ASSESSING THE IMPACT OF EPIDEMIOLOGY SURGE CAPACITY PROVIDED TO IMPROVE FOODBORNE ILLNESS AND RESPOND TO HIGH CONSEQUENCE INFECTIOUS DISEASE IN TEXAS, 2012 – 2016

A Dissertation

by

KAHLER WAYNE STONE

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PUBLIC HEALTH

Chair of Committee,	Jennifer A. Horney
Committee Members,	Thomas J. McDonald
	Maria Perez-Patron
	Cason Schmit
Head of Department,	Jennifer A. Horney

May 2018

Major Subject: Epidemiology and Environmental Health

ABSTRACT

Background: Due to the decentralized structure of the public health system in Texas, Local Health Departments (LHDs) in Texas provide public health services for the majority of Texans. In response to increasing caseloads of foodborne illnesses and high consequence infectious disease investigations, the Department of State Health Services (DSHS) requested funding from the Texas Legislature in 2013 and 2015 for a new state funded epidemiologist (SFE) program.

Methods: A cross-sectional survey was implemented to quantify roles, responsibilities, and training of SFE LHD epidemiologists in Texas in 2017. Electronic disease reporting data on 42 conditions were extracted from 2012-1016 in all LHD jurisdictions. Median time and percentage of complete reports were analyzed and compared across time and between SFE and non-SFE jurisdictions using Mann-Whitney t-tests and Z scores. Key informant interviews (14 of 32 from LHDs; 4 of 8 from regional HDs; 3 of 6 from state health department) were conducted and inductively analyzed for emerging themes.

Results: For LHDs included in this study, the mean number of epidemiologists per 100,000 was 0.73 in medium LHDs and 0.46 in large LHDs. The median time of disease processing improved from 14 days to 8 days between 2012 to 2016 and the percentage of case reports that were complete on first submission improved from 19.6 % to 27.7%. Improvements in quality of disease investigations, communication, timeliness, and overall epidemiology capacity within the LHD were noted.

Discussion: SFE positions makeup approximately 40 percent of the LHD epidemiologic workforce and 56 percent of medium sized LHD epidemiology staff in Texas. Through this

program, DSHS has increased epidemiology capacity almost two-fold from 0.28 to 0.47 epidemiologists per 100,000 people. The proportion of disease reporting improvements in timeliness and completeness was primarily due to the SFE workforce handling the majority of disease reports in Texas. All key informants agreed and described the positive impact on disease surveillance of the SFEs. Local epidemiology capacity has increased and, in turn, Texas public health surveillance capacity has improved at the state level.

DEDICATION

To my wife, Katy.

ACKNOWLEDGEMENTS

I am grateful to the many people who made this project a reality. First, I thank my wife, Katy. Without her unwavering love and support, I would never have considered coming back to school. Next, I thank my committee chair, Jennifer Horney, for her tireless and inspiring mentorship and encouragement, which allowed me to be the best version of myself professionally and personally. Her leadership and commitment to her students made this project possible. I would also like to thank my entire committee, Thomas McDonald, Maria Perez-Patron, and Cason Schmit for their unique and insightful perspectives and guidance. In addition, I want to thank Marilyn Felkner for her expertise and critical suggestions throughout this project. Her support and encouragement were crucial. This project would not be possible without collaboration from Eric Garza with the Texas Department of State Health Services. His unique perspective and field experience helped shape this project to what it became. Thanks are also due to all of the local and state public health officials who took the time to participate in this study and shared their experiences and insights for this project. It was an honor to work with the Texas public health workforce, a group of dedicated individuals who strive to better their communities daily. To all of my friends and colleagues who have supported and encouraged this pursuit, thank you. To my brothers and sisters, Lena, Dusty, Maggie, and Will, I am grateful for each of our relationships and your support through this. Finally, I want to thank my parents, Wayne and Judi Stone and Katy's parents, Bill and Carol Hyman for their enthusiastic encouragement and consistent engagement with this entire process.

CONTRIBUTORS AND FUNDING SOURCES

This work was supervised by a dissertation committee consisting of Professors Jennifer Horney and Maria Perez-Patron of the Department of Epidemiology and Biostatistics, Professor Thomas McDonald of the Department of Environmental and Occupational Health, and Professor Cason Schmit of the Department of Health Policy and Management. Each committee member invested valuable time and critique to this project.

Professor Marilyn Felkner of the University of Texas Department of Human Ecology and Eric Garza of the Texas Department of State Health Services contributed considerably with their subject matter expertise and framing of the project. Without them, this project would not have been possible.

No external funding was received to support the research and compilation of this document. However, I would like to acknowledge internal financial support from the Office of the Dean of the School of Public Health, the Texas A&M Institute for Sustainable Communities, and Professor Philip Berke of the Department of Landscape Architecture and Urban Planning.

NOMENCLATURE

ACA	Affordable Care Act
AEC	Applied Epidemiology Capacities
ASTHO	Association of State and Territorial Health Officials
CI	Confidence Interval
CSTE	Council for State and Territorial Epidemiologists
DSHS	Department of State Health Services
EAIDB	Emerging and Acute Infectious Disease Branch
ECA	Epidemiology Capacity Assessment
EPHS	Essential Public Health Services
HSR	Health Service Region
MMWR	Morbidity and Mortality Weekly Report
NACCHO	National Association of City and County Health Officials
NBS	NEDSS Based System
NEDSS	National Electronic Disease Surveillance System
OR	Odds Ratio
SFE	State-Funded Epidemiologist(s)
STLT	State, Territorial, Local, Tribal
TACCHO	Texas Association of City and County Health Officials

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

Page

1. INTRODUCTION

The purpose of this study was to describe and evaluate the impact of an epidemiologic surge capacity program established by the Texas Department of State Health Services and funded by the Texas Legislature beginning in 2013. This includes enumerating and characterizing the training and skills of the program's surge epidemiologists, quantitatively comparing disease reporting timeliness and completeness in Texas before and after the survey capacity program, and exploring the impact of the program on local public health surveillance through qualitative key informant interviews. This research project used both qualitative and quantitative methods to describe and evaluate the surge epidemiologist program to understand its impact on each local health department's unique structure and situation.

This section covers the existing knowledge about and literature related to epidemiology capacity and describes the basis and rationale for this study. Prior research and documented gaps are explained and discussed, providing the rationale and justification for this research project. As the public health workforce changes and grows, evaluations such as these provide critical input for public health leaders at the local, state, federal, and global levels.

1.1 Background

1.1.1 Essential Public Health Services

Local and state public health agencies provide a wide range of population-based public health services for their jurisdictions. These services were defined in 1994 when the Public Health Functions Steering Committee, a group comprised of local, state, and national public health organizations, developed the 10 Essential Public Health Services (EPHS) (Center for

Disease Control and Prevention 2017a). Using the 10 EPHS, the National Public Health Performance Standards Program (NHPSP) developed a list of services that public health agencies should strive to offer. The NHPSP provides performance standards for public health agencies to encourage and promote stronger public health preparedness, quality improvement, and stronger science-based public health practice (Center for Disease Control and Prevention 2017b). Specifically, these standards can be used to evaluate local and state public health systems, including public health surveillance and emergency preparedness (Lurie 2004).

However, due to inadequate organizational capacity and financial resources, public health agencies, particularly local health departments (LHDs) struggle to offer all 10 EPHS effectively (Hyde and Shortell 2012). Four of the ten EPHS (1,2,9, and 10) are linked to epidemiology capacity. EPHS 1 relates to the monitoring of health status to identify and solve community health problems. EPHS 2 includes diagnoses and investigations of health problems and health hazards. EPHS 9 evaluates effectiveness, accessibility, and quality of personal and population-based health services. EPHS 10 focuses on using research to find innovative solutions to health problems. Since epidemiology is linked to 4 of the 10 EPHS, health departments need epidemiologists as part of the workforce.

1.1.2 National Public Health Workforce

Public health requires a dynamic and highly trained workforce to constantly meet the new challenges it faces on a local, state, national, and global scale. From chronic disease morbidity and mortality to emerging infectious diseases to natural and man-made disasters, the public health workforce must be capable to respond. Assessing and documenting the capacity of the public health workforce to meet these challenges is critical to understanding if there are gaps or

shortages that should be addressed in order to protect the health of the public. Enumerating the workforce allows us to better understand its size and composition and identify areas of need that must be addressed. Understanding the capabilities and existing capacities further informs areas of need and improvement for better public health service.

Public health workforce data is limited in the U.S. In 2014, Beck et al. (2014) conducted a review of key studies that provided information on the public health workforce in the U.S. (Beck, Boulton, and Coronado 2014). These include the Association of Public Health Laboratories Workforce Capacity Assessment (APHL), Association of State and Territorial Health Officials profile survey (ASTHO), Council of State and Territorial Epidemiologists Epidemiology Capacity Assessment (CSTE), National Association of County and City Health Officials (NACCHO) profile survey, the Office of Personnel Management (OPM), and the University of Michigan Center of Excellence in Public Health Workforce Studies (UM CEPH). Of all governmental public health positions at local, state, and federal levels, public health emergency preparedness and epidemiology combine for 7,986 positions, or 3% of the entire workforce (Beck, Boulton, and Coronado 2014). This 3% is responsible for 4 of the 10 EPHS and should be better understood.

1.1.3 National Epidemiology Workforce

Epidemiology is a core public health function and an essential component of public health response (Haveman-Nies et al. 2011). The roles played by epidemiologists in emergency response are unique and should be characterized and enumerated to better understand the system's capacity and ability to respond to public health threats. Epidemiology capacity refers to the ability to provide comprehensive epidemiology services routinely to support essential public

health services in non-emergent situations. Public health surge capacity refers to the ability to implement core public health activities such as mass prophylaxis and vaccination, risk communication, and epidemiologic investigation in response to emergencies or disasters. It is important to understand and characterize both forms of capacity to improve public health services.

ASTHO, CSTE, and NACCHO have national epidemiology workforce information. CSTE has documented the epidemiology capacity of state health departments in the U.S. since 2001 using the Epidemiology Capacity Assessment (ECA) tool (Hadler et al. 2015). It is distributed to all state and territorial health departments in the U.S. and enumerates the number of epidemiologists by program area. Staff are further classified by education, experience, competency, salary, and job role. In 2013, 2,752 epidemiologists were employed by state health departments, the highest number reported since 2001, when the total number of epidemiologist employed by state health departments was 2,498. Infectious disease and maternal child health epidemiologists are the only two program areas where capacity has increased since 2001. However, the ECA includes only state health department data, which do not represent the entire public health system.

LHDs also provide EPHS. This is particularly true in states with decentralized public health authority, meaning that local jurisdictions (e.g., cities and counties) have the responsibility to provide public health services within their jurisdiction. LHDs have their own public health workforce to fulfill the public health mandates local governmental bodies. The ECA does not capture information on LHDs in the U.S.

In LHDs, epidemiology capacity information is currently limited. NACCHO's profile survey has collected information from all LHDs in the U.S. since 2005 on a range of topics, one

of which is workforce information. The NACCHO profile study has also demonstrated growth in the number of epidemiologists in LHDs, with 1,300 identified in 2005 to 1,600 in the 2016 profile (NACCHO 2016a). However, the NACCHO national profile data is limited since it only includes an estimated number of epidemiologists employed without other measures of capacity. No information regarding program area, competency, training needs, or experience is captured. Additionally, these reports are only representative of the overall U.S.; state specific epidemiology enumeration information is only available for purchase in raw data form and not in report form.

1.1.4 Funding of Epidemiologists

Since the World Trade Center terrorist attack on September 11, 2001, and the subsequent anthrax attacks, public health has benefited from increased funding to address biological, chemical, radiological, and other public health threats through public health preparedness funds. Initially, Congress allocated $3 billion to strengthen the public health infrastructure, tasking the U.S. Centers for Disease Control and Prevention (CDC) with disseminating these funds to states and establishing priorities for action (Lurie 2004). The Public Health Emergency Preparedness (PHEP) cooperative agreements are the main source of funding that state and LHDs rely on to effectively prepare and respond to public health threats (Horney et al. 2017). In addition to the need to increase overall threat preparedness, natural disasters like Hurricanes Katrina, Rita, and Wilma in 2005 and emerging infectious disease threats like the novel influenza A (H1N1) pandemic in 2009 highlighted the need for continued public health preparedness funding ("UN Press Meeting" 2005; Stier and Goodman 2007).

The increased preparedness funding changed the shape of public health agencies across the U.S. (Lurie, Wasserman, and Nelson 2006). To date, more than $11 billion has been awarded to state, tribal, local, and territorial (STLT) health departments (CDC 2017a). Despite this initial funding increase, public health preparedness funding has been declining on an annual basis. By 2016, funds provided by CDC as part of the PHEP cooperative agreement were one-third less than in 2001, dropping from $980 million to $651 million (Segal and Martin 2017). Moreover, Congress began to limit preparedness appropriations to specified threats in reaction to significant public health events, such as Smallpox, H1N1, or Ebola virus disease (EVD).

Compounding the issue of funding reductions and earmarking, the economic downturn beginning in 2008 negatively affected many health departments. According to economic surveys conducted by NACCHO and a study by Shah et al. (2016), during the recession demand for public health services increased while LHDs reported increased staff losses due to budget reductions. Loss of skilled workforce remains an issue for LHDs (Shah et al. 2016). In Texas, 36% of local health departments laid off staff due to budget cuts between 2008 and 2013. These economic realities negatively impacted the public health workforce, especially certain concentrations like epidemiology (Bevington 2014; Gebbie and Turnock 2006; NACCHO 2014).

Although NACCHO and CSTE do not provide detailed data about LHD epidemiology capacity, several small, state-based studies have attempted to characterize local capacity. The staff responsible for performing epidemiologic tasks such as disease surveillance, study design, data collection and analysis, and designing disease control methods can vary between small rural LHDs and large urban LHDs.- For example, O'Keefe and colleagues conducted a cross-sectional assessment of the quantity, education, training, and perceived competencies of epidemiologic staff (O'Keefe, Shafir, and Shoaf 2013). They found that there were differences in quantity,

education, training, and competency depending on LHD size. These findings are supported by the most recent national survey of LHDs conducted by NACCHO, which showed that as health department population served increased, the percentage of LHDs employing at least one epidemiologist increased (NACCHO 2016a). In fact, according to the NACCHO survey, LHDs serving populations of less than 250,000 people do not typically have an epidemiologist on staff. However, there are exceptions. Brazos County, Texas, home to Texas A&M University, is a community of an estimated 220,000 residents that does have an epidemiologist at the LHD (U.S. Census Bureau 2016; Witte 2016). Even with exceptions, a study conducted by Enanoria et al. in California LHD supported the NACCHO data, reporting that larger LHDs typically maintain epidemiologist positions and small LHDs do not (Enanoria et al. 2014). Little is known beyond these types of very course population size comparisons about epidemiology capacity at the local level.

