2% of the study sample are classified as non-white race. Furthermore, over 16% of the sample is considered to be in poverty or uninsured. Approximately 36% of LHDs in the sample served populations less than 25,000, and only 7% of LHDs served population sizes larger than 500,000. On average, there are 5.8 primary care physicians and 11.7 midlevels per 10,000 population. Geographic region is divided into three main classifications, with 38.9% of LHDs located in metro areas, 38.6% in urban (nonmetro), and only 13.9% in rural regions.

Table 4.1 - Sample Summary Statistics

Variable	Mean (SD)	Range
Health care supply factors		
Primary care physicians per 10000 population	5.8 (3.2)	0-24.5
Midlevels (PAs, NPs, APRNs) per 10000 population	11.7 (7.6)	0-100.9
FQHC present in counties, %	58.6	0-128
FQHC delivery sites per 100000 population	3.6 (8.8)	0-208.2
Total hospital beds per 100000 population	324.9 (430.06)	0-7815.9
General hospitals per 100000 population	4.63 (7.4)	0-86.2
Demographic factors		
% White race	84.8 (14.6)	15.5-99
% Non-white race	15.2 (14.6)	.99-84.5
% Hispanic ethnicity	7.1 (10.3)	.22-95.7
% In poverty	16.6 (5.7)	3.8-41.1
% Uninsured	16.5 (4.8)	6-36.8
LHD service provision		

% LHDs providing CVD screening	29.3	0-100
LHD staffing and leadership		
LHD staff per 10000 LHD population	8.9 (10.8)	0-195.8
% LHDs with clinician (MD, DO) executive director	11.9	0-100
% LHDs with public health (MPH, DrPH) executive director	19.3	0-100
LHD governance characteristics		
Local board of health (LBOH) present	70.3	0-100
State governance	22.4	0-100
Local governance	66.8	0-100
Shared governance	10.8	0-100
LHDs by location		
% Metro	38.9	0-100
% Urban (nonmetro)	38.6	0-100
% Rural	13.9	0-100
LHDs by jurisdiction		
% County	88.9	0-100
% Multi-county	11.1	0-100
LHD jurisdiction population size served		
Population size served < 25,000	36.0	0-100
Population size served 25,000 - 49,999	20.1	0-100
Population size served 50,000 - 99,999	15.8	0-100
Population size served 100,000 - 499,999	21.0	0-100
Population size served > 500,000	7.0	0-100
N = 1,645 Local Health Departments		

Abbreviations: FQHC, federally qualified health center; LHD, local health department

The results of the binary logit estimation are illustrated in Table 4.2. Results of the multinomial model are presented in Table 4.3. The results of the sequential logit model are not included in this paper, since the multinomial model proved to be a superior model to the sequential logits, and the second transition could not be computed due to too many missing observations.

Beta values and standard errors, as well as marginal effects (MEs) along with standard errors are reported. The signs of beta values may not have the same sign as the MEs. Therefore, our main interest is in how probabilities change as the covariates change. MEs will provide that information.[63] Therefore, interpretation of the results refer to the statistically significant MEs.

The results of the binary logit estimation are illustrated in Table 4.2. Referring to the marginal effects, the presence of a FQHC decreases the probability of being involved in delivering cardiovascular disease screening services, as opposed to choosing to not be involved by 8.93% (p<.001). Likewise, a unit increase in the percentage of non-white race decreases the probability of being involved by .35% (p<.001). An increase in the number of LHD staff employed per 10,000 population increases the probability of being involved in CVD screening by .45% (p<.001). However, having a clinician executive director of a LHD decreases involvement with CVD screening by 10.64% (p<.01). Furthermore, having a state or local governance decreases the probability of being involved by 28.96% (p<.001) and 27.31% (p<.001), respectively. On the other hand, LHDs with jurisdiction population sizes of 50,000-99,000, 100,000-499,999 and greater than 500,000 significantly increases the probability of being involved with CVD screening by 10.91% (p<.01), 18.3% (p<.01), and 33.5% (p<.001), respectively.

Table 4.2 - Results of the Binary Logit Estimation of Whether or Not a LHD is Involved in Delivering CVD Screening Activity

Variable	β	SE	ME	SE
FQHC present in counties	-0.466[a]	0.145	-0.0893[a]	0.0276
Total hospital beds per 100000 population	0.000	0.000	0.0000	0.0000
Primary care physicians per 10000 population	-0.051	0.026	-0.0097	0.0049
Midlevels (PAs, NPs, APRNs) per 10000 population	0.012	0.010	0.0024	0.0019
% Non-white race	-0.018[a]	0.006	-0.0035[a]	0.0010
% Hispanic ethnicity	-0.005	0.007	-0.0010	0.0014
% In poverty	0.063	0.015	0.0120	0.0028
% Uninsured	0.019	0.018	0.0037	0.0034
LHD staff per 10000 LHD population	0.024[a]	0.007	0.0045[a]	0.0013
LHD with clinician (MD, DO) executive director	-0.617[b]	0.213	-0.1064[b]	0.0325
LHD has a public health (MPH, DrPH) executive director	0.182	0.152	0.0353	0.0300
Local board of health (LBOH) present	0.242	0.145	0.0450	0.0264
Centralization (shared is omitted reference group)				
State governance	-1.321[a]	0.221	-0.2896[a]	0.0478
Local governance	-1.232[a]	0.200	-0.2731[a]	0.0454
LHD location (Rural is omitted reference group)				

Metro	0.439	0.228	0.0849	0.0445
Urban (nonmetro)	0.164	0.202	0.0313	0.0388
LHD jurisdiction population size served (<25,000 is omitted reference group)				
Population size served 25,000 - 49,999	0.267	0.185	0.0452	0.0314
Population size served 50,000 - 99,999	0.603[b]	0.207	0.1091[b]	0.0376
Population size served 100,000 - 499,999	0.744[b]	0.247	0.1380[b]	0.0458
Population size served > 500,000	1.638[a]	0.351	0.3353[a]	0.0696
LHD jurisdiction (county is omitted reference group)	-0.005	0.249	-0.0009	0.0473
N = 1,547 Local Health Departments				
Log likelihood = -874.3417				

Abbreviations: ME, marginal effect; FQHC, federally qualified health center; LHD, local health department

[a]P <.001

[b]P <.01

Contract Out

The results of the multinomial logit estimation are presented in Table 3. There were only two statistically significant variables with the choice to contract out. When focusing on the choice to contract out service, the presence of a FQHC increases the probability of a LHD contracting out CVD screening services by .1% (p<.05) as opposed to staying uninvolved. In addition, being a multi-county LHD decreases the probability of contracting out this service by .1% (p<.05) as well.

Perform Directly

Moreover, having a FQHC in the county decreases the probability of a LHD's choice to directly perform cardiovascular screening service activity by 10% (p<.001), as opposed choosing to be uninvolved. Furthermore, a unit increase in the number of primary care physicians per 10,000 decreases the probability of a LHD choosing to directly perform this service by approximately 1% (p<.01). The presence of a clinician executive director decreases the probability of directly performing CVD services by 10.72%. As the percentage of non-white individuals increase, the probability decreases by .34% (p<.001). In addition, having a state or local governance decreases the probability of directly performing the service by 28% and 26.9%, respectively. On the contrary, as the percentage of people in poverty increases, the probability of directly performing cardiovascular disease screening increases by 1.17% (p<.001). As the number of LHD staff per 10,000 population increases, the probability of directly performing this service also increases by .43% (p<.001). Jurisdiction population size served of 100,000 to 499,999 and greater than 500,000 increases the probability of directly performing CVD screening by 13% (p<.01) and 33.8% (p<.001). Lastly, LHD location in a metro area increases the probability of directly performing this service by 8.7% (p<.05).