1.1.5 Roles of Epidemiologists

Lack of funding is the main barrier identified to having an epidemiologist position (Hadler et al. 2015). In small LHDs, essential public health functions such as performing epidemiologic tasks such as disease surveillance, study design, data collection and analysis, and designing disease control methods are typically carried out by public health nurses or environmental health specialist positions through necessity, limiting the overall epidemiologic capacity of the LHD (Moehrle 2008). In addition to the number of epidemiologists being significantly smaller in small LHDs compared to medium and large sized LHDs, staff with formal training such as a master's degree in public health, are also typically lacking in smaller LHDs (O'Keefe et al., 2013). Retention can also be a problem in small LHDs. In Idaho where

most counties are small and rural, epidemiologist positions are hard to fill and retain, and often epidemiology staff do not meet the national competencies put forth by CSTE (Moehrle, 2008). In O'Keefe's cross-sectional study, one-third of epidemiology staff members in small and medium jurisdictions reported no formal training in epidemiology. In large LHDs with advanced positions in epidemiology, more robust epidemiologic work can be conducted such as advanced research studies and complex public health data analysis (Enanoria et al., 2014). However, each state is different. Understanding the LHD epidemiology capacity in Texas is important for knowing how to equip and better prepare for public health threats.

1.1.6 Contracted Epidemiologist Programs

The use of contract epidemiologists is not uncommon in large public health responses. For example, the Central America Field Epidemiology Training Program (CA FETP), a program modelled after the CDC's Epidemic Intelligence Service, was structured to train and contract field epidemiologists to help rebuild the public health infrastructure, heavily focused on public health surveillance activities (López and Cáceres 2008). The U.S. government has provided funds for contract epidemiologists to respond to an array of public health threats including influenza, food and waterborne diseases, and healthcare-associated infections (CDC 2017b). The CDC awarded $97 million to Zika epidemiology and laboratory capacity activities, including contract epidemiologists to focus on Zika virus surveillance and response (CDC 2017b). The majority of contract epidemiology work in the U.S. comes from federal funding such as the Epidemiology and Laboratory Capacity Cooperative Agreement that helps local, state, and territorial health departments, and the Prevention and Public Health Fund, a mandated fund that is part of the Affordable Care Act (ACA) (CDC 2017b).

1.1.7 Public Health Surveillance

Public health surveillance is a critical public health capability that is used in many different ways to collect, analyze, and act on information to improve the public's health (Horney 2017, p. 13). Several definitions for public health surveillance exist (World Health Organization 2008; Center for Disease Control and Prevention 2012; Porta 2008), but most include three consistent components. First, surveillance is the collection of health information on a population of interest in a systematic fashion, either passively or actively. The analysis and interpretation of the information collected is the second critical component. Looking for trends and disease patterns and describing these in the context of person, place, and time provides actionable information for public health officials. The final component is the dissemination of the data and analyzes for public health action (Horney 2017, p. 13). Epidemiologists work within this public health surveillance framework, which is frequently the centerpiece of their work. In the U.S., the majority of surveillance on infectious diseases is done passively through the National Notifiable Disease Surveillance System (NNDSS) relies on health-care professionals to report notifiable conditions to their local or state health department (CDC 2016).

Local, state, and territorial health departments collect information on notifiable disease conditions from health care providers within their jurisdiction and report to the CDC through the National Electronic Disease Surveillance System (NEDSS). Each state uses a NEDSS compatible system to conduct infectious disease surveillance. This system allows for quick standardized information sharing for public health action and inquiry.

1.1.8 Public Health Surveillance in Texas

Texas has 254 counties, 71 local public health departments/districts, 11 Health Service Regions (HSR), and a state health department functioning as part of a decentralized public health system. The Texas Based National Electronic Disease Surveillance System (NBS) is a NEDSS compatible system that utilizes passive surveillance and is used by all health jurisdictions in the state. When healthcare providers (e.g. primary or urgent care clinics, schools, hospitals, etc.) uncover suspect, probable, or confirmed cases of notifiable diseases, local or regional health departments are notified to confirm case status and begin investigating potential outbreaks. In gathering more information, the LHD or HSR enter or update case information in NBS (Texas Administrative Code 2018). Coordination and quality assurance of NBS is done by DSHS before transmitting surveillance data to the CDC. In this passive system, the initial report and investigation makeup the bulk of time between the first suspicion of a case and the confirmed case being fully reported to the CDC. NBS provides the necessary data for morbidity and mortality trends in Texas, an essential public health capability. An example is the Texas Reported Cases that are produced annually (Texas Department of State Health Services 2016). Without this system, disease surveillance in Texas would be sporadic and not complete.

1.1.9 Texas State-Funded Epidemiologist Program

In their 2013 Epidemiology Capacity Assessment (ECA), CSTE provided recommendations to fill gaps in epidemiology capacity identified. One recommendation called for state health departments to increase funding from state budgets for epidemiologists, rather than relying disproportionately on federal funds. In response to increasing caseloads of foodborne illnesses and high consequence infectious disease investigations in Texas, the state

health department started the state funded epidemiologist (SFE) program. Texas, in its' 83rd and 84th legislative sessions (2013 and 2015 respectively) funded 45 epidemiologist positions collectively for local health departments/districts in Texas to increase epidemiology capacity in the state in general, and to specifically improve response to infectious disease threats. DSHS provides the funds to LHDs through contracts and the LHD hires and employs the SFE position.

The SFE positions funded by the 83rd and 84th Texas legislative sessions were designed to improve local epidemiologic capacity in LHDs throughout the state (Garza 2016) (Figure 1.1). Among other requirements, the 45 epidemiologists in these positions are required to submit monthly and quarterly reports on case investigations and outbreaks. These reports are vital to monitor and document surveillance improvements in LHDs and to assess the investigation workloads throughout the state because LHDs in Texas comprise of a large share of the state's overall disease surveillance activities.

The first set of epidemiologists, funded in 2013, were specifically targeted for improving foodborne illness surveillance. Reporting and investigation timelines were set as benchmarks for contracts between the state and LHDs to ensure improvements in surveillance. The second set of epidemiologists, funded in 2015, were added to increase local capacity to respond to high consequence infectious disease, including EVD. Since 2013, the foodborne illness positions have shifted into a more general epidemiology role to serve the LHDs overall surveillance needs. All SFE positions are now in DSHS general revenue and are on a recurring 2-year contract with LHDs. However, the impact of these state funded epidemiologist (SFE) positions on epidemiology surge capacity and public health surveillance and response is not well understood. In part this is because in a decentralized system, each LHD is unique and varies in both structure and size, handling epidemiology functions differently. This proposed project will improve our

understanding of the role that epidemiology capacity plays in LHD effectiveness in response to either typical notifiable disease burden (e.g., foodborne disease) or public health emergencies (e.g. EVD).

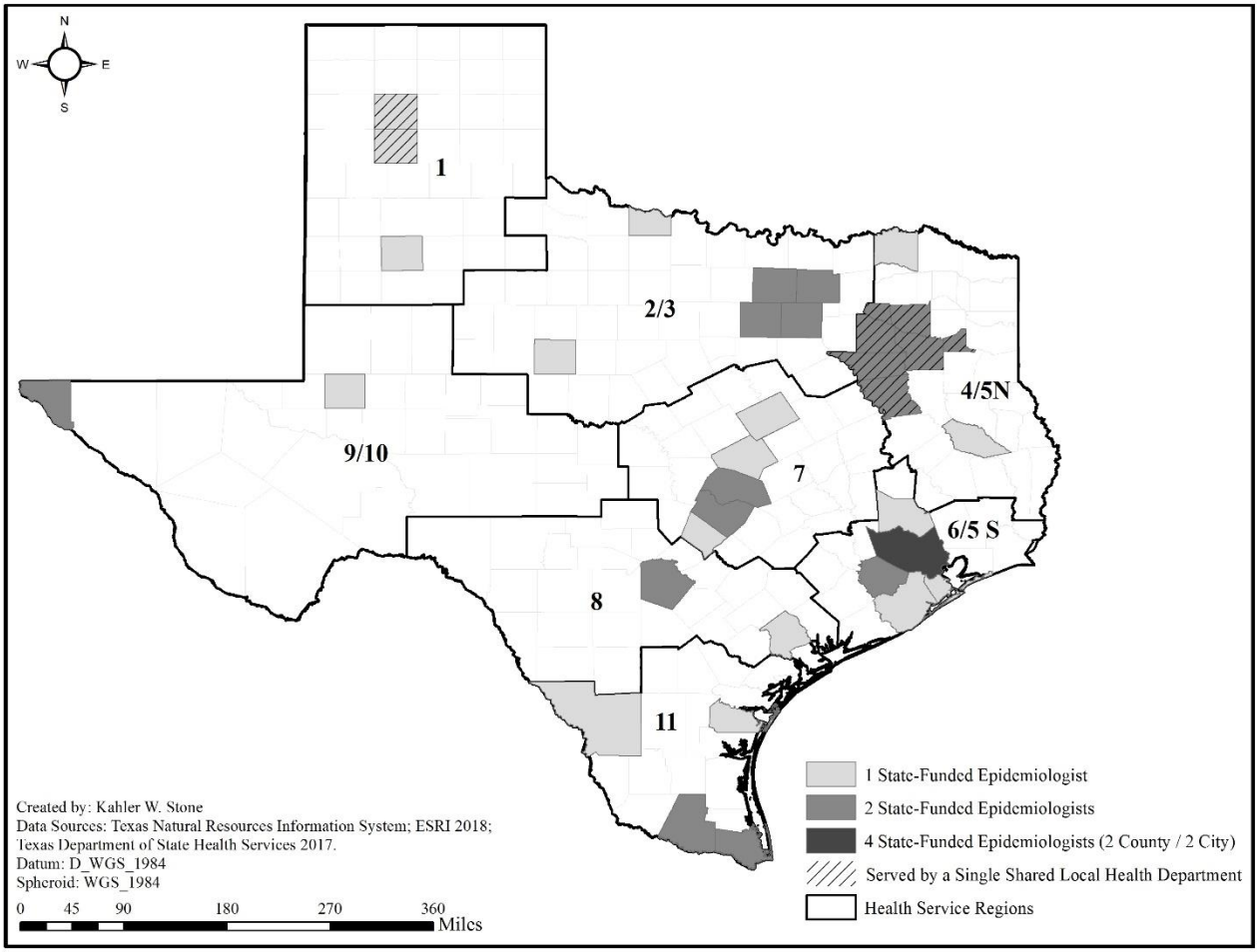

Figure 1.1 Distribution of state-funded epidemiologist positions in Texas, 2017.

1.2 Study Rationale

All LHDs in Texas use NBS to report and track notifiable diseases. This system has been in place for more than 10 years and data in the system is routinely cleaned and subjected to quality assurance. NBS provides time-stamped reporting and disease investigation data, allowing for the assessment of the timeliness of reporting throughout Texas. Timeliness and completeness metrics have been used in a similar way for assessing surveillance improvement in other states, such as North Carolina (Samoff et al. 2013). In this study, timeliness and completeness were assessed by comparing median time intervals from the first report from the LHD to the state and from the state to the CDC before and after the implementation of an intervention. In the proposed study, the SFE program serves as the intervention and allows for comparison of reporting time intervals before and after the SFE program was initiated. Similarly, LHDs that received SFEs could be compared with LHDs that did not receive an SFE. Completeness in reporting can be assessed based on the number of incomplete or incorrect notifications sent to LHDs before the case is approved by the state health department and sent to the CDC for notification.

It is important to enumerate epidemiologists in LHDs to identify capacity gaps and areas of unmet need. (Beck, Boulton, and Coronado 2014; Beck et al. 2015; Chapple-McGruder et al. 2017). For example, describing the roles and responsibilities and competency levels of epidemiologists in LHDs can help to identify areas where EPHS are not being met. It has been shown that as the number of epidemiologists increases the capacity also increases. Therefore, it is important to understand the number and function of epidemiologists in LHDs as the first step to improving public health services associated with epidemiology in local jurisdiction.

However, quantitative data is not sufficient to account for the unique characteristics of LHD in Texas. Each LHD is different in organizational structure, size, and population served.

Additionally, the operation of epidemiology or disease surveillance programs in LHDs may vary. Accordingly, key informant interviews will provide detailed insight into the function, role, and impact of the SFE program through applied qualitative methods (Farquhar et al. 2006).

1.3 Significance

Public health surveillance is the cornerstone of public health practice. The Public Health Infrastructure Improvement Goals in Healthy People 2020 specifically include the need to increase the proportion of tribal, state, and local public health agencies offering comprehensive epidemiology services (Healthy People 2020 2017). With the onboarding of electronic laboratory reporting as a key component of 'meaningful use' as part of the ACA, health departments have seen increases in the number of notifiable condition reports per jurisdiction (Dixon, Gibson, and Grannis 2014). These increased reports, coupled with health department downsizing, present unique challenges for the public health workforce to properly conduct surveillance and investigate cases thoroughly (NACCHO 2016a). The number of local and state health department epidemiologists and surveillance staff has been documented as lacking full capacity by CSTE and NACCHO, specifically in this case infectious disease surveillance (CSTE 2014). This is particularly problematic in Texas where passive disease reporting is burdensome on reporting entities, slowing the investigation and response time for public health departments (Silk and Berkelman 2005; Jajosky and Groseclose 2004; Doyle, Glynn, and Groseclose 2002).

In an attempt to address the needs and shortcomings of public health surveillance gaps in Texas, DSHS committed significant resources to the SFE program. Examining the impacts of the SFE program on overall epidemiologic capacity enhancement and public health surveillance is important to understand the value of these investments. The findings from this research have

implications on funding and resource allocation at the local, state, and federal government level. The opportunity to evaluate this program provides a natural experiment to better understand epidemiologic capacity and demonstrate how capacity is associated with the provision of epidemiologic services at LHDs in Texas.

1.4 Overview of Study Design

The overall goal of this project was to describe epidemiologists hired through the SFE program by experience, training, and competency and assess the effectiveness of the SFE program overall. This goal was met through an online assessment of each SFE, analyzing data related to the timeliness and completeness of notifiable condition reporting in Texas, and qualitatively explored the impact of SFE program in LHDs using key informant interviews. Utilizing a cross-sectional, mixed-method approach provides evidence of the impact the SFE program has had on public health surveillance and epidemiology surge capacity in Texas.

This study and all aspects of data collection, analysis, and reporting were approved by the Texas A&M Institutional Review Board (IRB2017-0366M).

1.5 Epidemiology Capacity Assessment Data Collection

A cross-sectional survey was implemented to enumerate LHDs with SFEs, general roles, and epidemiologic training in Texas in 2017. CSTE developed and validated an epidemiology capacity assessment tool for state health departments and adapted the tool for LHD assessment use (CSTE 2012, 2017). This LHD tool will be referred to as the "individual assessment" (Appendix A). The individual assessment tool has been used since 2001 by CSTE to characterize epidemiology capacity in state and territorial health departments and is described in detail on the

CSTE website http://www.cste.org/group/ECA. The tool has only had minor changes and adjustments since its creation to maintain the integrity of the tool and to provide data on trends over time related to the nature and makeup of the epidemiologist workforce in state health departments. Using a standardized tool allows results from this study to be compared to previous studies and capacity assessments.

In capturing competency, skill level, experience, and training needs, the individual assessment allows for the classification of epidemiologist capabilities and responsibilities to better understand the overall capacity of the epidemiology workforce in Texas (CDC and CSTE 2008). The individual assessment uses the Applied Epidemiology Competencies (AECs), to allow individual epidemiologists to self-identify their competency level and classify their skill level and training needs. The AECs were developed in a collaborative effort by CSTE and the CDC to describe the roles and skill needed for applied epidemiologists working in the field as part of the Core Competencies for Public Health Professionals (CDC and CSTE 2008).

This is only the second study to use this tool to study individual epidemiologic capacity within LHDs. The first, a descriptive cross-sectional study conducted in LHDs nationwide, was conducted by O'Keefe et al. (2013), (O'Keefe, Shafir, and Shoaf 2013). In this case, the individual assessment tool was adapted and modified slightly to address study specific questions. In this study, only two questions were added to the individual assessment to gather information specific to SFE tasks and logistics specific to the Texas SFE program.

The SFE program funds 45 LHD epidemiologist positions, therefore the target sample size for the individual assessment was N=45. The SFE program coordinator at DSHS provided a list of epidemiologists in the SFE program in LHDs. Each LHD SFE position received an email with study information and a link to the individual assessment in Qualtrics (Provo, Utah, USA

2017), a secure online survey management system, accompanied by instructions and FAQs for participants. Each SFE position was given a unique access link to their individual assessment with specific instructions for completing the assessment. Two weeks prior to distributing the link to all SFE positions, the individual assessment was pilot tested with two SFEs in two different LHDs. The individual assessment included questions on training, experience, and tier specific self-assessed competency in 30 skill domains corresponding to AECs. Participants were given 6 weeks to complete the online individual assessment. Email reminders were sent periodically to encourage completion of the assessment. Since only 40 of the 45 SFE positions were currently filled, thus the target sample was reduced to N=40. Because LHD epidemiologists have demanding schedules and a prior nationwide study yielded a low response rate (27% in the O'Keefe et al. study), a letter from the DSHS SFE coordinator was sent to each SFE prior to the email with the survey link, to explain the study and validate the collaboration between DSHS and Texas A&M on this project.

1.6 Electronic Disease Reporting Data Collection

In collaboration with DSHS, Texas notifiable disease reporting data was acquired from the Texas NBS system from 2012-2016. NBS is the electronic statewide database for all notifiable conditions. DSHS staff queried and provided extracted de-identified data in electronic format for analysis using Microsoft Excel. There are more than 90 notifiable conditions in Texas; however, to simplify data collection and analysis for this study, only certain conditions – those most commonly handled by LHD epidemiologists and SFEs – were extracted (Table 1.1). In Texas, notifiable conditions are grouped by the programs that investigate and control them. All

notifiable conditions included in this study are managed by the Emerging and Acute Infectious Disease Branch (EAIDB) in different prevention and control teams, including foodborne, healthcare safety, high consequence infectious disease, invasive and respiratory infectious disease, and vaccine preventable diseases.

The extracted notifiable conditions were accompanied by the following variables: jurisdiction where case was investigated, date, Morbidity and Mortality Weekly Report (MMWR) year, SFE status, initial report time to LHD, report time from LHD to state, report time to CDC, and quality approval/rejects. A LHD size variable that categorized LHDs into various sizes (small, medium, large) was added to further tabulate and compare reporting timeliness and completeness by stratification. Variables of case load (cases per jurisdiction) and rural/urban status of the LHD were also added to the dataset. The final dataset containing electronic disease reports in Texas from 2012 to 2016 included 71 unique local reporting jurisdictions, 43 conditions, and 139,035 reports.

Table 1.1 Notifiable conditions extracted from NBS in Texas.

Notifiable conditions investigated by Local Health Departments and the Emerging and Acute Infectious Disease Branch at Texas Department of State Health Services, Texas 2017.

Texas Investigation Team	Foodborne	Healthcare Safety	High Consequence Infectious Disease	Invasive and Respiratory Infectious Disease	Vaccine Preventable Disease
Condition	Amebiasis	Carbapenem-resistant Enterobacteriaceae (CRE)	Ascariasis	Amebic Meningitis or Encephalitis	Acute Flaccid Myelitis (AFM)
	Botulism	Multidrug-resistant Acinetobacter (MDR-A)	Hepatitis C	Influenza-associated pediatric mortality	Diphtheria
	Campylobacteriosis	Vancomycin-intermediate Staph aureus (VISA)	Trichuriasis	Legionellosis	Haemophilus influenzae
	Cryptosporidiosis	Vancomycin-resistant Staph aureus (VRSA)	Viral hemorrhagic fever	Novel coronavirus	Hepatitis A
	Cyclosporiasis			Novel Influenza	Hepatitis B
	Fascioliasis			Streptococcus, invasive Group A	Measles (Rubeola)
	Hepatitis E			Streptococcus, invasive Group B	Mumps
	Listeriosis				Neisseria meningitidis
	Salmonellosis				Pertussis
	Shiga toxin-producing Escherichia coli (STEC)				Poliomyelitis
	Shigellosis				Rubella
	Typhoid fever (Salmonella typhi)				Streptococcus pneumoniae
	Vibriosis				Tetanus
	Yersiniosis				Varicella (Chickenpox)

1.7 Qualitative Key Informant Interview Data Collection

In-depth open-ended interviews in qualitative health research have been used to identify potential shortfalls in health delivery or modifiable procedures (Tong, Sainsbury, and Craig 2007). These interviews offer a depth and range of information not found in a structured questionnaire. Accordingly, key informant interviews were conducted with LHD leadership in health departments that had an SFE position, as well as regional and state and regional epidemiology staff that have contact with SFE positions (Figure 1.2). The State of Texas public health system has local, regional, and state components, and each of these components provides epidemiologic services. In Texas, 31 local jurisdictions received SFEs. Thus, 31 key informant interviews were attempted with one representative from each LHD that received a SFE position to collect local qualitative data on the impact of adding an SFE. DSHS has 11 HSR operated by eight regional offices/headquarters. One key informant interview from an epidemiologist in each of the eight regional offices was attempted to obtain a regional perspective on the addition of the SFE positions throughout the state. The EAIDB at DSHS coordinates the prevention, investigation, and control of conditions that SFE positions routinely investigate and work with. The EAIDB program at DSHS is the central working place where diseases are reported to before being passed on to the CDC for national surveillance. Each of the five program areas in EAIDB were contacted for a key informant interview, preferably the team lead for that program.

LHDs that received SFE program funding, contact information of supervisors and/or points of contacts were provided by DSHS. Using the DSHS website, each regional lead epidemiologist was identified, along with their contact information, and asked to participate in this study. Each EAIDB team lead's name and contact information was gathered using the DSHS

website and through collaboration with the SFE program coordinator, who also works in EAIDB at DSHS. With all contact information consolidated, each selected potential participant was emailed with study information and a request to participate in a 30-minute telephone interview. Some LHDs had multiple supervisors or points of contacts listed. In these cases, a key informant interview was attempted with the first name, then on to the second if the first was unable to participate. If participants agreed to be interviewed, a time was scheduled in the following weeks.

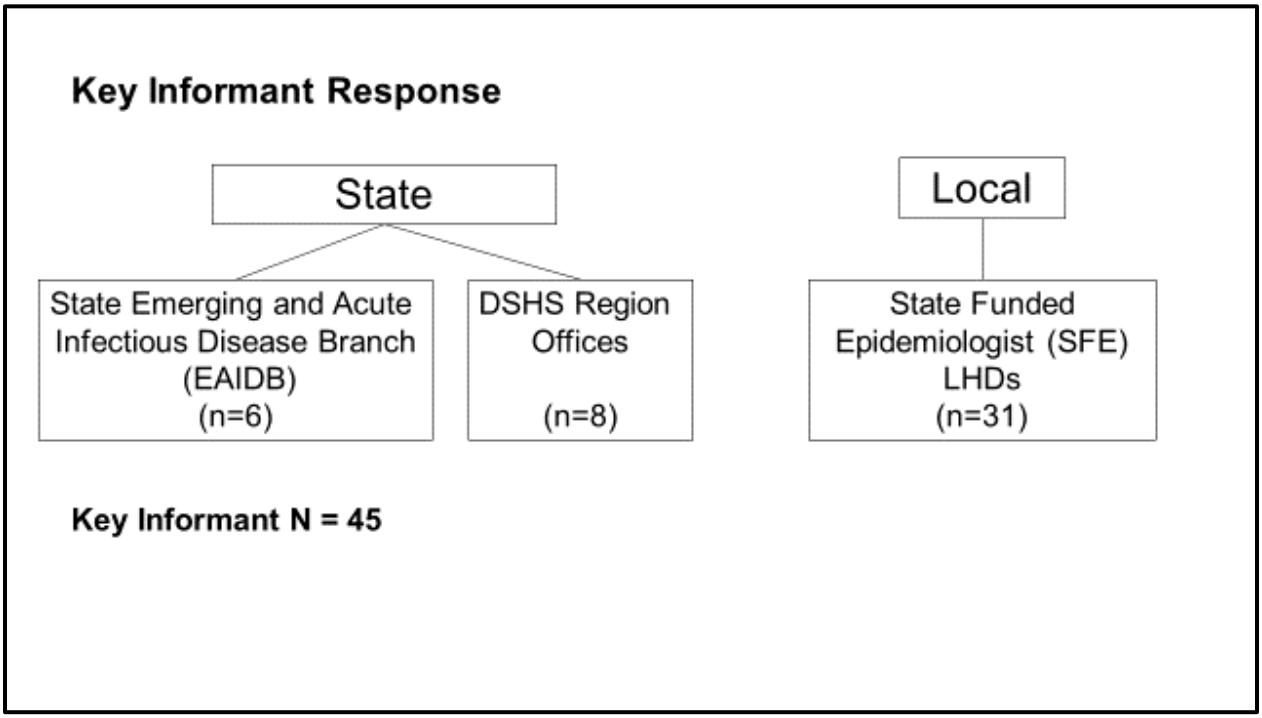

Figure 1.2 Sampling scheme for qualitative key interviews with LHD and state HD staff (n=45).

Each key informant was contacted via email up to two times schedule a telephone interview. All interviews were recorded with verbal consent to ensure accurate information was collected and reported. A semi-structured questionnaire was used and included the following components (Appendix B), strengths and weaknesses of SFEs, benefits to program areas, impact on disease surveillance, roles and responsibilities, and barriers adding SFEs at LHDs or within different regions/state.

1.8 Analysis Plan

For the individual assessment sent to all SFE (n=40), data was exported from Qualtrics (Berlin, Germany) to Microsoft Excel and Stata 14 (College Station, TX) for analysis. LHDs were categorized as small (<50,000 population served based on July 1, 2015, US Census estimates), medium (50,000 – 500,000 population served), or large (>500,000 population served). LHD size was used to further characterize the distribution, skill, and competency levels of epidemiologists in Texas. The proportion of epidemiologists per 100,000 people served, tier group, gender, experience, skill level, and training needs were then cross tabulated and compared to previous CSTE ECA reports.

Timeliness and completeness of NBS data were assessed and jurisdictions with an SFE were compared to LHDs without an SFE. Timeliness was defined as the earliest time a suspected case was identified to the approved final notification to the state, and from the state to the CDC. Completeness is defined as the percentage of investigation reports submitted for approval to the state that were not rejected because of incomplete information or errors in reporting. An additional variable was created to classify two time periods for SFE LHDs, the period prior to

obtaining a SFE positon and the period after obtaining a position. Using an LHD onboarding variable (pre-SFE and after), we assessed changes in timeliness and completeness before and after the implementation of the SFE program. Median time-intervals for reporting were compared using Mann-Whitney tests to identify significant differences and z-scores were used to identify significant differences in proportions of incomplete case reports. All data analysis was performed using Stata 14. The ‘ranksum’ command with the ‘porder’ option was used to test the two-time intervals (timeliness before SFE implantation and after) as independent variables using Wilcoxson’s test statistic and Mann and Whitney’s *U* statistic to calculate a *z* statistic and probability of the two samples being significantly different, as shown below (Equation 1).

$$T = \sum_{i=1}^{n_1} R_{1i}$$

$$U = T - \frac{n_1(n_1+1)}{2}$$

$$z = \frac{T - E(T)}{\sqrt{\mathrm{Var}(T)}}$$

$$p = \frac{U}{n_1 n_2}$$

Equation 1 Calculation of Wilcoxson's test statistic and Mann and Whitney's U statistic

Transcripts of the key informant interviews were content analyzed for key themes using inductive coding (i.e., there were no predetermined themes; themes emerged from the data through review and comparison). First, audio recording were transcribed using ATLAS.ti Version 8.0 (Berlin, Germany). Transcripts were then coded for themes inductively. To increase the reliability of coding, content was coded independently by two researchers and themes identified were compared, reconciled, and compiled (Burnard et al. 2008). Reconciled themes were copied into a Microsoft Word® (Redmond, WA) spreadsheet for analysis. Themes were reported in categories and supporting quotations were noted that supported particular themes.

1.9 Specific Aims

Aim 1: Describe local health department epidemiology capacity in Texas state funded epidemiologist local health departments.

Objective 1.1: Conduct a literature review on epidemiology surge capacity in the United States and Texas from 1990 to 2017.

Objective 1.2: Describe the epidemiology surge capacity in Texas LHDs in 2017 by general roles, epidemiologic training, and applied epidemiology competencies.

Rationale: It is important to enumerate epidemiologists in LHDs to identify capacity gaps and areas of unmet need.

Aim 2: Evaluate changes in public health surveillance potentially associated with the provision of epidemiology surge capacity.

Objective 2.1: Compare public health disease surveillance timeliness and completeness as well as the overall burden of notifiable diseases in SFE local jurisdictions before and after SFEs were placed, using two approximate timeframes, e.g., before 2014 and after 2014.

Objective 2.2: Compare public health disease surveillance timeliness and completeness, as well as the overall burden of notifiable diseases in local jurisdictions with an SFE compared to local jurisdictions without an SFE.

Rationale: Timeliness and completeness of disease reporting are two essential metrics for assessing effectiveness of communicable disease surveillance.

Aim 3: Describe the role and impact of state funded epidemiologists in local health departments in Texas.