Table 4.3 - Results of the Multinomial Logit Estimation of CVD Screening Activity Delivery Choice (Not involved (Base), Contract Out, or Perform Directly)

Variable	Contract out				Perform directly			
	β	SE	ME	SE	β	SE	ME	SE
Primary care physicians per 10000 population	0.0518	0.1025	0.0006	0.0008	-0.0548[c]	0.0264	-0.0104[c]	0.0049
Midlevels (PAs, NPs, APRNs) per 10000 population	0.0275	0.0362	0.0002	0.0003	0.0119	0.0100	0.0022	0.0019
FQHC present in counties	1.3643	0.8648	0.0099[c]	0.0050	-0.5125[a]	0.1465	-0.0996[a]	0.0274
Total hospital beds per 100000 population	-0.0016	0.0018	0.0000	0.0000	0.0001	0.0002	0.0000	0.0000
% Non-white race	-0.0296	0.0308	-0.0002	0.0003	-0.0183[b]	0.0056	-0.0034[a]	0.0010
% Hispanic ethnicity	-0.0070	0.0392	0.0000	0.0003	-0.0054	0.0075	-0.0010	0.0014
% In poverty	0.0584	0.0658	0.0003	0.0005	0.0632[a]	0.0152	0.0117[a]	0.0028
% Uninsured	-0.0355	0.0869	-0.0003	0.0007	0.0211	0.0180	0.0041	0.0034
LHD staff per 10000 LHD population	0.0290	0.0185	0.0002	0.0002	0.0235[b]	0.0068	0.0043[a]	0.0012
LHD with clinician (MD, DO) executive director	-0.0902	0.8861	0.0008	0.0076	-0.6369[b]	0.2163	-0.1072[a]	0.0320
LHD has a public health (MPH, DrPH) executive director	-0.0590	0.7275	-0.0010	0.0056	0.1864	0.1533	0.0358	0.0298
Local board of health (LBOH) present	0.7138	0.8530	0.0044	0.0050	0.2297	0.1464	0.0406	0.0262
Centralization (shared is omitted reference group)								
State governance	-1.7313	1.2942	-0.0092	0.0107	-1.3172[a]	0.2218	-0.2813[a]	0.0477
Local governance	-0.9337	0.8836	-0.0045	0.0107	-1.2426[a]	0.2015	-0.2689[a]	0.0454
LHD location (Rural is omitted reference group)								

Metro	-0.2557	1.2681	-0.0033	0.0111	0.4549[c]	0.2299	0.0874[c]	0.0441
Urban (nonmetro)	-0.2776	1.0821	-0.0026	0.0081	0.1772	0.2041	0.0341	0.0385
LHD jurisdiction population size served (<25,000 is omitted reference group)								
Population size served 25,000 - 49,999	0.4734	0.9424	0.0033	0.0079	0.2645	0.1865	0.0427	0.0310
Population size served 50,000 - 99,999	-13.193	618.259	-0.0068	0.0047	0.6445[b]	0.2083	0.1174	1.0428
Population size served 100,000 - 499,999	0.9979	1.2756	0.0076	0.0134	0.7395[b]	0.2497	0.1313[b]	0.0455
Population size served > 500,000	0.8399	1.7769	0.0012	0.0131	1.6758[a]	0.3540	0.3376	0.0698
LHD jurisdiction (county is omitted reference group)	- 13.9866	702.4286	-0.0099[c]	0.0031	0.0416	0.2500	0.0111	0.0475
Log likelihood = -922.97802								
N = 1,547 Local Health Departments								

Abbreviations: ME, marginal effect; FQHC, federally qualified health center; LHD, local health department

[a]P <.001

[b]P <.01

[c]P <.05

Discussion

The multinomial model reveals that the increase in the number of primary care physicians per 10,000 population decreases the probability that the LHD will directly perform CVD screening by 1%. This supports our hypothesis. It also supports the possible existence of a substitution effect that may have occurred in the communities in the study sample.

Moreover, the presence of a clinician executive director is strongly associated with declines in the probability of directly performing CVD screening. This finding could possibly be explained by the fact that that the clinician director prefers to stay uninvolved in the provision of this service because he or she believes that CVD screening should be done by the other providers in the community.

As the number of staff hired in a LHD increases, so does the increase in the probability of a LHD directly performing CVD screening. In addition, this finding also supports previous evidence that an increase in LHD staff has a positive association with declines in CVD mortality.[93] Wright & Nice[13] mentioned that the direction of the relationship is difficult to discern, however. They posit that a LHD may choose to offer screening services because of a belief that the community needs them and consequently, the LHD then hires necessary staff. The other explanation is that LHDs with adequate resources may choose to expand their scope of service no matter the community need.

The presence of a FQHC produces significant results in regards to both choices. The results from the multinomial model reveal that having a FQHC in the LHD jurisdiction increases the probability of contracting out CVD screening. This increase may be due, in part, by shared service arrangements between LHDs and FQHCs.[94] LHD and FQHC partnerships are encouraged, and recommendations in 2010 were made to highlight effective ways to do so.[94] The presence of a FQHC also decreases the probability of directly performing it, further supporting the choice to contract out instead. Furthermore, CVD is among the top three primary diagnoses in FQHCs.

The results also revealed important findings from the demand side. In terms of sociodemographic characteristics, an increase in the percentage of non-white individuals decreases the probability of directly performing the service. A possible explanation could be that non-white individuals may prefer to go to another health system, more specifically, a FQHC. Recent evidence points out that residents actually prefer the type of care they receive in FQHCs.[17] Furthermore, more than half of the patients in a FQHC are racial minorities.[95] It is probable that low income racial minorities, who make up the majority of the patient base in FQHCs, are the same group we observe is associated with the decreased probability of directly performing CVD screening. This further supports why the presence of a FHQC increases the probability of contracting out this service since LHDs and FQHCs are encouraged to collaborate.[94] On the other hand, however, as the percentage of people in poverty increases, so does the probability of directly performing CVD screening. This may be because some directors believe that offering clinical preventive services is a part of the overall mission of public health, or some LHDs may simply have the resources and capabilities to perform CVD screening directly.

Having a state or local governance decreases the probability of performing this service directly, as opposed to staying uninvolved. Since the degree of centralization may have consequential influence on spending,[84] it may also play a role in why LHDs opt to stay uninvolved when they have a state or local governance. State and local agencies may choose to stay uninvolved either because of financial and budgetary reasons, or it is because decision makers are aware of other providers in the community can provide this service instead.