Objective 3.1: Quantitatively and qualitatively, describe the roles and responsibilities of SFE in their respective LHD through a standardized questionnaire and key informant interviews with epidemiologists and LHD leadership.

Objective 3.2: Describe the reported impact of SFE in local health departments on epidemiology capacity through key informant interviews with state and regional epidemiologists.

Rationale: Qualitative data can be used to provide details about the SFE program from both the LHD and state health department perspective.

2. CHARACTERIZING EPIDEMIOLOGIC CAPACITY IN A LARGE, DECENTRALIZED STATE HEALTH DEPARTMENT, TEXAS, 2017

2.1 Introduction

Public health surveillance is the cornerstone of essential public health practice. Local and state public health agencies provide a wide range of population-based public health services for their jurisdictions. These services were defined in 1994 when the Public Health Functions Steering Committee, a group comprised of local, state, and national public health organizations, developed the 10 Essential Public Health Services (EPHS) (Center for Disease Control and Prevention 2017a). Using the 10 EPHS, the National Public Health Performance Standards Program (NHPSP) developed a list of foundational services that public health agencies should strive to offer. The NHPSP provides performance standards for public health agencies to encourage and promote stronger public health preparedness, quality improvement, and stronger science-based public health practice (Center for Disease Control and Prevention 2017b). Specifically, these standards can be used to evaluate local and state public health systems, including public health surveillance and emergency preparedness (Lurie 2004).

However, due to inadequate organizational capacity and financial resources, public health agencies, particularly local health departments (LHDs) struggle to offer all 10 EPHS effectively (Hyde and Shortell 2012) (Figure 2.1). Four of the ten EPHS (1,2,9, and 10) are dependent on epidemiology capacity. EPHS 1 relates to the monitoring of health status to identify and solve community health problems. EPHS 2 includes diagnoses and investigations of health problems and health hazards. EPHS 9 evaluates effectiveness, accessibility, and quality of personal and

population-based health services. EPHS 10 focuses on using research to find innovative solutions to health problems.

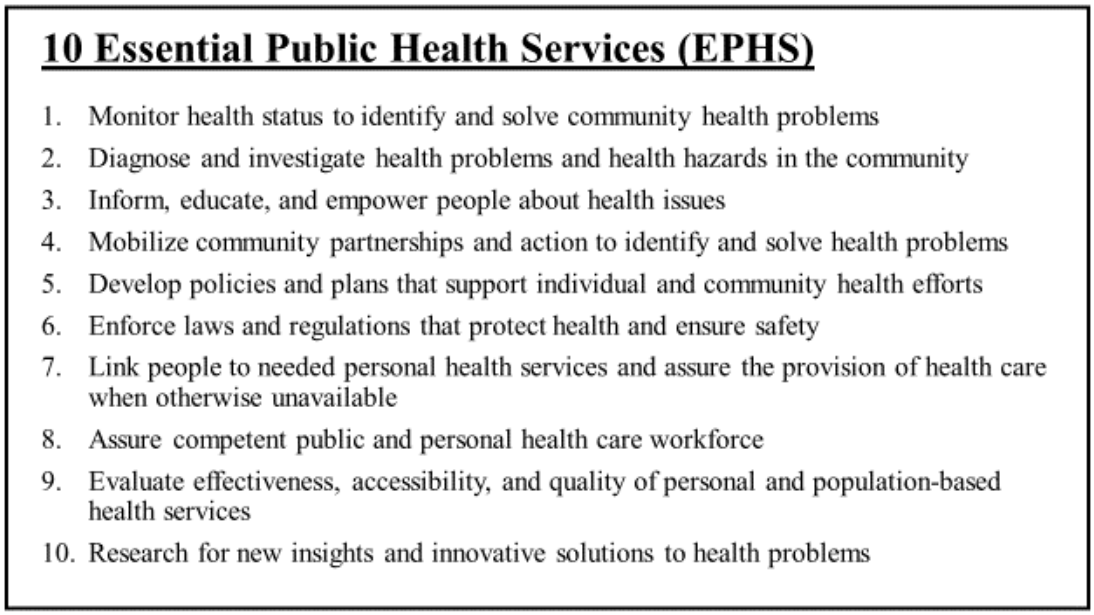

Figure 2.1 Ten Essential Public Health Functions. Adapted from (Center for Disease Control and Prevention 2017a)

The Public Health Infrastructure Improvement Goals in Healthy People 2020 specifically include the need to increase the proportion of tribal, state, and local public health agencies offering comprehensive epidemiology services, including surveillance. Passive disease reporting, which is widely used across the U.S. and in Texas, is already known to be burdensome on reporting entities, slowing investigation and response time for public health departments (Doyle, Glynn, and Groseclose 2002; Jajosky and Groseclose 2004; Silk and Berkelman 2005).

The Council of State and Territorial Epidemiologists (CSTE) has estimated and tracked the epidemiologic workforce in state health departments since 2001 and periodically updates their information (Hadler et al. 2015). Identifying and documenting epidemiology capacity gaps and needs in state health departments provide public health opportunities to improve on capacity and ultimately public health essential services. In their 2013 Epidemiology Capacity Assessment (ECA), CSTE provided recommendations to fill gaps in epidemiology capacity. One recommendation called for state health departments to increase funding from state budgets for epidemiologists, rather than relying disproportionately on federal funds. Although state health department epidemiology capacity has been documented, limited information exists for LHD epidemiology capacity.

The National Association of City and County Health Officials (NACCHO) profile survey has collected information from all LHDs in the U.S. since 2005 on a range of topics, one of which is workforce information. The NACCHO profile study has also demonstrated growth in the number of epidemiologists in LHDs, with 1,300 identified in 2005 to 1,600 in the 2016 profile (NACCHO 2016a). However, the NACCHO national profile data is limited since it only includes an estimated number of epidemiologists employed without other measures of capacity. No information regarding program area, competency, training needs, or experience is captured. Additionally, these reports are only representative of the overall U.S.; state specific epidemiology enumeration information is only available for purchase in raw data form and not in report form.

Texas has 254 counties, 71 local public health departments/districts and a state health department that operates as a decentralized public health system with 11 Health Service Regions (HSR) that are functionally condensed to eight. Due to the decentralized structure of the public

health system in Texas, LHDs in Texas provide public health services for the majority of Texans. In response to increasing caseloads of foodborne illnesses and high consequence infectious disease investigations in Texas, the state health department requested funding for the state funded epidemiologist (SFE) program. The Texas Legislature, in its' 83rd and 84th legislative sessions (2013 and 2015 respectively), funded 45 epidemiologist positions to be assigned to local health departments/districts in Texas to increase epidemiology capacity in the state in general, and specifically to improve response to infectious disease threats. The Texas Department of State Health Services (DSHS) provides funds to LHDs through contracts and the LHD is responsible for hiring and employing the SFE position. The majority of contract epidemiology work in the U.S. comes from federal funding such as the Epidemiology and Laboratory Capacity Cooperative Agreement that helps local, state, and territorial health departments, and the Prevention and Public Health Fund, a mandated fund that is part of the Affordable Care Act (ACA) (CDC 2017b). The SFE program is unique in its approach to increasing the epidemiology workforce in Texas by providing state funds to LHDs across the state specifically for epidemiology positions.

The first set of epidemiologists, funded in 2013, were specifically targeted for improving foodborne illness surveillance. Reporting and investigation timelines were set as benchmarks for contract performance between the state and LHDs to ensure improvements in surveillance. No experience or education requirements were placed in the first round of contracts. The second set of epidemiologists, funded in 2015, were added to increase local capacity to respond to high consequence infectious disease, including Ebola virus disease (EVD). In an attempt to improve epidemiology capacity in LHDs further, the second round of contracts required SFE positions to have at least two years of epidemiologic experience or a Master of Public Health. Over time, the

foodborne illness positions have shifted into a more general epidemiology role to serve the LHDs overall surveillance needs. All SFE positions are now in DSHS general revenue and are funded through a recurring 2-year contract with LHDs. However, the impact of these SFE positions on epidemiology surge capacity and public health surveillance and response is not currently well understood, in part because in a decentralized system each LHD differs in terms of structure, size, and management of epidemiology functions.

The purpose of this study was to describe and evaluate the impact of an epidemiologic surge capacity program established by the DSHS and funded by the Texas Legislature beginning in 2013. This includes counting LHD epidemiologists and characterizing the SFE workforce by experience, competency level, and training needs. It is important to quantify and characterize epidemiologists in LHDs to identify capacity gaps and areas of unmet need (Beck, Boulton, and Coronado 2014; Beck et al. 2015; Chapple-McGruder et al. 2017). For example, categorizing the roles and responsibilities and competency levels of epidemiologists in LHDs can help in identifying areas where EPHS are not being met. Understanding the number and function of epidemiologists in LHDs is the first step to improving public health services associated with epidemiology in local jurisdiction.

2.2 Methods

2.2.1 Study Population

The SFE program in Texas provides contracts for 45 positions to 31 unique LHDs of varying size. At the time of this study, 40 of the 45 positions were filled, thus the target sample was 40 for the online survey representing 29 health departments. Several of the vacancies were in LHDs that have more than one SFE position. Therefore, in this study, 40 SFE positions

representing 29 LHDs were targeted for participation. The SFE program coordinator at DSHS provided a list of epidemiologists in the SFE program and their corresponding LHDs. Each LHD SFE position received an email with study information and a link to the individual assessment, accompanied by instructions and FAQs for participants.

2.2.2 Assessment Tool

A cross-sectional survey was implemented to quantify LHD contracted epidemiologists in the SFE program, general roles, and epidemiologic training in Texas in 2017. The CSTE ECA tool was used to count and characterize competencies and training needs of health department epidemiologists. This tool will be referred to as the "individual assessment" (Appendix A). The individual assessment tool has been used by CSTE since 2001 to characterize epidemiology capacity in state and territorial health departments and is described in detail on the CSTE website http://www.cste.org/group/ECA. The tool has only had minor changes and adjustments since its creation to maintain the integrity of the tool and to provide data on trends over time related to the nature and makeup of the epidemiologist workforce in state health departments. Using a standardized tool for this study is important and allows for comparability of our data with previous studies and capacity assessments.

In capturing competency, skill level, experience, and training needs, the individual assessment allows for the classification of epidemiologist capabilities and responsibilities to better understand the overall capacity of the epidemiology workforce in Texas (CDC and CSTE 2008). The individual assessment uses the Applied Epidemiology Competencies (AECs) to allow individual epidemiologists to self-identify their competency level and classify their skill level and training needs. The AECs were developed in a collaborative effort by CSTE and the CDC to

describe the roles and skill needed for applied epidemiologists working in the field as part of the Core Competencies for Public Health Professionals (CDC and CSTE 2008). The individual assessment included questions on training, experience, and tier specific self-assessed competency in approximately 30 skill domains corresponding to AECs.

To our knowledge, this is only the second study to use this tool to study individual epidemiologic capacity within LHDs. The first, a descriptive cross-sectional study conducted an assessment of epidemiologic capacity in LHDs nationwide (O'Keefe, Shafir, and Shoaf 2013). In this study, the authors adapted and modified the individual assessment tool to address study specific questions related to perceived LHD capacity from the epidemiologist and public health director perspectives. Similarly, we added two questions to the individual assessment tool to gather information specific to SFE tasks and logistics specific to the Texas SFE program. These questions were added in consultation with DSHS SFE program staff to ensure the additional information collected was useful for program planning.

2.2.3 Data Collection

The individual assessment was designed and conducted using Qualtrics (Provo, Utah, USA 2017), a secure online survey management system that offers tools for dissemination and response tracking. Two weeks prior to distributing the individual assessment to all SFE positions, the individual assessment was pilot tested with two SFEs in different LHDs. Each SFE position was given a unique access link to their individual assessment with specific instructions for completing the assessment. Participants were given 6 weeks to complete the online individual assessment. Each potential participant was contacted three times before considering him or her a non-response. Email reminders were sent periodically to encourage completion of the assessment

for those that agreed but did not finish the assessment immediately. LHD epidemiologists have demanding schedules and the prior nationwide study yielded a low response rate (27% in the O'Keefe et al. study). A letter from the DSHS SFE program coordinator was sent to each SFE prior to the recruitment email, to explain the study and validate the collaboration between DSHS and Texas A&M University on this project to encourage response from LHD epidemiologists.

2.2.4 Analysis

Data was exported from Qualtrics (Provo, Utah, USA 2017) to Microsoft Excel Redmond, WA 2016) and Stata 14 (College Station, TX) for analysis. LHDs were categorized as small (<50,000), medium (50,000 – 500,000), or large (>500,000) based on the population served according to July 1, 2015, US Census estimates. The proportion of epidemiologists per 100,000 people served, tier level, gender, experience, skill level, and training needs were then cross tabulated and compared to previous CSTE ECA reports. The mean ratio of epidemiologists per 100,000 population was calculated by LHD size and overall for comparison to CSTE ECA reports and other literature. Confidence intervals at the 95% level were calculated for percentage estimates and included in the tables.

This study and all aspects of data collection, analysis, and reporting were reviewed and approved by the Texas A&M Institutional Review Board (IRB2017-0366M).

2.3 Results

Between November 29, 2017 and January 8, 2018, 32 online surveys were collected with an overall response rate of 80% (32 of 40). Those that did not respond to this survey were listed in medium and large LHDs. No other information on the non-respondents was captured. Two individual assessments were not included in the analysis for being largely incomplete. These two specific respondents had been contacted multiple times, in addition to the study protocol of three attempts, for completion and correction. In this study, the 32 of 40 SFE positions that participated represented 26 of the 29 LHDs that currently had a SFE position filled. Of the 26 LHDs in this study, 7 have only 1 epidemiologist and each are a SFE.

Of the respondents, 41 percent (N=13) were male, 56 percent (N=18) female, and 3 percent (N=1) preferred not to say (Table 2-1). Of the respondents, 9 percent (N=3) identified as Asian, 16 percent (N=5) Black, 19 percent (N=6) Hispanic, 41 percent (N=13) non-Hispanic White, and 15 percent (N=5) other or unknown (Table 2.1). The median age of all SFE was 31 (range, 24 – 64). Race, gender, and median age all differed from the national state health department epidemiology workforce. Nineteen percent of SFEs report being Hispanic. Likewise, SFEs reported a higher percentage of being male compared to the national estimate, 41 percent to 29 percent.

Table 2.1 Texas state-funded epidemiologist characteristics in comparison to national sample of state health department epidemiologists.

	SFE (N = 32)			**Reference** (CSTE Report)
Characteristics	*% (No.)*	*95% LCL*	*95%UCL*	*%*
Median Age	31 years (range, 24-64)			40 years (range, 22-88)
Gender				
Male	41 (13)	24	58	29
Female	56 (18)	39	73	71
Unknown / Prefer not answer	3 (1)	0	9	0
Race/Ethnicity				
Asian	9 (3)	0	19	9
Black	16 (5)	3	29	8
Hispanic	19 (6)	5	33	4
White	41 (13)	24	58	76
Other	12 (4)	1	23	3
Unknown	3 (1)	0	9	0
Tier level				
Entry level epidemiologist (Tier 1)	28 (9)	12	44	25
Mid-level epidemiologist (Tier 2)	47 (15)	30	64	41
Senior-level epidemiologist (Tier 3a)	22 (7)	8	36	23
Senior scientist / subject matter expert (Tier 3b)	0 (0)	0	0	11
Unknown	3 (1)	0	9	0
Academic Education				
Professional degree (MD, DMD, DVM, etc.)	12 (4)	1	23	11
PhD or DrPH	3 (1)	0	9	16
Master's degree	72 (23)	56	88	61
Registered Nurse	3 (1)	0	9	2
Bachelor's degree or lower	9 (3)	0	19	10
Epidemiology-Specific Training				
PhD, DrPH, other doctoral degree in epidemiology	3 (1)	0	9	9
Professional background (MD, DO, DVM, DDS) with dual degree in epidemiology	3 (1)	0	9	6
MPH, MSPH, other master's degree in epidemiology	66 (21)	50	82	45
BA, BS, other bachelor's degree in epidemiology	0 (0)	0	0	1
Completed formal training program in epidemiology (e.g., EIS, CSTE)	9 (3)	0	19	4
Completed some coursework in epidemiology	9 (3)	0	19	23
Received on-the-job training in epidemiology	9 (3)	0	19	10
No formal training in epidemiology	0 (0)	0	0	2

SFE = State-Funded Epidemiologist; CSTE = Council for State and Territorial Epidemiologists; MD = Medical Doctor; DMD = Doctor of Dental Medicine; DVM = Doctor of Veterinary Medicine; DO = Doctor of Osteopathic Medicine; DDS = Doctor of Dental Surgery; EIS = Epidemic Intelligence Service; LCL = Lower Confidence Limit; UCL = Upper Confidence Limit; Totals may not sum to 100% because of rounding.

Of SFE respondents, 47 percent (N=13) reported being a mid-level epidemiologist where 28 (N=9) and 22 (N=7) percent reported being entry-level or senior-level respectively. No respondents reported meeting the epidemiologist tier level of a senior scientist/subject matter expert according to the CSTE AEC. Most SFEs had advanced academic training, with 87 percent (N=28) having a master's degree or higher. Compared to state health department epidemiologists nationwide, more SFEs have a master's degree as their highest level of academic training, while less SFEs have a PhD or DrPH comparatively. Having a doctoral professional degree, being a registered nurse, or a bachelor's degree or lower, 12 percent (N=4), 3 percent (N=1), and 9 percent (N=3) respectively were similar to the national estimates. In epidemiologic-specific training, 66 percent (N=21) reported having a MPH or other master's degree with a concentration in epidemiology, significantly higher than the national estimate of 45 percent. All SFEs reported having some type of formal training in epidemiology or a bachelor's degree specialized in epidemiology.

None of the SFE respondents indicated that they work in a small LHD (<50,000 population served) (Table 2.2). Forty-one percent of SFEs work in medium sized LHDs and 53 percent in large LHDs and six percent did not indicate which LHD they worked for so unknown what LHD size. Entry level SFEs are distributed evenly among medium and large LHD; 27 percent of mid-level SFEs and 71 percent of senior-level SFEs work in medium LHDs; 67 percent of mid-level SFEs and 29 percent of senior-level SFEs work in large LHDs.

SFEs were asked to quantify the epidemiologist positions in their respective LHDs. Based on their report, a total of 25 epidemiologists work in medium LHDs, and 67 epidemiologists work in large LHDs in Texas. In medium LHDs, SFE positions account for 56 percent of epidemiologist positions and 34 percent of epidemiologist positions in large LHDs.

For LHDs captured in this study, the mean number of epidemiologists per 100,000 population served in medium LHDs was 0.73 and 0.46 in large LHDs.

Table 2.2 Local health department epidemiologist distribution in Texas by health department size and population served (N=32).

	LHD Size			
	Small	**Medium**	**Large**	**Unknown**
Tier level	*% (CI)*	*% (CI)*	*% (CI)*	*% (CI)*
Entry level epidemiologist (Tier 1)	0 (0 - 0)	44 (12 - 76)	44 (12 - 76)	12 (0 - 31)
Mid-level epidemiologist (Tier 2)	0 (0 - 0)	27 (5 - 50)	67 (43 - 91)	6 (0 - 18)
Senior-level epidemiologist (Tier 3a)	0 (0 - 0)	71 (37 - 100)	29 (0 - 63)	0 (0 - 0)
All Tiers	0 (0 - 0)	41 (23 - 59)	53 (36 - 70)	6 (0 - 14)
No. epidemiologists	*No. (%)*	*No. (%)*	*No. (%)*	*No. (%)*
Reported total no. epidemiologists	0	25	67	3
% SFE	0 (0)	14 (56)	23 (34)	0 (0)
Mean epidemiologist per 100,000	0	0.73	0.46	-
Mean epidemiologist per 100,000 without SFE program	0	0.32	0.27	-

Notes: CI = 95% Confidence Interval; Small LHD (<50,000); Medium LHD (50,000 – 500,000); Large LHD (>500,000)

Most SFEs are relatively new to epidemiology positions, with three-quarters (75%; N=24) of SFEs having 4 or less years of experience and 16 percent (N=5) having 10 or more years (Figure 2.2). When SFEs were asked how many years before they planned to retire or change careers, 50 percent (N=16) reported less than 10 years, 20 percent (N=6) reported a planned retirement in the next 3-9 years, and 30 percent (N=10) reported a planned retirement in less than 2 years.

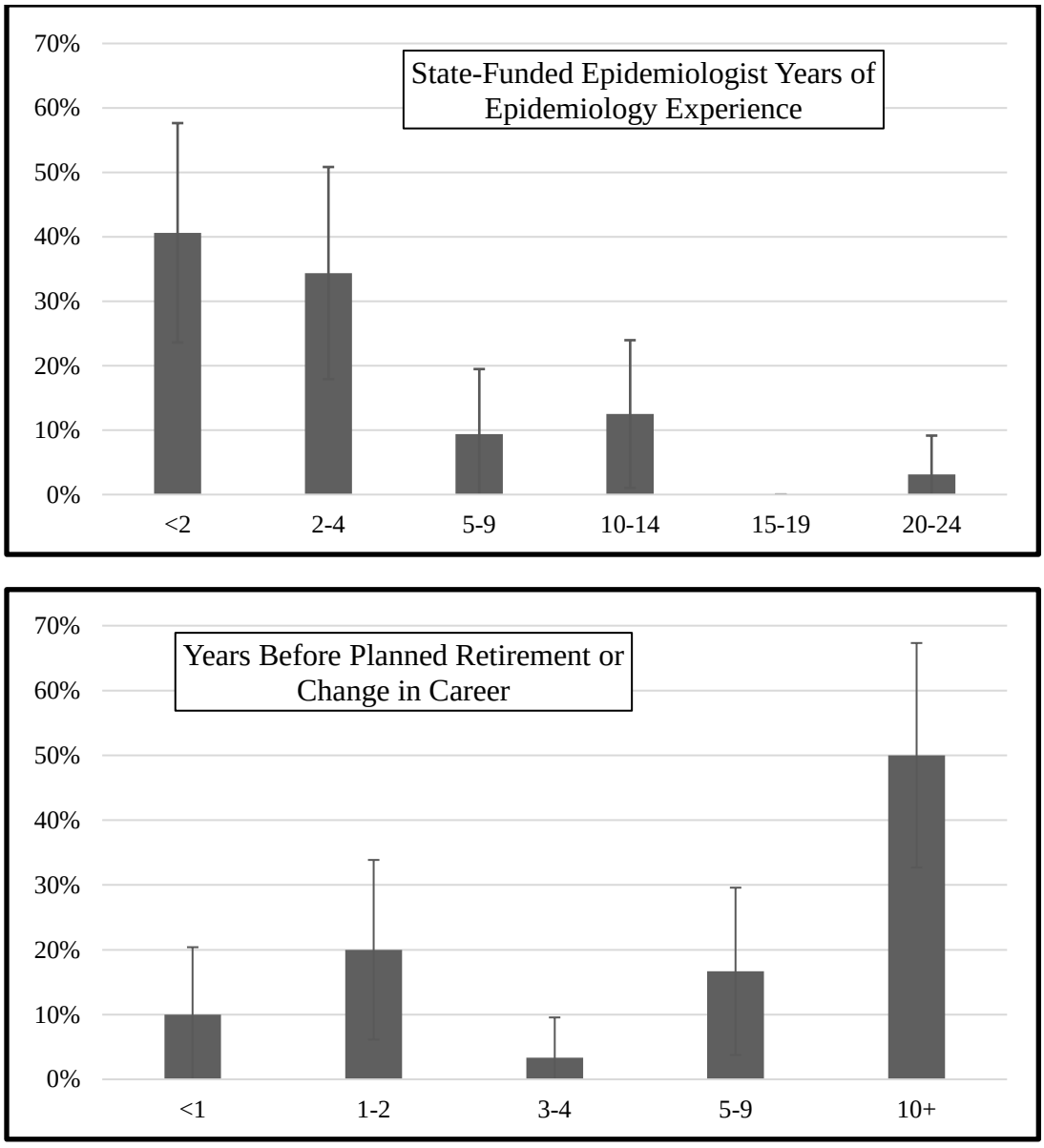

Figure 2.2 State-funded epidemiologist experience and future retirement or career change estimates.

The majority of SFE's time is allocated to infectious disease control program areas (e.g., foodborne, waterborne, vaccine preventable disease, high consequence infectious disease, invasive and respiratory disease, healthcare associated infection), including 84 percent for all tier

levels, and 86 percent, 82 percent, and 87 percent for tier 1, 2, and 3a respectively (Figure 2.3). The program area second to infectious disease was Bioterrorism/Emergency Response, where across all tiers, 8 percent of their time was allocated. The remaining time was allocated to environmental health (4%) and other program areas (3%). Tier 2 epidemiologists reported the most diversity in the allocation of their time, with 82% of their time allocated to infectious diseases and 18 percent allocated to bioterrorism/emergency response, environmental health, and other activities combined.

The majority of time working dedicated to infectious disease control was spent on case investigation (53%).Other major duties related to infectious disease control included data entry (18%), outbreak control (15%), and public health communication about infectious diseases (13%). Overall, infectious disease control activities were similar among epidemiologists of all tiers. The greatest difference was between tier 1 epidemiologists who reported the highest percentage of time spent on outbreak control (19%) compared to (tier 3a) epidemiologists, who spent 11 percent of their infectious disease control time on outbreak control. Tier 3a epidemiologists spent most of their time related to infectious disease control on public health communication activities (15%).

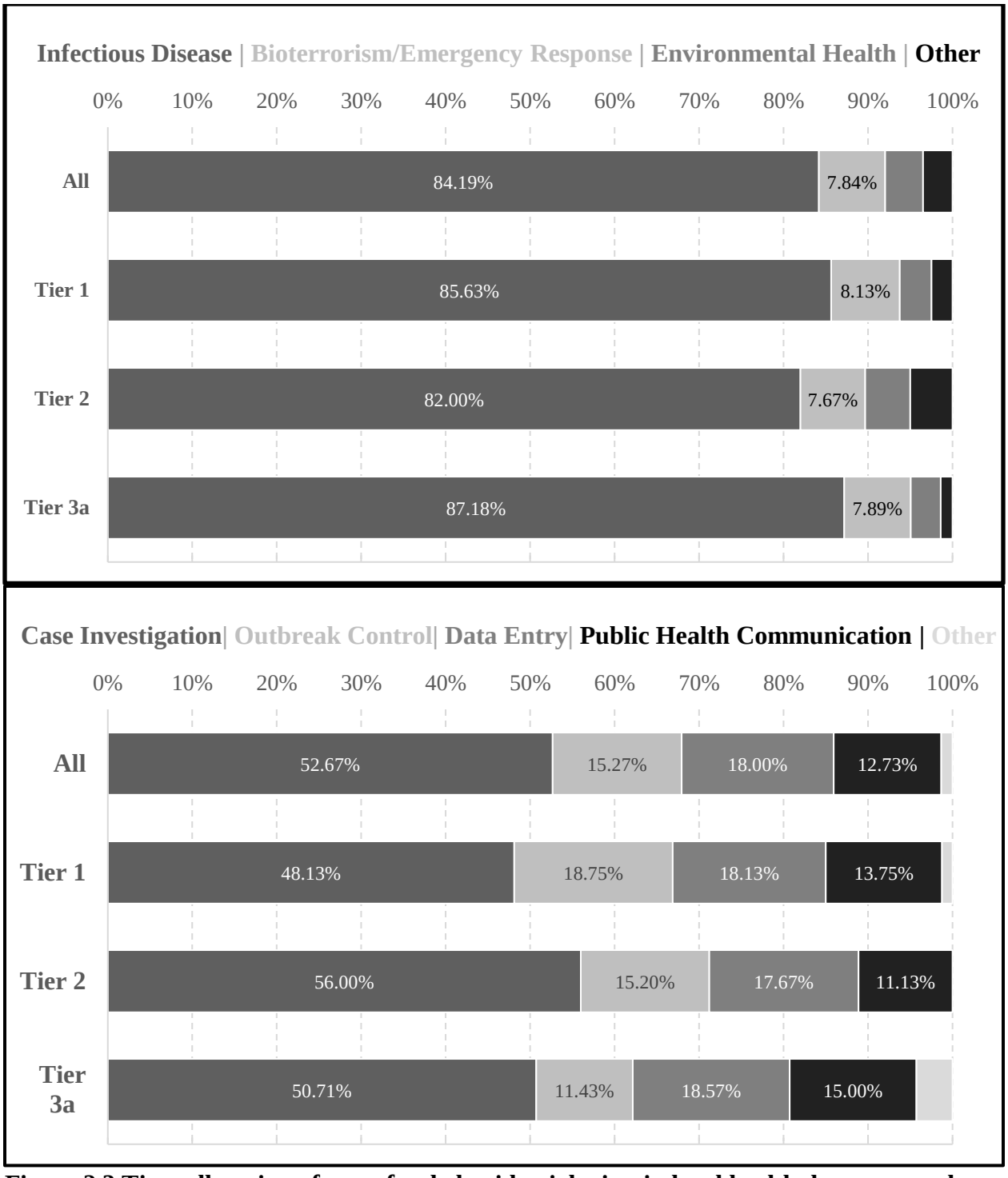

Figure 2.3 Time allocation of state-funded epidemiologists in local health departments by program area and specific infectious disease control activities.