Lastly, LHD location in a metro area increases the probability of directly performing this service. Moreover, jurisdiction population size served of 99,999 to 499,999 and greater than 500,000 increase the probability of directly performing CVD screening as well. These findings support evidence on the existence of rural-urban disparities in CVD screening. It also supports the supposition that LHDs in larger jurisdictions may choose to directly perform CVD screening regardless of the presence of private providers in the community because of adequate resources and capacity.[13]

These results contribute to a priority area in both public health and medicine. As heart disease is the number one cause of death, finding best practices between both fields calls for synergy and collaborations to find the best strategies to improve population health and curb costs. Early detection through screening, coupled with drug adherence, can give out national hope in eliminating CVD.[96]

Limitations

There are a few limitations in this study. First, our study has a cross-sectional study design. No cause-effect relationship is implicated. Future studies could have a longitudinal study design to strengthen the associations and uncover trends over time. This could be done in the near future after the 2016 NACCHO Profile Survey and 2015-2016 AHRF are released. Furthermore, external validity is limited to county and multi-county LHDs only. City, city-county, and multi-city LHDs were excluded from this study, and therefore the results cannot be generalized to all LHDs in the United States. However, the majority of LHDs across the United States are on the county level.

Conclusions

In conclusion, our hypothesis was correct. Our results support the supposition that a LHD's choice to be involved with CVD screening is dependent on the availability or supply of private providers (i.e., primary care physicians). Other significant associations concerning LHD staff, population size served, metropolitan location, and the presence of a FQHC are noteworthy, especially with the choice to contract out. This study implies that CVD screening services entail a complex relationship with other providers as well as FQHCs. Moreover, the evidence from this study provides further support that increases in LHD staff is associated with the reduction of CVD mortality. It also supports provides further support for public health funding. Mays and Smith who revealed over a 13 year time period, for every 10% increase in public health spending, CVD mortality rates fell by 3.2%.[84] In summary, the interplay between public health inputs and population health outcomes further illustrate the need to support public health practice policy.

CHAPTER 5
IMPLICATIONS FOR PUBLIC HEALTH

Introduction

The private healthcare sector includes physicians, physician assistants, nurse practitioners, and advanced practice registered nurses (midlevels). Private practices and clinics are often thought as the usual sources of care for clinical preventive services. However, other health systems in the public sector, such as federally qualified health centers (FQHCs) and local health departments (LHDs) also offer these services along with

In 2012, the Institute of Medicine (IOM) published a report entitled, *Primary Care and Public Health: Exploring Integration to Improve Population Health*, and reminded us all of the need for integration and collaboration among health systems in order to achieve optimal population health outcomes. Neither medical care nor public health alone can save our nation's health. Therefore, it is of utmost importance to re-examine the provision of health healthcare services among LHDs[12] and understand a LHD's choice to be involved with disease screening activities, such as cancer and cardiovascular disease screening.

It was posited that the provision of such services is conditional on the supply and availability of private healthcare providers in the community who are independent of LHD funding, suggesting a substitution effect. Thus, we hypothesized that a LHD's choice to be involved in either cancer or CVD screening, by either directly performing the service or contracting it out, is conditional on the availability and capacity of other providers who are independent of LHD funding in the community. Using a cross-sectional study design, we used maximum likelihood estimation with binomial, multinomial, and sequential logit models to test our hypotheses.

We first merged the 2013 NACCHO Profile Survey with the 2013 NACCHO Boundary Files and the 2013-2014 and 2014-2015 Area Health Resource Files (AHRF). Results for each service were surprisingly different. A LHD's choice to be involved with the provision of cancer screening is not associated with the availability of other healthcare providers in the community. However, the training (degree) of the LHD director (MPH, DrPH), key sociodemographic variables, governance characteristics, and jurisdiction population size may have some influence in the decision making process since those covariates were statistically significant. For CVD screening, results illustrated that the LHD's choice to be involved by directly performing CVD screening is associated with the availability of private providers in the community. Other key variables such as the number of LHD staff, metro location, governance, and jurisdiction population size were strongly associated with a LHD's decision.

Cancer screening: Implications for public health practice and policy

The results of our studies revealed both surprising and consistent results from previous studies. TAlthough the results suggest that the availability and supply of private healthcare providers who are independent of LHD funding are not associated with a LHD's decision to be involved with cancer screening, we learned valuable information regardless. Perhaps it is not a substitution effect we should be investigating, but a synergistic one. Moreover, one of the key characteristics that should have special attention is the training or degree of the LHD director. The decision to be involved with cancer screening is associated with whether or not the LHD director has a public health degree (MPH or DrPH). Another key variable is the association with the number of LHD staff. As the number of LHD staff increases, so does the probability that a LHD will directly perform cancer screening. From a practice standpoint, these findings help to validate the vast contribution of public health staff and management in the improvement of population health outcomes.

Because of the nature of the survey, NACCHO asked the survey respondent if the LHD was involved with cancer screening, but the question did not stratify cancer screening into the differing types. However, LHDs are mainly involved with cervical, breast, and colorectal cancer screenings. There is meaningful evidence on the effectiveness of these screening activities, as supported by recommendations from the United States Preventive Services Taskforce (USPSTF). However, despite these recommendations, minimal progress in increasing cancer screening rates in the past decades have occurred. Racial and ethnic minorities, low-income, and uninsured individuals have disproportionately higher rates of cancer diagnoses who often present in later, more advanced stages.[97] In attempts to reduce disparities in breast and cervical cancer, Congress passed the Breast and Cervical Cancer Mortality Prevention Act in 1990. Ten years later, the National Breast and Cervical Cancer Early Detection Program (NBCCEDP) was implemented. Our findings illustrate several important observations from the demand side (i.e., the uninsured or non-white populations) and further justify the need for on-going legislation and continued federal funding support for this program.

Part of the funding from the NBCCDEP supports both clinical and non-clinical cancer screening components. The IOM stated in the report, *Primary care and public health: exploring integration to improve population health*, "In particular, the NBCCEDP could leverage its non-screening components to help integrate public health and primary care, reducing an existing community clinical services gap and facilitating health care access for a broader population than traditionally reached.[98] This recommendation can open up doors for increasing LHD staff without a clinical background. Non-clinical staff could be properly trained through workshops, certifications, and seminars to effectively provide health education on the life-saving capabilities of screening as well as follow-up if precancerous lesions or masses are found.

From a health policy perspective, it may be feasible and cost-effective if the scope of practice for culturally competent non-clinical staff could be widened. An example could be a non-clinical LHD staff could educate the patient while he or she is waiting for the clinician in the exam room. This would reinforce the importance of screening and could perhaps increase follow-up and/or treatment adherence rates. It is important to note that reminder registries are not enough for adherence; understanding the cultural and institutional barriers and contexts are necessary for follow-up or routine screening.[99]

Furthermore, the non-clinical staff could educate the patient if he or she is suspected to need further examinations and biopsies. Less advanced clinical skills are more paramount than ever as numerous who were previously uninsured now have access to care. Policies that support widening the scope of practice for practitioners with less skills than midlevels (i.e., licensed practical nurses, LHD staff with a public health bachelor or master's degree trained in health behavior or health promotion) should be considered in light of the non-clinical health education components of cancer screening. From a practice standpoint, this provides evidence that increased funding should be allocated towards the training of the future public health workforce. Policymakers should be informed of the importance of providing funding and scholarships for those who wish to pursue a career in public health. Further, as many health professional shortage areas (HPSAs) and medically underserved areas (MUAs) struggle with physician shortages, the need for innovative ways to deliver timely and effective clinical care to rural or low-resource communities is a priority. Timeliness of screening is a significant factor in survival, as many invasive cancers can be caught early, lessening the risk of more advanced treatments, costs, and deaths.