The percentage of at SFEs reporting at least intermediate competency increased as tier level increased (Table 2.3). Tier 3a epidemiologists reported at least an intermediate level of competency in 100 percent of the competencies specific to tier 3a. As tier level increased, the mean percentage increased for those reporting advanced or expert competency. For example, Tier 1 epidemiologists reported that in 18 percent of the 30 competencies specific to tier 1 they had advanced or expert competency compared to tier 3a epidemiologists who reported that they had advanced or expert competency in 73 percent of their competency categories.

Table 2.3 State-funded epidemiologist cumulative competencies by tier level.

Tier Level	N	No. Competencies	Report at least intermediate competency		Report advanced-expert competency		Report needing more training	
			Mean, %	Range, %	Mean, %	Range, %	Mean, %	Range, %
Tier 1	9	30	98	71 - 100	18	0 - 42	26	13 - 63
Tier 2	15	31	99	75 - 100	54	13- 88	29	14 - 50
Tier 3a	7	32	100	100 - 100	73	25 - 100	40	14 - 57

Notes: Each competency was reported as minimal or none, basic, intermediate, advanced, or expert by each SFE in their respective tier. Training was reported as minimal or none to needs significant training by using a scale of 1-5 with 5 needing the most training (4 & 5 were combined to indicate more training needed in similar fashion to CSTE AEC). Tier 1 = Entry-level epidemiologist; Tier 2 = Mid-level epidemiologist; Tier 3a = Senior-level epidemiologist

Some tier 1 epidemiologists reported no advanced or expert competency levels for some competencies. As tier level increased and advanced/expert competency level increased, an inverse relationship can be seen in self-reported need for training. As tier level increased, so does the percentage of competencies indicated for needing more training. Tier 1 epidemiologists report 26 percent of the tier 1 competencies need more training and 40 percent of the tier 3a competencies need more training for tier 3a epidemiologists.

2.4 Discussion

This cross-sectional survey utilizing the CSTE ECA was designed to quantify the number of LHD epidemiologists who were part of the SFE program and to describe their general roles, epidemiologic competency, and training needs. Findings from the survey of SFEs provides data on the characteristics of the epidemiology workforce in Texas and allows for the comparison of the SFE workforce to national averages in state health departments.

The demographic makeup of SFEs are different in several ways from the national estimates. Texas SFEs were slightly younger than the national workforce. This could be due to a lower percentage of high tier level epidemiologists in the SFE program compared to the national estimates. For example, no SFE reported being in the tier 3b (senior scientist/subject matter expert) level. In the national sample, the majority of epidemiologists are women (71%). However, in Texas, while women are still the majority in the SFE positions (56%), there are more men in SFE positions than expected based on national estimates.

By supplying LHDs with funding for epidemiologists with training at the MPH level, LHD epidemiology and surveillance programs benefit from obtaining more specialized epidemiologic capacity. The majority of respondents with epidemiology specific academic training reported having a master's of public health with a concentration or specialization in epidemiology. The SFEs reported higher levels of epidemiology specific training compared to national estimates, particularly when considering the number of SFEs with an MPH. Having formal training, such as an MPH with a concentration in epidemiology from an accredited graduate education program, can build epidemiologic capacity (Moser, Ramiah, and Ibrahim 2008). For example, an SFE who completed a master's degree in public health with an emphasis in epidemiology will meet most of the tier 1-epidemiologist competency recommendations by

CSTE AECs. A core competency of an MPH graduate is how to recognize public health data for surveillance activities and how to interpret it (Moser et al., 2008). These competencies align with the tier 1-epidemiologist AECs (CDC & CSTE, 2008). Few SFEs received only on the job training relied on a few epidemiology specific courses. However, comparative national data collected by CSTE in 2004 found that 29 percent of epidemiologists had no formal training. These SFE positions supply LHDs with greater epidemiologic capacity through adding predominantly graduate level trained individuals.

SFE respondents reported relatively few years of experience, with 41 percent reporting less than 2 years of experience compared to the national estimates of 18 percent (CSTE 2014). Only 3 percent of SFEs had at least 20 years of experience, significantly less than the national estimate of 13 percent. However, although the SFEs reported relatively few years of experience, 30 percent of SFEs indicated that they would either retire or change careers in the next 2 years, a turnover rate of 15 percent. According to the 2013 CSTE national report, state health department epidemiologists with at least a master's degree had an 11 percent turnover rate. Although a turnover rate for SFEs is estimated at 15 percent over two years, 50 percent of SFEs reported retiring or changing careers in the next 10 years, reducing the estimated turnover rate to 10 percent over 10 years. It does however indicate potential higher turnover in SFEs who have worked only two years. It is known that recruitment and retention of healthcare workers is more difficult in rural setting compared to urban (MacDowell et al. 2010). The public health workforce is similar, especially in specialized fields such as epidemiology. According to a NACCHO study in 2016, epidemiologists are the 4th most difficult position to recruit in LHDs and even more difficult in small to medium sized LHDs (NACCHO 2016b). When examined further, SFE positions had no significant differences in desire to retire or change career by LHD size. Perhaps

the difference in turnover rate reported in SFEs and the national estimates in states is due to salary not being competitive. In the same NACCHO study, non-competitive pay was the number one reason for recruiting and retaining specialized staff (NACCHO 2016b).

Tier-based competencies were assessed among SFEs as well. Similar to national estimates, as the tier-level of the epidemiologist assessed increased, the reported competency also increased. However, the finding of this study contradict national estimates in reported training needs. SFEs reported needing more training as their tier-level and level of competency increased, as opposed to the national estimates, where training needs decreased as competency level increased. This phenomenon could be due to self-efficacy attribution and the complexity of increased tier competencies, where in this case all tier levels are interested in increasing their knowledge, especially those who report already high competency (Hoffmann 1999; Hoogveld, Paas, and Jochems 2005).

In 2013, an estimated 2,752 epidemiologists worked in state health departments in the U.S., a ratio of 0.87 epidemiologists per 100,000 population (Hadler et al. 2015). In its report, CSTE clearly called for additional epidemiologists to meet optimal capacity recommending that states increase state funding for these positions. The optimal number ratio to meet capacity needs is 1.31 epidemiologists per 100,000 according to CSTE's study. In LHDs who have SFE contracts in Texas, medium LHDs have 0.73 epidemiologists per 100,000 people and large LHDs have 0.46 per 100,000, both lower than the national state health department mean. Regardless of LHD size, an estimated 0.47 epidemiologists per 100,000 people are in Texas LHDs. SFE positions makeup approximately 40 percent of the LHD epidemiologic workforce and 56 percent of medium sized LHD epidemiology staff. Without the SFE program, the select LHDs in this study would only have 0.28 per 100,000, far below the national estimates in state

health departments and below CSTE ECA reported need for increased ratios to meet the demand of epidemiologic services required. Through funding this program, DSHS has increased epidemiology capacity almost two-fold from 0.28 to 0.47 epidemiologists per 100,000 people. Increasing capacity in this way supports LHDs in providing EPHS, particularly (1,2,9, and 10). EPHS 1 and 2 are directly impacted in LHDs with SFE as our study shows 70 percent of all SFEs spend their time investigating cases and controlling outbreaks. This program has also supplied seven LHDs with their sole epidemiologist, providing capacity where there was little or none to begin with. This aligns with the Public Health Infrastructure Improvement Goals in Healthy People 2020. The goals specifically include the need to increase the proportion of tribal, state, and local public health agencies offering comprehensive epidemiology services (Healthy People 2020 2017).

3. CHANGES TO TIMELINESS AND COMPLETENESS OF COMMUNICABLE DISEASE REPORTING IN TEXAS FOLLOWING THE IMPLEMENTATION OF A LOCAL HEALTH DEPARTMENT EPIDEMIOLOGY SURGE CAPACITY PROGRAM

3.1 Introduction

Local and state public health agencies provide a wide range of population-based public health services for their jurisdictions. These services were defined in 1994 when the Public Health Functions Steering Committee, a group comprised of local, state, and national public health organizations, developed the 10 Essential Public Health Services (EPHS) (Center for Disease Control and Prevention 2017a). Using the 10 EPHS, the National Public Health Performance Standards Program (NHPSP) developed a list of foundational services that public health agencies should strive to offer. The NHPSP provides performance standards for public health agencies to encourage and promote stronger public health preparedness, quality improvement, and stronger science-based public health practice (Center for Disease Control and Prevention 2017b). Specifically, these standards can be used to evaluate local and state public health systems, including public health surveillance and emergency preparedness (Lurie 2004).

Disease surveillance, a facet of epidemiology, is encompassed by EPHS 1 which relates to the monitoring of health status to identify and solve community health problems and EPHS 2, which includes diagnoses and investigations of health problems and health hazards (Figure 3.1) (Center for Disease Control and Prevention 2017a). Frequently, local and state public health agencies face challenges in providing all 10 EPHS effectively, including EPHS 1 and 2 (Hyde and Shortell 2012). Communicable disease reporting and the subsequent investigation of cases is a critical component of the public health system's ability to track, control, and prevent outbreaks

and reduce morbidity and mortality in populations. Timely and complete disease surveillance are two indicators of successful EPHS 1 and 2. Public health agencies continuously work to improve disease surveillance activities by implementing new strategies for improvements in timeliness and completeness.

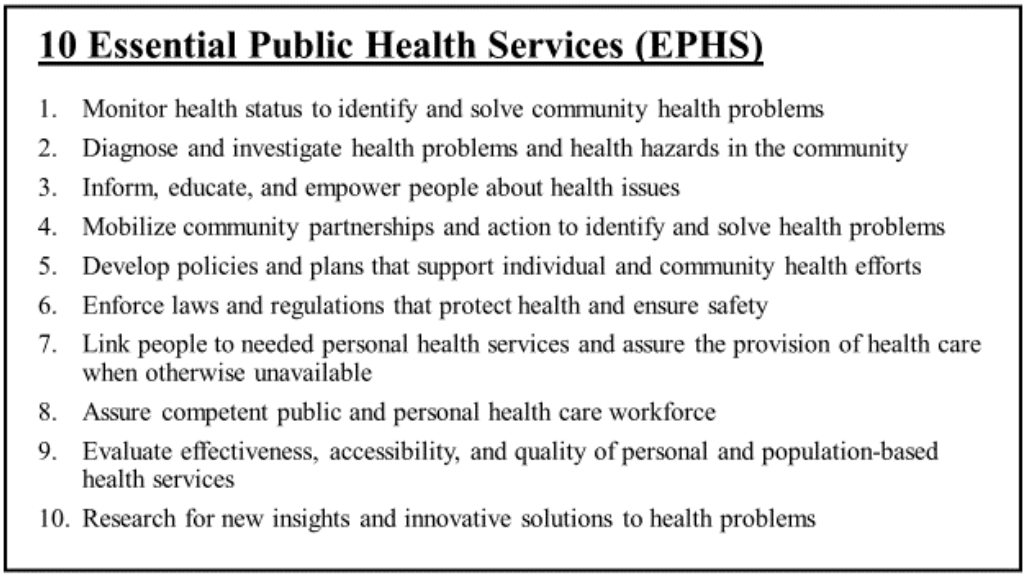

Figure 3.1 Ten Essential Public Health Services. Adapted from (Center for Disease Control and Prevention 2017a)

Electronic Lab Reporting (ELR), commonly the first report of a case of a communicable disease to the public health system, has been shown to improve timeliness and accuracy of disease reporting in state and local public health departments (Jajosky and Groseclose 2004; Samoff et al. 2013; Johnson et al. 2014; Dixon et al. 2017). In addition to ELR, further automated functions built into health information exchanges and electronic health records

(EHRs) are being explored for their potential to improve public health disease reporting (Digital Bridge 2018). For example, one study found public health's participation in health information exchanges with local and regional health providers improved timeliness and completeness of disease reports to public health since more information is automatically populated in disease reports (Painter et al. 2017). Although electronic and automated reporting systems improve timeliness and completeness, they might also increase investigative burden for state and local health departments (LHDs) because they also increase the number of reports that must be investigated (Nguyen et al. 2007; Overhage, Grannis, and McDonald 2008). These investigations require epidemiologists and disease investigators to identify and collect the remaining pertinent case information and determine the case status of each report. LHDs are known to have limited resources to conduct surveillance activities on a routine basis, let alone surge events (Gensheimer et al. 1999). As electronic disease surveillance systems become more automated, local health departments remain under- resourced and staffed to meet the need for timely and complete case investigation (Vogt et al. 2006; Rutz, Wee, and Feldman 2016; Chughtai et al. 2016).

The Center for Disease Control and Prevention's (CDC) Public Health Emergency Preparedness (PHEP) cooperative agreement has provided funds to health departments to improve epidemiology and surveillance activities since 2001 (CDC 2017a). However, by 2016, funds provided by the CDC as part of the PHEP cooperative agreement were one-third less than in 2001, dropping from $980 million to $651 million (Segal and Martin 2017). According to economic surveys conducted by the National Association of County and City Health Officials (NACCHO) and a study by Shah et al. (2016), during the 2008 economic recession, demand for public health services increased while LHD staff were reduced due to budget constraints. The loss of skilled workforce staff remains an issue for LHDs (Shah et al. 2016). In Texas, 36% of

local health departments laid off staff due to budget cuts between 2008 and 2013. These reductions in funding negatively impacted the public health workforce, especially certain concentrations like epidemiology (Bevington 2014; Gebbie and Turnock 2006; NACCHO 2014).

The Public Health Infrastructure Improvement Goals in Healthy People 2020 specifically include the need to increase the proportion of state, tribal, local, and territorial (STLT) public health agencies offering comprehensive epidemiology services, including surveillance. Passive disease reporting (e.g., diseases reports from reporting entities, typically health care providers or laboratories, to public health departments) is widely used across the U.S. and in Texas. Passive reporting is already known to be burdensome on reporting entities, slowing investigations and increasing response time for public health departments (Doyle, Glynn, and Groseclose 2002; Jajosky and Groseclose 2004; Silk and Berkelman 2005). Foodborne illness reporting is a substantial part of the investigative burden of surveillance for LHDs. Even without active case-finding, reported foodborne condition rates have increased in Texas from 2012 to 2016, most notably in campylobacteriosis (9.1 to 16.5 per 100,000), cryptosporidiosis (1.1 to 2.6 per 100,000), Escherichia coli (1.9 to 3.6 per 100,000), and shigellosis (7.3 to 15.5 per 100,000) rates (Texas Department of State Health Services 2016). The workload substantially increased for LHDs in investigating and processing foodborne illnesses from 2012 to 2016, in part due to the expansion of ELR, which increased the number of passive surveillance reports finding their way to LHDs.

Public health in Texas operates as a decentralized system. Seventy-one local public health departments/districts implement public health activities for 63 of the 254 counties. Eight Health Service Regions (HSR), which are organizationally part of the Texas Department of State Health Services, carry out public health activities in the remaining counties. The state health

department central office coordinates activities and provides guidance, but has no organizational jurisdiction over local public health departments/districts.

Officially, Texas law requires healthcare providers (e.g., primary or urgent care clinics, schools, hospitals, laboratories, etc.to notify the health department when the provider becomes aware of suspect, probable, or confirmed cases of notifiable conditions. (Texas Administrative Code 2018). In reality, disease reporting is a passive surveillance system that relies on providers' voluntary compliance. The National Electronic Disease Surveillance System (NEDSS) Based System (NBS) serves as the repository for statewide disease reporting data and is accessible for both input and extraction to LHDs, HSRs, and the central office. Laboratories submit the vast majority of disease reports simultaneously to the relevant LHD and HSR and to the central office through electronic laboratory reports (ELR) which are routed from the laboratory to the health departments via the NBS. Providers may also report directly to their LHD or HSR by phone or fax. Public health staff then manually enter these reports into NBS. Based on these initial reports, whether in-person or electronic, public health staff gather additional data as needed to confirm case status and perform follow-up investigations or interventions. As part of the process of gathering more information, the LHD or HSR enter or update case information in NBS. The Department of State Health Services (DSHS) does coordination and quality assurance of NBS prior to the transmission of surveillance data to CDC. In this passive system, the time between diagnosis and initial report and the follow-up investigation timeframes make up the bulk of time between the first suspicion of a case and the confirmed case being fully reported to the CDC.

In response to increasing caseloads of foodborne illnesses and surge needs from high consequence infectious disease investigations in Texas, DSHS started the state funded epidemiologist (SFE) program. Texas, in its' 83rd and 84th legislative sessions (2013 and 2015

respectively), funded 45 epidemiologist positions collectively for local health departments/districts in Texas to increase epidemiology capacity in the state in general and to specifically improve response to infectious disease threats. DSHS provides the funds to LHDs through contracts, and the LHD hires and employs the SFE.

Similar to previous studies that have compared changes in timeliness and completeness based on the introduction of new systems (e.g., ELR), we sought to understand whether the SFE program changed the timeliness and completeness of disease reporting in Texas.

3.2 Methods

3.2.1 Data Collection

In collaboration with DSHS, Texas notifiable condition reporting data was acquired from the Texas NBS system for the years 2012-2016. DSHS staff queried and provided extracted de-identified data in electronic format for analysis using Microsoft Excel. The 43 communicable disease conditions typically handled by most SFE positions were included in the data (Department of State Health Services 2017). All notifiable conditions included in this study are managed by the Emerging and Acute Infectious Disease Branch (EAIDB) of DSHS as part of different prevention and control teams, including foodborne, healthcare safety, high consequence infectious disease, invasive and respiratory infectious disease, and vaccine preventable diseases.

The following variables were obtained for each case report: jurisdiction where case was investigated, case status (not a case, suspect, probable, confirmed), onset date, diagnosis date, Morbidity and Mortality Weekly Report (MMWR) year (2012 – 2016), SFE status (yes / no), initial report time to public health system (either state or LHD in days), report time from LHD to

state (days), report time to CDC (days), and case report approval. An onboarding variable was created to represent the year in which a SFE LHD received a SFE (2014 or 2016). The final dataset contained 139,035 electronic condition reports on 43 conditions in 71 unique local reporting jurisdictions.

3.2.2 Data Cleaning

Since not all jurisdictions consistently report suspect (n=2,367) or non-cases (n=20,235), only probable and confirmed cases were included in the analysis. In addition, case investigations with a time interval of more than 365 days from first report to public health and first notification to the state health department were not included in this study (N= 1,497; 1.1 percent of all case reports). The majority (71 percent) of case reports that had processing times greater than 365 (Range: 366 to 7800 days) days were foodborne conditions with missing data. Finally, data were restricted to MMWR years 2012, 2014, and 2016 due to the timing of the SFE program. In 2012, the SFE program was not in place. In 2014, the first wave of SFE were incorporated into LHDs. By 2016, all SFEs were in their respective LHDs. Because each LHDs onboarding timelines for their SFEs varied, 2013 and 2015 data were not used as these were the years of onboarding. The final dataset included 66,694 confirmed and probable case reports from 2012 (N= 18,326), 2014 (N= 21,489), and 2016 (N= 26,879).

3.2.3 Data Analysis

Timeliness and completeness of NBS data were assessed and jurisdictions with an SFE were compared to LHDs without an SFE over time. Timeliness was defined as the time period between the earliest time a case was reported to the public health system from a provider or

laboratory to notification to the state and the time period between the state's receipt of the report and their report to CDC. Completeness is defined as the percentage of investigation reports submitted for approval to the state that were only submitted once without additional submissions needed for edits or the addition of information to supplement incomplete data. Using an LHD onboarding variable (pre-SFE, first phase, all SFE), we assessed changes in timeliness and completeness before, during, and after the implementation of the SFE program. Median time-intervals for reporting were compared using Mann-Whitney tests to identify statistically significant differences and z-scores were used to identify differences in proportions of complete first time submission case reports. All data analyses were performed using Stata 14 (College Station, TX, U.S.).

3.3 Results

The median number of days required for total public health processing of reports in SFE LHDs in 2012 before SFEs were implemented was 1 day longer than reports in non-SFE LHDs (14 days versus 13 days) (Figure 3.1). However, in 2012 the SFE LHDs (before they received their SFE positions) handled 75 percent of all reported cases. In 2012, 2014, and 2016 all time intervals were different in SFE vs non-SFE LHD reports, with the exception of the time interval from the state receiving the report to notifying the CDC, this interval remained the same from year to year and across SFE status (Figure 3.1, 3.2, 3.3). In 2016, when all SFEs were working in their respective LHDs, the overall median days for public health processing was 11 days for SFE and non-SFE reports, an overall reduction in median time in days from 2012. The number of case reports increased from 2012 (18,826 case reports) to 2016 (26,879 case reports) in both SFE LHDs and non-SFE LHDs proportionally. As before the SFE program, the health

departments/districts that received an SFE still processed the majority of reports overall (76 percent).

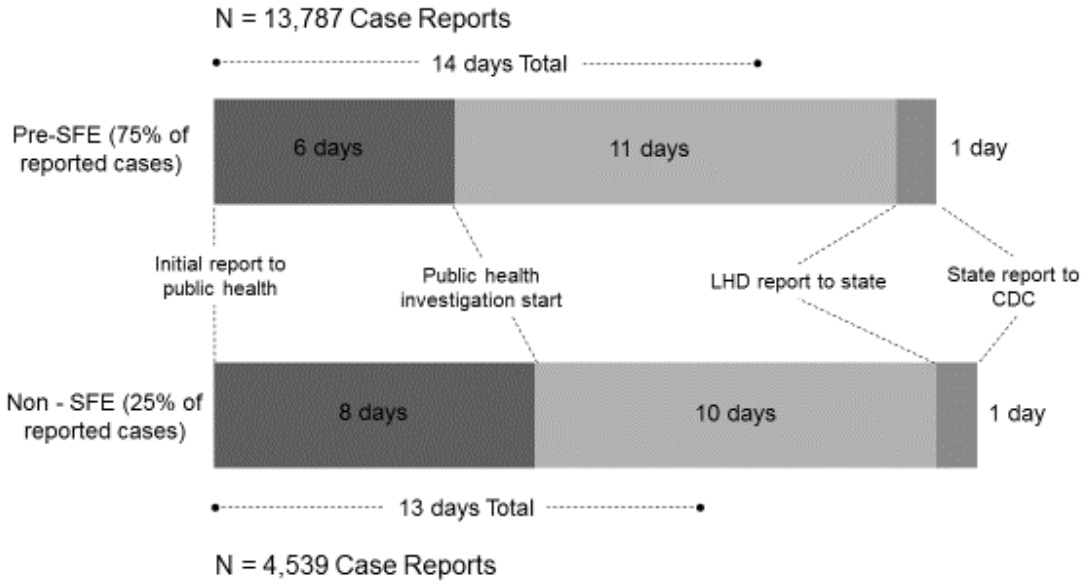

Figure 3.2 Timeline (median days) of public health processing of notifiable conditions in local health departments by SFE Status: Texas, 2012.

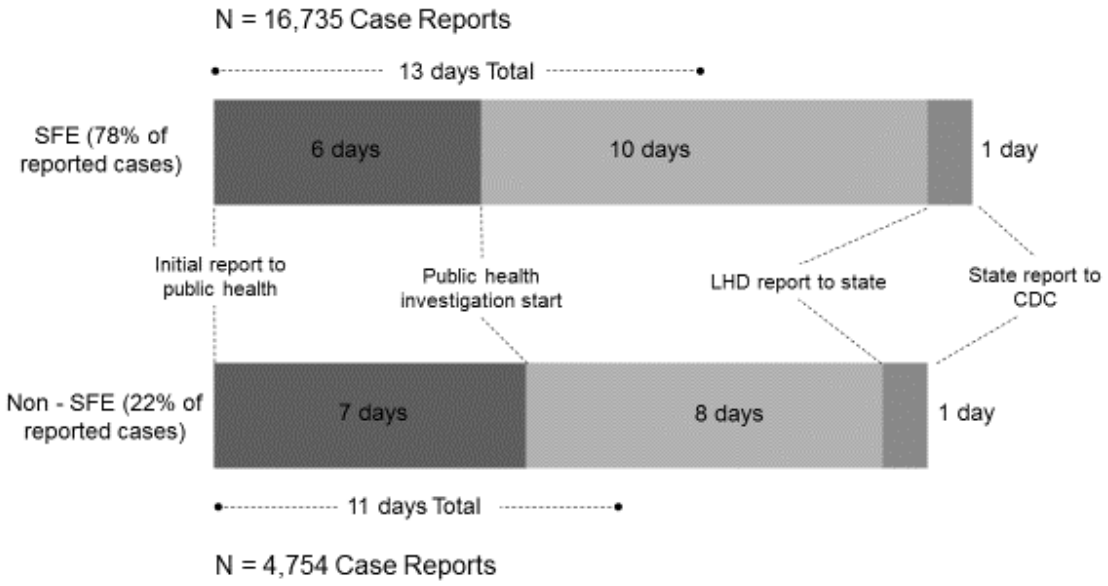

Figure 3.3 Timeline (median days) of public health processing of notifiable conditions in local health departments by SFE Status: Texas, 2014.

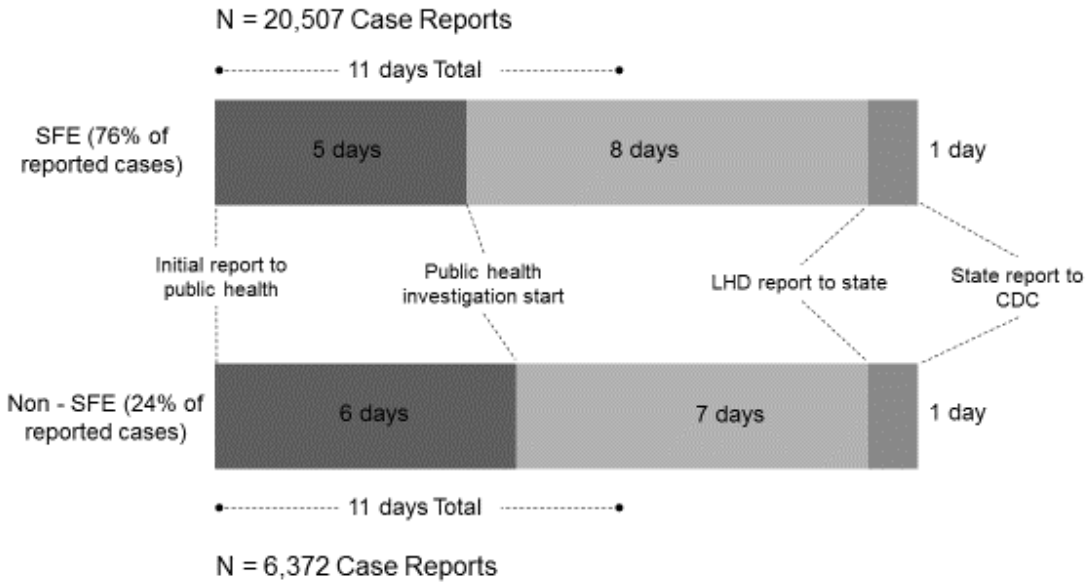

Figure 3.4 Timeline (median days) of public health processing of notifiable conditions in local health departments by SFE Status: Texas, 2016.

Looking only at reports handled by LHDs that participated in the SFE program in three time periods, the median number of days for processing from intial report to notification to the state decreased between 2012 and 2014 from 11 to 10 days and between 2014 and 2016 from 10 to 8 days (Table 3.1). The percent of complete first-time notifications from SFE program LHDs to the State also increased as the SFE program was fully implemented from 2012 to 2014 (19.58 percent) and from 2014 to 2016 (27.71 percent).

Table 3.1 Timeliness (median days) and completeness in state-funded epidemiologist program local health departments before, during, and after intervention, Texas 2012-2016.

	SFE LHDs		
Year	*Median days*	*Completeness (%)**	*No. of Cases*
2012 (pre-SFE)	11	19.58	13,787
2014 (Phase 1 SFE)	10	28.88	16,735
2016 (Phase 2 SFE)	8	27.71	20,507
Comparison using Mann-Whitney test	*P-value*	*P-value*	
2012 vs 2014	<0.000	<0.000	
2014 vs 2016	<0.000	0.013	
2012 vs 2016	<0.000	<0.000	

SFE = State-funded epidemiologist; LHD = Local health department;
Median days: From first report to public health to first submission to state health department
* Completeness refers to the percent of reports submitted to state from LHD that did not require multiple submissions for edits or additional information before submitting to CDC.

In 2016, the majority of case reports were processed by SFE jurisdictions across all condition groups (Table 3.2). Of the five categories (foodborne, healthcare, high-consequence infectious, invasive and respiratory infectious, and vaccine-preventable diseases) foodborne diseases were more complete in first time reporting to the state in SFE jurisdictions (23.5%) compared to non-SFE (17.88%) but had similar reporting times (Median 7 days for both) in 2016. However, the overall number of cases in SFE counties were higher. The reporting timeliness with healthcare associated diseases in 2016 was slower in SFE LHDs compared to non-SFE LHDs (median 24 days vs 7 days).

Only two of the five disease categories did not see improvements in first time reporting completeness from 2014 to 2016: high consequence infectious disease and vaccine preventable diseases (Table 3.3). Foodborne diseases first time reporting completeness improved in both SFE (20.88% to 23.5%) and non-SFE LHDs (11.1% to 17.88%) from 2014 to 2016. SFE LHDs showed almost a 3-fold improvement in complete healthcare associated diseases from 2014 to 2016. Vaccine-preventable disease reporting completeness was worse in 2014 (46.14% vs 47.36%), but was better in non-SFE reports compared to SFE reports (44.69% vs 36.96% respectively) in 2016. SFE LHDs were responsible for the majority of all complete first reports in each disease category in 2014 and 2016.