Cardiovascular disease screening: Implications for public health practice and policy

Heart disease is the number one cause of mortality in the United States. Many individuals do not know that they may have early onset CVD, but screening can help identify early risk factors, so patients can work towards eating a healthy, low sodium diet, for example, increase physical activity levels, or take prescribed treatments, such as cholesterol lowering statins.

The multinomial model revealed that the increase in the number of primary care physicians per 10,000 population did indeed decrease the probability that the LHD will directly perform CVD screening by 1%. As the population increases, so does the significance and magnitude of this effect. This has consequences for both medical care and public health, as it supports the existence of a substitution effect. Primary care physicians and midlevels should consider opening up communication with public health practitioners and create a shared dialogue on the best ways to provide CVD screening in the specific community.

The results also illustrated that an increase in the percentage of non-white racial minorities decreases the probability of directly performing CVD screening. Racial and ethnic minorities could simply be going to another health system, such as a FQHC for CVD screening. However, as the percentage of people in poverty increases, so does the probability of directly performing CVD screening. This finding may be attributed to the fact that some LHD directors may believe that offering clinical preventive services is a part of the overall mission of public health. Or, perhaps, some LHDs may have adequate resources to directly perform CVD screening. Our findings support on-going legislation and funding for for chronic disease screening low-income, uninsured, or racial and ethnic minorities who experience a disproportionate burden from CVD.

A multitude of ED visits are from strokes or cardiac events and chest pain is listed as a top reason.[100] The trends revealed that in general, the larger the LHD, the better resourced it is, and the LHD has the capacity to perform CVD screening directly. However, some LHDs display tendencies to rely on others who are independent of public health funding (e.g., FQHCs) to provide the service. Findings associated with declines in CVD mortality rates, supported through increases in public health spending[84] and LHD staff employed[93] further justify the need for some LHDs to directly perform CVD screening.

Conclusion

In conclusion, cancer and cardiovascular disease screenings give many people a chance to live healthier, better lives. Because of our findings, improving individualized patient care can lead to real impacts on population health. Health systems should work toward a common goal to reduce cancer and CVD morbidities and mortalities. Emphasis should be on the lifespan, with primary, secondary, and tertiary prevention, for health and wellness are dynamic. With evidence from novel findings that increases in public health spending leads to dramatic decreases in both cancer and CVD mortality,[84] Congress and state legislatures should realize the overall and long-term impact of prevention and the need for on-going research to inform best practices and health policies.

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APPENDIX I
SPECIFICATION TESTS

<u>Finding the preferred model (binomial logit models)</u>

Parsimonious model without interaction terms

logit p = β_0 + fqhcpresβ_1 + per100_totalhospbedsβ_2 + **per10_primcarephysβ_3** + **per10_midlevelsβ_4**
+ p_percentpplnonwhite2013β_5 + p_percentpplhisp2013β_6 + p_percentpplinpov2013β_7
+ p_percentpplunins2013β_8 + lhdemployer10β_9 + clindirpresβ_{10} + phdirpresβ_{11}
+ lbohβ_{12} + c0govcatβ_{13} + rucametro β_{14} + rucaurbanβ_{15} + jurspopsizecat$_{16}$ + ε

With interaction terms

logit p = β_0 + fqhcpresβ_1 + per100_totalhospbedsβ_2 + **per10_primcarephysβ_3** + **per10_midlevelsβ_4**
+ p_percentpplnonwhite2013β_5 + p_percentpplhisp2013β_6 + p_percentpplinpov2013β_7
+ p_percentpplunins2013β_8 + lhdemployer10β_9 + clindirpresβ_{10} + phdirpresβ_{11}
+ lbohβ_{12} + c0govcatβ_{13} + rucametro β_{14} + rucaurbanβ_{15} + rucametro*per10_primcarephysβ_{16}
+ rucametro*per10_midlevelsβ_{17} + rucaurban* per10_primcarephys$_{18}$
+ rucaurban* per10_midlevelsβ_{19} + jurspopsizecat$_{20}$ + ε

The "logit p" is the log of the probability of choosing the discrete choice dependent variable (0,1).

<u>Hausman Test Results</u>

***HAUSMAN TEST OUTPUT FOR CANCER SCREENING MNL MODEL**

```
Note: the rank of the differenced variance matrix (0) does not equal the number of
coefficients being tested (50); be sure this is what you expect, or there may be
problems computing the test.  Examine the output of your estimators
        for anything unexpected and possibly consider scaling your variables so that
the coefficients are on a similar scale.
```

	---- Coefficients ---- (b) partial	(B) all	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
contract				
2.jurisdic~e	-1.476891	-1.476891	0	0
1.fqhcpres	.728354	.728354	0	0
p_perc~e2013	.0093413	.0093413	0	0
p_perc~p2013	-.004984	-.004984	0	0
p_perc~v2013	.0448418	.0448418	0	0
p_perc~s2013	-.1011442	-.1011442	0	0
lhdemploy~10	.0242913	.0242913	0	0
1.clindirp~s	-.0540225	-.0540225	0	0
1.phdirpres	-.2418583	-.2418583	0	0
1.lbohpres	.5923794	.5923794	0	0
1bn.c0govcat	-2.995445	-2.995445	0	0
2.c0govcat	-2.536145	-2.536145	0	0
1.rucametro	.5246477	.5246477	0	0
1.rucaurban	-.2102856	-.2102856	0	0
1bn.jurspo~t	.6111563	.6111563	0	0
2.jurspops~t	.8403058	.8403058	0	0
3.jurspops~t	.9018718	.9018718	0	0
4.jurspops~t	1.215918	1.215918	0	0
per10_prim~s	.0132599	.0132599	0	0
1.rucametr~s	-.0702391	-.0702391	0	0
per10_midl~s	.016384	.016384	0	0
1.rucametr~s	.0086368	.0086368	0	0
per100_tot~s	.0001756	.0001756	0	0
1.rucametr~s	-.0006454	-.0006454	0	0
_cons	-1.583586	-1.583586	0	0

```
-------------+----------------------------------------------------------------
direct       |
2.jurisdic~e |    .2463095     .2463095               0               0
  1.fqhcpres |    .0279319     .0279319               0               0
p_perc~e2013 |   -.0065667    -.0065667               0               0
p_perc~p2013 |   -.0123565    -.0123565               0               0
p_perc~v2013 |    .0613967     .0613967               0               0
p_perc~s2013 |    .0415392     .0415392               0               0
lhdemploy~10 |    .0185718     .0185718               0               0
1.clindirp~s |   -.2508029    -.2508029               0               0
 1.phdirpres |    .2878713     .2878713               0               0
  1.lbohpres |    .1560032     .1560032               0               0
1bn.c0govcat |   -1.425153    -1.425153               0               0
  2.c0govcat |   -2.043053    -2.043053               0               0
 1.rucametro |    .3131264     .3131264               0               0
 1.rucaurban |    .1129166     .1129166               0               0
1bn.jurspo~t |    .2572065     .2572065               0               0
2.jurspops~t |    .7149778     .7149778               0               0
3.jurspops~t |    .5567551     .5567551               0               0
4.jurspops~t |    .5864557     .5864557               0               0
per10_prim~s |    .0284793     .0284793               0               0
1.rucametr~s |   -.0579207    -.0579207               0               0
per10_midl~s |   -.0257822    -.0257822               0               0
1.rucametr~s |    .0454651     .0454651               0               0
per100_tot~s |   -.0002109    -.0002109               0               0
1.rucametr~s |   -.0000809    -.0000809               0               0
       _cons |   -.8244536    -.8244536               0               0
------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from mlogit
           B = inconsistent under Ha, efficient under Ho; obtained from mlogit

    Test:  Ho:  difference in coefficients not systematic

                  chi2(0) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        0.00
                Prob>chi2 =           .
                (V_b-V_B is not positive definite)
```

***HAUSMAN TEST OUTPUT FOR CVD SCREENING MNL MODEL**

```
Note: the rank of the differenced variance matrix (0) does not equal the number of
coefficients being tested (50); be sure this is what you expect, or there may be
problems computing the test.  Examine the output of your estimators
        for anything unexpected and possibly consider scaling your variables so that
the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |    partial        all         Difference          S.E.
-------------+----------------------------------------------------------------
contract     |
2.jurisdic~e |   -14.67496    -14.67496               0               0
  1.fqhcpres |    1.221286     1.221286               0               0
p_perc~e2013 |   -.0334765    -.0334765               0               0
p_perc~p2013 |   -.0056945    -.0056945               0               0
p_perc~v2013 |    .0592469     .0592469               0               0
p_perc~s2013 |   -.0269614    -.0269614               0               0
lhdemploy~10 |    .0251023     .0251023               0               0
1.clindirp~s |   -.1226309    -.1226309               0               0
 1.phdirpres |    .0024495     .0024495               0               0
  1.lbohpres |    .6867842     .6867842               0               0
1bn.c0govcat |   -1.770894    -1.770894               0               0
  2.c0govcat |   -.8678868    -.8678868               0               0
```

```
   1.rucametro |    -.729047     -.729047               0               0
   1.rucaurban |    .1098945     .1098945               0               0
  1bn.jurspo~t |    .4614484     .4614484               0               0
  2.jurspops~t |   -14.17041    -14.17041               0               0
  3.jurspops~t |    .6986486     .6986486               0               0
  4.jurspops~t |    .4149051     .4149051               0               0
  per10_prim~s |   -.0804522    -.0804522               0               0
  1.rucametr~s |    .2635594     .2635594               0               0
  per10_midl~s |    .0591647     .0591647               0               0
  1.rucametr~s |   -.0845169    -.0845169               0               0
  per100_tot~s |    -.002214     -.002214               0               0
  1.rucametr~s |    .0020632     .0020632               0               0
         _cons |   -5.335471    -5.335471               0               0
-------------+----------------------------------------------------------------
direct         |
  2.jurisdic~e |    .0476698     .0476698               0               0
     1.fqhcpres |   -.5051533    -.5051533               0               0
  p_perc~e2013 |   -.0182128    -.0182128               0               0
  p_perc~p2013 |   -.0050141    -.0050141               0               0
  p_perc~v2013 |    .0652426     .0652426               0               0
  p_perc~s2013 |    .0204492     .0204492               0               0
  lhdemploy~10 |    .0238498     .0238498               0               0
  1.clindirp~s |   -.6474553    -.6474553               0               0
   1.phdirpres |    .1870254     .1870254               0               0
     1.lbohpres |     .223064      .223064               0               0
  1bn.c0govcat |   -1.324782    -1.324782               0               0
    2.c0govcat |   -1.240968    -1.240968               0               0
   1.rucametro |     .432342      .432342               0               0
   1.rucaurban |    .1714027     .1714027               0               0
  1bn.jurspo~t |    .2963241     .2963241               0               0
  2.jurspops~t |      .67062       .67062               0               0
  3.jurspops~t |    .7591342     .7591342               0               0
  4.jurspops~t |    1.695354     1.695354               0               0
  per10_prim~s |   -.0511455    -.0511455               0               0
  1.rucametr~s |   -.0132051    -.0132051               0               0
  per10_midl~s |    .0022773     .0022773               0               0
  1.rucametr~s |    .0268177     .0268177               0               0
  per100_tot~s |     .000162      .000162               0               0
  1.rucametr~s |   -.0008557    -.0008557               0               0
         _cons |   -1.437397    -1.437397               0               0
------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from mlogit
           B = inconsistent under Ha, efficient under Ho; obtained from mlogit

    Test:  Ho:  difference in coefficients not systematic

                  chi2(0) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        0.00
                Prob>chi2 =           .
                (V_b-V_B is not positive definite)
```

APPENDIX II
SEQUENTIAL LOGIT ESTIMATION (CANCER)

```
*Sequential Logit Model output for CANCER SCREENING

*Transition 1: A LHD chooses between becoming involved (1) or not involved (0)

*The binary dependent variable is "any_caninv - not involved = 0; involved =1"

*Calculating Average ME for the BIN model.
margins, dydx(*) noatlegend

*Same output that from the original BIN logit regression model.

. margins, dydx(*) noatlegend

Average marginal effects                          Number of obs    =       1565
Model VCE    : OIM

Expression   : Pr(any_caninv), predict()
dy/dx w.r.t. : 1.fqhcpres per100_totalhospbeds per10_primcarephys per10_midlevels
p_percentpplnonwhite2013 p_percentpplhisp2013 p_percentpplinpov2013
p_percentpplunins2013 lhdemployper10 1.clindirpres 1.phdirpres 1.lbohpres
               1.c0govcat 2.c0govcat 1.rucametro 1.rucaurban 1.jurspopsizecat
2.jurspopsizecat 3.jurspopsizecat 4.jurspopsizecat 2.jurisdiction_type

------------------------------------------------------------------------------------
------
                         |            Delta-method
                         |      dy/dx   Std. Err.      z    P>|z|     [95% Conf.
Interval]
-------------------------+----------------------------------------------------------
------
              1.fqhcpres |   .0155489   .0288854     0.54   0.590    -.0410654
.0721632
    per100_totalhospbeds |  -.0000356   .0000345    -1.03   0.301    -.0001033
.000032
      per10_primcarephys |   .0018332   .0050381     0.36   0.716    -.0080413
.0117077
         per10_midlevels |  -.0004886   .0020061    -0.24   0.808    -.0044204
.0034432
p_percentpplnonwhite2013 |  -.0011078   .0010574    -1.05   0.295    -.0031804
.0009647
    p_percentpplhisp2013 |  -.0026404    .001462    -1.81   0.071    -.0055059
.000225
   p_percentpplinpov2013 |   .0126472   .0029928     4.23   0.000     .0067814
.0185131
   p_percentpplunins2013 |    .006767   .0035636     1.90   0.058    -.0002174
.0137514
          lhdemployper10 |   .0039437   .0013901     2.84   0.005     .0012191
.0066683
           1.clindirpres |  -.0424295   .0388555    -1.09   0.275    -.1185848
.0337258
             1.phdirpres |   .0545541   .0310692     1.76   0.079    -.0063404
.1154486
              1.lbohpres |   .0393928   .0281698     1.40   0.162    -.0158191
.0946046
                         |
                c0govcat |
                      1  |   -.305994   .0431654    -7.09   0.000    -.3905967   -
.2213913
                      2  |  -.4355785   .0376935   -11.56   0.000    -.5094564   -
.3617007
```

```
                                |
             1.rucametro |   .1016435   .0453418     2.24   0.025     .0127751
.1905119
             1.rucaurban |   .0269714   .0399351     0.68   0.499       -.0513
.1052429
                                |
          jurspopsizecat |
                      1  |   .0530814   .0355812     1.49   0.136    -.0166565
.1228193
                      2  |   .1443993    .040708     3.55   0.000      .064613
.2241855
                      3  |   .1174309   .0478561     2.45   0.014     .0236347
.211227
                      4  |   .1282085   .0695054     1.84   0.065    -.0080196
.2644366
                                |
     2.jurisdiction_type |   .0292782   .0495634     0.59   0.555    -.0678642
.1264206
--------------------------------------------------------------------------------
------
Note: dy/dx for factor levels is the discrete change from the base level.

scalar ll_a = e(ll)

predict fit_a, xb

*Transition 2: Among LHD who are involved with cancer screening activity (performing
directly or contracting out as opposed to no inv)

gen performdir=0 if canservice_type==3
replace performdir=1 if canservice_type==2
label variable performdir "perform directly = 0; contract out = 1"
label define dir 0 "perform directly" 1 "contract out"
label values performdir dir

fre performdir

. fre performdir

performdir -- perform directly = 0; contract out = 1
-----------------------------------------------------------------------
                           |      Freq.    Percent      Valid       Cum.
---------------------------+-------------------------------------------
Valid   0 perform directly |        660      40.12      92.05      92.05
        1 contract out     |         57       3.47       7.95     100.00
        Total              |        717      43.59     100.00
Missing .                  |        928      56.41
Total                      |       1645     100.00
-----------------------------------------------------------------------

. logit performdir $xlist

Iteration 0:   log likelihood = -192.84987
Iteration 1:   log likelihood = -173.39768
Iteration 2:   log likelihood = -168.28581
Iteration 3:   log likelihood = -168.20325
Iteration 4:   log likelihood = -168.20299
Iteration 5:   log likelihood = -168.20299

Logistic regression                               Number of obs   =        702
                                                  LR chi2(21)     =      49.29
                                                  Prob > chi2     =     0.0005
Log likelihood = -168.20299                       Pseudo R2       =     0.1278
```

```
------------------------------------------------------------------------------------
             performdir |      Coef.   Std. Err.      z    P>|z|     [95% Conf.
Interval]
-------------------------+----------------------------------------------------------
              1.fqhcpres |   .5724763    .395424     1.45   0.148    -.2025405
1.347493
    per100_totalhospbeds |    .000127   .0002641     0.48   0.631    -.0003906
.0006447
      per10_primcarephys |  -.0256841   .0604858    -0.42   0.671     -.144234
.0928658
         per10_midlevels |   .0167188   .0226597     0.74   0.461    -.0276933
.061131
p_percentpplnonwhite2013 |   .0104272   .0126857     0.82   0.411    -.0144364
.0352907
    p_percentpplhisp2013 |    .007368   .0226076     0.33   0.744     -.036942
.051678
   p_percentpplinpov2013 |  -.0202111   .0377537    -0.54   0.592     -.094207
.0537849
   p_percentpplunins2013 |   -.145398    .049878    -2.92   0.004     -.243157    -
.0476389
          lhdemployper10 |   .0048732   .0167735     0.29   0.771    -.0280023
.0377487
           1.clindirpres |   .2049044   .4781375     0.43   0.668    -.7322279
1.142037
             1.phdirpres |  -.5164796   .4015322    -1.29   0.198    -1.303468
.270509
              1.lbohpres |   .3795235   .3963619     0.96   0.338    -.3973316
1.156379
                         |
               c0govcat |
                     1  |  -1.540796   .6325449    -2.44   0.015    -2.780561    -
.3010305
                     2  |  -.4432076   .3910854    -1.13   0.257    -1.209721
.3233057
                         |
             1.rucametro |  -.5096301   .7154592    -0.71   0.476    -1.911904
.8926442
             1.rucaurban |    -.52096   .6460644    -0.81   0.420    -1.787223
.7453029
                         |
          jurspopsizecat |
                     1  |   .4104269   .5369548     0.76   0.445    -.6419852
1.462839
                     2  |   .2007516   .6033711     0.33   0.739    -.9818339
1.383337
                     3  |   .1825535    .668434     0.27   0.785    -1.127553
1.49266
                     4  |   .3257088   .8504311     0.38   0.702    -1.341105
1.992523
                         |
     2.jurisdiction_type |  -1.738378   .9238636    -1.88   0.060    -3.549118
.0723614
                   _cons |   .1119881   1.160473     0.10   0.923    -2.162497
2.386473
------------------------------------------------------------------------------------

margins, dydx(*) noatlegend

scalar ll_p = e(ll)

predict fit_p, xb

di ll_a + ll_p
-1118.4908
```

```
. mlogit canservice_type $xlist

Iteration 0:   log likelihood = -1269.3291
Iteration 1:   log likelihood = -1128.7312
Iteration 2:   log likelihood = -1117.3369
Iteration 3:   log likelihood = -1117.2113
Iteration 4:   log likelihood = -1117.2108
Iteration 5:   log likelihood = -1117.2108

Multinomial logistic regression                   Number of obs     =       1565
                                                  LR chi2(42)       =     304.24
                                                  Prob > chi2       =     0.0000
Log likelihood = -1117.2108                       Pseudo R2         =     0.1198

------------------------------------------------------------------------------------
------
         canservice_type |      Coef.   Std. Err.      z    P>|z|     [95% Conf.
Interval]
-------------------------+----------------------------------------------------------
not_involved             |  (base outcome)
-------------------------+----------------------------------------------------------
contract                 |
              1.fqhcpres |   .7140555   .3809069     1.87   0.061    -.0325083
1.460619
    per100_totalhospbeds |   .0001719   .0002884     0.60   0.551    -.0003934
.0007372
      per10_primcarephys |  -.0239275   .0586738    -0.41   0.683     -.138926
.0910711
         per10_midlevels |   .0103318   .0208026     0.50   0.619    -.0304406
.0511041
p_percentpplnonwhite2013 |   .0082686   .0125902     0.66   0.511    -.0164076
.0329449
    p_percentpplhisp2013 |  -.0045519   .0213185    -0.21   0.831    -.0463353
.0372316
   p_percentpplinpov2013 |   .0414519   .0364809     1.14   0.256    -.0300493
.1129532
   p_percentpplunins2013 |  -.0994021   .0486301    -2.04   0.041    -.1947155    -
.0040888
          lhdemployper10 |    .023836    .011786     2.02   0.043     .0007359
.046936
           1.clindirpres |  -.0622742   .4449387    -0.14   0.889     -.934338
.8097897
             1.phdirpres |  -.2503539   .3900697    -0.64   0.521    -1.014876
.5141686
              1.lbohpres |   .6064821   .4013302     1.51   0.131    -.1801106
1.393075
                         |
                c0govcat |
                      1  |  -2.991305   .6444818    -4.64   0.000    -4.254466    -
1.728144
                      2  |   -2.54805   .4231037    -6.02   0.000    -3.377318    -
1.718782
                         |
             1.rucametro |    .075051   .6799798     0.11   0.912    -1.257685
1.407787
             1.rucaurban |  -.1388776   .6174125    -0.22   0.822    -1.348984
1.071229
                         |
          jurspopsizecat |
                      1  |   .6258986   .5175632     1.21   0.227    -.3885067
1.640304
                      2  |    .847844   .5757191     1.47   0.141    -.2805447
1.976233
```

```
                     3 |    .892279    .649584     1.37   0.170    -.3808823
2.16544
                     4 |   1.184628   .8320434     1.42   0.155    -.4461467
2.815404
                       |
     2.jurisdiction_type |    -1.3668    .903345    -1.51   0.130    -3.137324
.4037239
                   _cons |  -1.300662   1.079715    -1.20   0.228    -3.416864
.8155403
-------------------------+----------------------------------------------------------------
------
direct                   |
              1.fqhcpres |   .0181835    .139757     0.13   0.896    -.2557352
.2921022
    per100_totalhospbeds |  -.0002235   .0001762    -1.27   0.205    -.0005688
.0001218
      per10_primcarephys |   .0104772   .0247127     0.42   0.672    -.0379589
.0589132
         per10_midlevels |  -.0033588   .0099048    -0.34   0.735     -.022772
.0160543
p_percentpplnonwhite2013 |  -.0065511   .0051255    -1.28   0.201    -.0165969
.0034948
    p_percentpplhisp2013 |  -.0132462   .0071064    -1.86   0.062    -.0271746
.0006822
   p_percentpplinpov2013 |   .0630056   .0147722     4.27   0.000     .0340526
.0919586
   p_percentpplunins2013 |   .0428789   .0173478     2.47   0.013     .0088779
.0768799
          lhdemployper10 |   .0179347   .0067364     2.66   0.008     .0047316
.0311379
           1.clindirpres |  -.2241178    .194993    -1.15   0.250     -.606297
.1580614
             1.phdirpres |   .2938095   .1473652     1.99   0.046     .0049789
.5826401
              1.lbohpres |   .1528561   .1392918     1.10   0.272    -.1201509
.425863
                         |
                c0govcat |
                      1  |  -1.427199   .2543352    -5.61   0.000    -1.925687   -
.9287112
                      2  |  -2.028854   .2406887    -8.43   0.000    -2.500595   -
1.557113
                         |
             1.rucametro |   .5101167   .2195575     2.32   0.020     .0797919
.9404415
             1.rucaurban |   .1437761   .1938956     0.74   0.458    -.2362524
.5238045
                         |
          jurspopsizecat |
                      1  |   .2351991   .1759924     1.34   0.181    -.1097398
.5801379
                      2  |   .6769865   .1980592     3.42   0.001     .2887977
1.065175
                      3  |   .5302248    .233122     2.27   0.023     .0733142
.9871355
                      4  |   .5427795   .3359615     1.62   0.106     -.115693
1.201252
                         |
     2.jurisdiction_type |   .2393523    .236364     1.01   0.311    -.2239127
.7026172
                   _cons |  -1.017094   .4529154    -2.25   0.025    -1.904791   -
.1293957
------------------------------------------------------------------------------------------
scalar ll_mnl = e(ll)
```

```
predict fit_mnl, xb

scalar dev = 2*(ll_mnl - ll_a - ll_p)

di dev, chi2tail(22,dev)
2.5600057 .99999988
```

VITA

GEORGIANNE F. TIU

DOB: November 22, 1986
Birthplace: Kansas City, Missouri

I. EDUCATION

2011 M.P.H., Leadership, Management & Policy (now Health Services Management), University of Cincinnati, College of Medicine, Department of Environmental Health

2009 B.S., Biology, University of Kentucky, College of Arts & Sciences, *cum laude*

II. ACADEMIC AND PROFESSIONAL POSITIONS

2014 – 2015 President, AcademyHealth Student Chapter, University of Kentucky, College of Public Health

2014 Intern, Kentucky State Representative Susan Westrom of the 79th District, Frankfort, Kentucky

2014 Selected Abstract Reviewer, Social Research, Policy, and Practice (SRPP), Gerontological Society of America (GSA) 67th Annual Meeting

2013 Planning Committee Member, Ohio Valley Appalachia Regional Geriatric Education Center (OVAR/GEC), College of Public Health

2013 Research Grantee, Health Resources and Services Administration (HRSA), Kentucky and Appalachia Public Health Training Center (KAPHTC)

2013 Intern, National Academy of Social Insurance (NASI), Somers Aging and Long-Term Care Internship, The George Washington University, School of Nursing, Center for Aging, Health & Humanities, Washington, D.C.

2012 – 2013 Graduate Research Assistant, National Coordinating Center for Public Health Services & Systems Research (PHSSR), University of Kentucky, College of Public Health

2010 Intern, Appalachian Regional Healthcare (ARH), Lexington, Kentucky

2009 Selected Panel Member, University of Kentucky-West Virginia Louis Stokes Alliance for Minority Participation (UK-WV LSAMP)

2008 – 2009 Vice President, National Society of Collegiate Scholars (NSCS), University of Kentucky

2008 – 2009 Research Fellow, National Science Foundation (NSF), Office of Undergraduate Research, University of Kentucky

2008 – 2009 Research Fellow, National Science Foundation (NSF), Appalachian and Minority Science, Technology, Engineering, and Mathematics Majors (AMSTEMM), University of Kentucky

2007 – 2009 Research Assistant, Department of Chemistry, Sanders Brown Center on Aging, University of Kentucky

III. TEACHING EXPERIENCES

2015 Teaching Assistant, "Health Services and Systems Organizations," Masters, Fall Semester, College of Public Health, University of Kentucky

2015 Instructor, "Health and Medical Care Delivery Systems," Undergraduate, Spring Semester, College of Public Health, University of Kentucky

2014 Teaching Assistant, "Management of Public Health Organizations," Masters, Fall Semester, College of Public Health, University of Kentucky

2014 Teaching Assistant, "Well Managed Public Health Organizations," Doctoral, Fall Semester, College of Public Health, University of Kentucky

IV. INVITED LECTURES

2014 Invited lecturer, undergraduate general studies course, tutorial on reference management software and how to find peer reviewed journal articles, University of Kentucky, Lexington, Kentucky, November 3-4, 2014.

2013 Invited lecturer, incoming Master of Public Health students at the University of Cincinnati, College of Medicine, Department of Environmental Health, Cincinnati, OH, September 27, 2013.

2011 Radio talk show guest, "Health Matters," Morehead State University Radio Talk Show, Morehead, Kentucky, November 12, 2011

V. PEER REVIEWED PUBLICATIONS

1. Di Domenico, F, Sultana, R, **Tiu, GF,** Scheff, NN, Perluigi, M, Cini, C, Butterfield, DA. (2010). Protein Levels of Heat Shock Proteins 27, 32, 60, 70, 90 and Thioredoxin-1 in Amnestic Mild Cognitive Impairment: An Investigation on the Role of Cellular Stress Response in the Progression of Alzheimer's Disease. *Brain Research, 1333,* 72-81. doi:10.1016/j.brainres.2010.03.085. [PMID: 20362559]

2. **Tiu, GF,** Sultana, R, Butterfield, DA. (2009). The Levels of Signaling Proteins in Brain of Control Subjects versus Brain from Subjects with Mild Cognitive Impairment: Insights into Alzheimer's Disease. *Kaleidoscope: University of Kentucky Journal of Undergraduate Scholarship, 8,* 62-69.

3. **Tiu, GF,** Sultana, R, Butterfield, DA. (2009). Investigating Heat Shock Protein Expression Levels with the Interaction of Ceria Nanoparticles in the Cerebral Cortex: Insights into Alzheimer's Disease. *Kaleidoscope: University of Kentucky Journal of Undergraduate Scholarship, 8,* 124-126.

VI. SCIENTIFIC PRESENTATIONS

Schuster, AM, Niro, N, Schuier, M, **Tiu, GF**, Abofaye, M. Preparing for disaster: Lexington, Kentucky's emergency plans for older adults. Poster presentation at the 36th Annual Meeting Southern Gerontological Society, April 15-18, 2015, Williamsburg, Virginia.

Tiu, GF, Scutchfield, FD. Rural Physicians and their Spouses in the Appalachian Regional Healthcare (ARH) System: Factors that Influence Retention. Oral presentation at the Appalachian Regional Healthcare (ARH) Medical Leadership Staff Council, January 17, 2015, Lexington, Kentucky.

Tiu, GF, Mays, GP. Regional Variation in Economic Values of Unpaid Care for Individuals with Alzheimer's disease and other Dementias and Medicare Nursing Home Expenditures for Long-term Care. Poster presentation at the American Society for Health Economists (ASHEcon) Fifth Biennial Conference, June 22-25, 2014, Los Angeles, CA, University of Southern California.

Tiu, GF, Mays, GP. Regional Variation in Economic Values of Unpaid Care for Individuals with Alzheimer's disease and other Dementias and Medicare Nursing Home Expenditures for Long-term Care. Poster presentation at the American Public Health Association (APHA) 141st Annual Meeting, November 2-6, 2013, Boston, MA.

Tiu, GF, Ying, J, Scutchfield, FD, Lamberth, CD. Rural Physicians and their Spouses: Factors that Influence Retention in Central Appalachia. Poster presentation at the American Public Health Association (APHA) 141st Annual Meeting, November 2-6, 2013, Boston, MA.

Tiu, GF, Mays, GP. Informal Unpaid Caregiving for Alzheimer's disease and Other Dementias and Its Relationship with Long-Term Care Medicare Nursing Home Expenditures. Poster presentation at the AcademyHealth Annual Research Meeting, Long-term Care Interest Group, June 22, 2013, Baltimore, MD.

Tiu, GF, Ying, J, Scutchfield, FD, Lamberth, CD. Rural Physicians and their Spouses: Factors that Influence Retention in Central Appalachia. Poster presentation at the College of Public Health Research Day in conjunction with the Center for Clinical and Translational Sciences, April 15, 2013, Lexington, Kentucky.

Tiu, GF, Ying, J, Scutchfield, FD. Rural Physicians in Central Appalachia: Factors that Influence Recruitment and Retention. Oral presentation at the Appalachian Regional Healthcare (ARH) Medical Leadership Staff Council, May 20, 2012, Lexington, Kentucky.

Tiu, GF, Ying, J, Scutchfield, FD. Rural Physicians in Central Appalachia: Factors that Influence Recruitment and Retention. Oral presentation at the Appalachian Regional Healthcare (ARH) Medical Leadership Staff Council, May 20, 2012, Lexington, Kentucky.

Tiu, GF, Sultana, R, Butterfield, DA. The Levels of Signaling Proteins in Brain of Control Subjects Versus Brain from Subjects with Mild Cognitive Impairment: Insights into Alzheimer's Disease. Poster presentation at the Kentucky Academy of Science (KAS) Conference, November 1, 2009, Lexington, Kentucky.

Tiu, GF, Sultana, R, Butterfield, DA. The Levels of Signaling Proteins in Brain of Control Subjects Versus Brain from Subjects with Mild Cognitive Impairment: Insights into Alzheimer's Disease. Oral presentation at the Appalachian and Minority Science, Technology, Engineering, and Mathematics Majors (AMSTEMM) Research Colloquium, November 1, 2009, Lexington, Kentucky.

Tiu, GF, Sultana, R, Butterfield, DA. The Levels of Signaling Proteins in Brain of Control Subjects Versus Brain from Subjects with Mild Cognitive Impairment: Insights into Alzheimer's Disease. Poster presentation at the National Conferences on Undergraduate Research (NCUR), April 16 - 18, 2009, University of Wisconsin-LaCrosse, La-Crosse, Wisconsin.

Tiu, GF, Sultana, R, Butterfield, DA. The Levels of Signaling Proteins in Brain of Control Subjects Versus Brain from Subjects with Mild Cognitive Impairment: Insights into Alzheimer's Disease. Poster presentation at the Showcase of Undergraduate Scholars, April 29, 2009, Lexington, Kentucky.

VII. HONORS, AWARDS & CERTIFICATIONS

2015	Nominee, Golden Apple Teaching Award, College of Public Health, University of Kentucky
2013 – 2014	Elected Student Research Chair, College of Public Health, University of Kentucky
2012 – 2013	Donovan Scholar in Gerontology, College of Public Health, University of Kentucky
2013	Nominated Member, Phi Kappa Phi Honorary Society, University of Kentucky
2012	Preconception Peer Educator, College of Medicine, University of Cincinnati
2009	Second Place Winner, Oswald Research & Creativity Program, University of Kentucky
2005	Recipient, Commonwealth Scholarship, University of Kentucky

VIII. PROFESSIONAL ORGANIZATIONS

2014 – present	Public Health Foundation (PHF)
2013 – present	American Society of Health Economists (ASHEcon)
2013 – present	Phi Kappa Phi Honorary Society
2013 – present	National Academy of Social Insurance (NASI), Associate Member
2013 – present	AcademyHealth
2012 – present	American Public Health Association (APHA)
2013 – 2014	Gerontological Society of America (GSA)
2007 – 2009	National Society of Collegiate Scholars (NSCS)
2007 – 2009	Society for the Promotion of Undergraduate Research (SPUR)

IX. COMPUTER SKILLS

Stata, SAS, SPSS, Microsoft Excel, Adobe Photoshop CS

X. VOLUNTEER EXPERIENCES

Volunteer for Medical Mission, Surgery Department & Primary Care Clinics, University of the Philippines Medical Alumni Society of America, Cebu, Philippines, February 7-10, 2012

Volunteer, Clover Fork Clinic, Primary Care, Harlan, Kentucky, February 2010

Volunteer, St. Joseph Hospital, Pharmacy Department, Lexington, Kentucky, January 2007- January 2009

Volunteer, St. Joseph Hospital, Surgery Department, Lexington, Kentucky, January 2007- January 2009

Volunteer, Daniel Boone Clinic & Emergency Department, Harlan Appalachian Regional Hospital, Primary Care, Harlan, Kentucky, August 2004 - May 2005

(Student's Signature) Georgianne F. Tiu

(Date) 06/06/2016