Table 3.2 Timeliness of reports from local health departments with and without SFEs, Texas 2014 and 2016.

	Number of cases		Median days of public health processing		Proportion of cases within SFE status		Proportion of all cases	
Condition category	*SFE*	*Non-SFE*	*SFE*	*Non-SFE*	*SFE*	*Non-SFE*	*SFE*	*Non-SFE*
2014								
Foodborne diseases	9,073	2,793	11	9	0.54	0.59	0.76	0.24
Healthcare associated diseases	1,149	214	56	18	0.07	0.05	0.84	0.16
High-consequence infectious diseases	36	14	8	17	0.00	0.00	0.72	0.28
Invasive and respiratory infectious diseases	1,713	452	8	6	0.10	0.10	0.79	0.21
Vaccine-preventable diseases	4,764	1,281	8	7	0.28	0.27	0.79	0.21
Total	16,735	4,754	10	8			0.78	0.22
2016								
Foodborne diseases	12,448	4,268	7	7	0.61	0.67	0.74	0.26
Healthcare associated diseases	1,873	355	24	7	0.09	0.06	0.84	0.16
High-consequence infectious diseases	34	11	14	20	0.00	0.00	0.76	0.24
Invasive and respiratory infectious diseases	2,207	561	7	7	0.11	0.09	0.80	0.20
Vaccine-preventable diseases	3,945	1,177	7	6	0.19	0.18	0.77	0.23
Total	20,507	6,372	8	7			0.76	0.24

SFE = State-funded epidemiologists; LHD = Local health department

Table 3.3 Completeness of reports from local health departments with and without SFEs, Texas 2014 and 2016.

	Number of cases		Percent complete		Proportion of cases within SFE status		Proportion of all cases	
Condition category	*SFE*	*Non-SFE*	*SFE*	*Non-SFE*	*SFE*	*Non-SFE*	*SFE*	*Non-SFE*
2014								
Foodborne diseases	9,073	2,793	20.88	11.1	0.54	0.59	0.86	0.14
Healthcare associated diseases	1,149	214	10.27	12.15	0.07	0.05	0.82	0.18
High-consequence infectious diseases	36	14	50	35.71	0.00	0.00	0.78	0.22
Invasive and respiratory infectious diseases	1,713	452	31.93	23.01	0.10	0.10	0.84	0.16
Vaccine-preventable diseases	4,764	1,281	47.36	46.14	0.28	0.27	0.79	0.21
Total	16,735	4,754	28.88	21.79			0.78	0.22
2016								
Foodborne diseases	12,448	4,268	23.5	17.88	0.61	0.67	0.79	0.21
Healthcare associated diseases	1,873	355	27.98	33.24	0.09	0.06	0.82	0.18
High-consequence infectious diseases	34	11	23.53	36.36	0.00	0.00	0.67	0.33
Invasive and respiratory infectious diseases	2,207	561	34.8	38.15	0.11	0.09	0.78	0.22
Vaccine-preventable diseases	3,945	1,177	36.96	44.69	0.19	0.18	0.73	0.27
Total	20,507	6,372	27.71	25.5			0.76	0.24

SFE = State-funded epidemiologists; LHD = Local health department

3.4 Discussion

Infectious disease reporting timeliness and completeness improved in both SFE and non-SFE LHDs from 2012 before the SFE program was implemented to 2016 when it was fully functional. Both the time interval between receiving a report to starting an investigation at the LHD and the time interval from investigation start to report to the state decreased from 2012 to 2016 in both SFE and non-SFE LHDs. Decreasing the time to starting disease investigations is of critical importance in identifying and confirming potential outbreaks, especially high-consequence infectious diseases (Davis 2000). In 1988, the Institute of Medicine (IOM) recommended that all public health agencies systematically collect, analyze, and perform epidemiologic investigation on health problems related to the public (IOM, 1988, p. 141). LHDs in Texas do the bulk of disease surveillance reports, therefore, increasing capacity and timeliness at this level is important. Based on this study of electronic disease reports, the SFE program is associated with improvements in timeliness on all time-intervals that the LHD is associated with.

The first phase of the SFE program was designed to improve foodborne disease surveillance and response throughout Texas because of the burden of increased foodborne illnesses and outbreak investigations (Texas Department of State Health Services 2016). The epidemiologists deployed in the first phase of the program were assigned to foodborne diseases specifically and to help in multi-state salmonella cluster investigations. LHDs with highest need for improvements in foodborne disease investigation timeliness and completeness and who saw higher burden of disease reports were issued contracts for a SFE. In this study, the LHDs who received a SFE in the first phase improved in their timeliness and completeness of foodborne diseases and carried the bulk foodborne disease reports in the state, meeting the goals of the program. SFE LHDs investigate the majority of local level notifiable diseases in Texas. Though

improvements in median days of report processing and completeness between 2012 and 2016 were noted in this study, the proportion and magnitude of cases that improved in these jurisdictions is noteworthy. With the aid of the SFE program, local jurisdictions who have the highest burden of disease improved timeliness even as disease report counts also increased.

Another important element of this program is the effect of the SFEs on the shared burden of disease investigation at the local and regional health department level. In Texas, not all LHDs have epidemiology or disease investigation staff for notifiable diseases. DSHS HSR provide epidemiology and investigation support to all LHDs within their region, including those that do not have any epidemiology capacity as well as those with limited capacity. The SFE program provided epidemiologists in jurisdictions where there were previously no epidemiologist or disease investigation staff. The increased capacity at the local level from this program has enabled HSRs to help other jurisdications without SFEs. This could explain why non-SFE LHDs also saw increases in timeliness and completeness over the study period.

The analysis of timeliness and completeness of communicable disease reporting from the Texas NBS was subject to several limitations. First, only a limited number of variables and characteristics were made available for this dataset in order to keep the identity of the reporting jurisdiction masked. Another limitation is the way that completeness was assessed. The dataset did not contain individual fields from investigation reports to precisely measure the level of completeness in each report. Instead, the percentage of case reports that were sufficient enough to report on to the CDC without further submissions was deemed complete. Though this measure is likely a good proxy for completeness, we do not know with certainty that the report was complete, only that it was deemed adequate to be processed from DSHS to CDC. Healthcare associated diseases are processed differently than the other condition categories. They are more

dependent on local healthcare facilities and additional approvals within DSHS. Therefore these case reports may have altered the timeliness and completeness overall due the differences in processing. Finally, additional LHD variables such as total case load, number of disease investigators or epidemiologists per LHD is not known. The number of probable and confirmed cases does not capture the full workload of investigating and processing the number of reports that a LHD manages and NBS does not capture this entirely. For example, reports that are not cases are not all entered into NBS. For this reason, we did not use non-cases. Not fully understanding the amount of case reports and work done by LHDs by not having non-cases is a limitation. However, reports of probable and confirmed case reporting timeliness and completeness is ultimately of interest. Alerting public health officials of cases and outbreaks more quickly allows the public health system to respond to disease threats to effectively (Nguyen et al. 2007).

4. HOW DO SURGE CAPACITY POSITIONS INCREASE EPIDEMIOLOGIC CAPACITY? RESULTS FROM A QUALITATIVE STUDY OF TEXAS LOCAL HEALTH DEPARTMENTS

4.1 Introduction

Epidemiology is a core public health function and an essential component of public health response (Haveman-Nies et al. 2011). Understanding the roles played by epidemiologists during emergency responses is essential to better understand the system's capacity for responding to public health threats. Epidemiology capacity refers to the ability to provide comprehensive epidemiology services to support essential public health services in non-emergent situations on a routine basis. Public health surge capacity refers to the ability to implement core public health activities such as mass prophylaxis and vaccination, risk communication, and epidemiologic investigation in response to emergencies or disasters. It is important to understand and characterize both forms of capacity to improve public health services.

The Council of State and Territorial Epidemiologists (CSTE) has documented the epidemiology capacity of state health departments in the U.S. since 2001 using the Epidemiology Capacity Assessment (ECA) tool (Hadler et al. 2015). The ECA is distributed to all state and territorial health departments in the U.S. and enumerates the number of epidemiologists by program area. Staff are further classified by education, experience, competency, salary, and job role. In 2013, 2,752 epidemiologists were employed by state health departments This is the highest number reported since 2001, when the total number of epidemiologist employed by state health departments was 2,498. The number of state epidemiologist positions continued rising until the 2008 economic crisis. The lowest number of state epidemiologists was reported in 2009

with 2,193. Much of the growth since 2001 has been in infectious disease epidemiology (related to public health preparedness and emergency response funding made available after September 11 and the anthrax attacks of 2001). There has also been overall growth at the state level in maternal and child health epidemiology. However, the ECA includes only state health department data, which do not represent the entire public health system. Global epidemiology capacity is also important. From 1980 to 2016, the number of field epidemiology training programs in foreign countries increased from 1 to 65 with goals to build local epidemiology capacity worldwide (Jones et al. 2017).

Local Health Departments (LHDs) also provide essential public health services. This is particularly true in states with decentralized public health authority, meaning that local jurisdictions (e.g., cities and counties) have the responsibility to provide public health services within their jurisdiction. LHDs have their own public health workforce to fulfill the public health mandates from the local administrative governmental bodies.

The ECA does not capture information on LHDs in the U.S., which means that LHD epidemiology capacity data is limited. Of national public health workforce data sources, the Association of State and Territorial Health Officials (ASTHO), CSTE, and National Association of County and City Health Officials (NACCHO) have epidemiology workforce information. NACCHO's profile survey has collected information from all LHDs in the U.S. since 2005 on a range of topics, one of which is workforce information. The NACCHO profile study has also demonstrated growth in the number of epidemiologists in LHDs, with 1,300 identified in 2005 to 1,600 in the 2016 profile (NACCHO 2016). However, the NACCHO national profile data is limited since it only includes an estimated number of epidemiologists employed without other

measures of capacity. No information regarding program area, competency, training needs, or experience is captured.

In their 2013 ECA, CSTE identified gaps in epidemiology capacity and provided recommendations to address them. One recommendation called for state health departments to increase funding from state budgets for epidemiologists, rather than relying disproportionately on federal funds. In response to increasing caseloads of foodborne illnesses and high consequence infectious disease investigations in Texas, the state health department started the state funded epidemiologist (SFE) program. Texas has 254 counties, 71 local public health departments/districts, 8 functional Health Service Regions (HSR), and a state health department operating as part of a decentralized public health system. Texas, in its' 83rd and 84th legislative sessions (2013 and 2015 respectively) funded 45 epidemiologist positions collectively for local health departments/districts in Texas to increase epidemiology capacity in the state in general, and to specifically improve response to infectious disease threats. The Texas Department of State Health Services (DSHS) provides the funds to LHDs through contracts and LHDs hire and employ the SFE position. The SFE positions funded by the 83rd and 84th Texas legislative sessions were designed to improve local epidemiologic capacity in LHDs throughout the state (Garza 2016).

Lack of funding is the main barrier identified to having an epidemiologist position (Hadler et al. 2015). In small LHDs, essential public health functions related to epidemiology such as disease surveillance, study design, data collection and analysis, and designing disease control methods are typically carried out by public health nurses or environmental health specialist positions out of necessity, limiting the overall epidemiologic capacity of the LHD (Moehrle 2008). In addition to the overall number of epidemiologists, the ability of small LHDs

(compared to medium and large LHDs) to have epidemiology staff with formal training such as a master's degree in public health, is also limited (O'Keefe et al., 2013). Retention can also be a problem in small LHDs. In Idaho, where most counties are small and rural, epidemiologist positions are hard to fill and retain, and often epidemiology staff do not meet the national competencies put forth by CSTE (Moehrle, 2008). Enanoria et al. found in a cross-sectional study of local epidemiologists in the U.S., that one-third of epidemiology staff members in small and medium jurisdictions reported no formal training in epidemiology in 2013 (Enanoria et al., 2014). This study also noted that in large LHDs, where staff may include advanced positions in epidemiology, more robust epidemiologic work can be conducted such as advanced research studies and complex public health data analysis.

The use of contract epidemiologists is not uncommon in large public health responses. For example, the Central America Field Epidemiology Training Program (CA FETP), a program modeled after the CDC's Epidemic Intelligence Service, was structured to train and contract field epidemiologists to help rebuild the public health infrastructure and was heavily focused on public health surveillance activities (López and Cáceres 2008). The U.S. government has provided funds for contract epidemiologists to respond to an array of public health threats including influenza, food and waterborne diseases, and healthcare-associated infections (CDC 2017). In 2016, The CDC awarded $97 million to Zika epidemiology and laboratory capacity activities, including contract epidemiologists to focus on Zika virus surveillance and response (CDC 2017). The majority of contract epidemiology work in the U.S. comes from federal funding such as the Epidemiology and Laboratory Capacity Cooperative Agreement, which helps local, state, and territorial health departments increase capacity, and the Prevention and Public

Health Fund, a mandated fund that is part of the Patient Protection and Affordable Care Act (ACA) (CDC 2017).

Each LHD in Texas is different in organizational structure, size, and population served. Additionally, the operation of epidemiology or disease surveillance programs in LHDs may vary. Although epidemiologists in Texas LHDs work closely with DSHS officials, who provide statewide notifiable disease investigation guidance, each SFE position in their respective LHD, play different roles and have somewhat different responsibilities. Because of the unique nature of LHDs in Texas, key informant interviews were used to provide detailed insight into the function, role, and impact of the SFE program through applied qualitative methods (Farquhar et al. 2006).

4.2 Methods

4.2.1 Population

The State of Texas public health system is comprised of local-, regional-, and state-level public health services, including epidemiologic services. Key informant interviews were conducted with LHD leadership in health departments that had an SFE position, as well as with regional and state epidemiology staff that have frequent contact with SFE positions. For this qualitative study, representatives from each level made up the study population. In Texas, 31 local jurisdictions received SFEs. Thus, 31 key informant interviews were attempted with one representative from each LHD who received a SFE position to collect local data on the impact of adding an SFE. The LHD representative was an epidemiologist manager/supervisor or health department director who oversees SFE epidemiologist duties. Each HSR has an epidemiology and surveillance department or unit that oversee infectious disease surveillance within the region and works closely with LHD epidemiologists. For the regional level, each of the eight HSR's

lead epidemiologists who interact with LHD SFEs was invited for an interview. The DSHS SFE program operates in the Emerging and Acute Infectious Disease Branch (EAIDB) and has six disease control teams, foodborne diseases, healthcare associated infections, high-consequence infectious diseases, invasive and respiratory infectious diseases, surveillance infrastructure, and vaccine-preventable diseases, all of which may interact with the SFEs. Each disease control team lead was targeted for inclusion in this study to provide input from the central office perspective on SFEs in LHDs. The total sampling frame was comprised of 31 LHD epidemiologist managers/supervisors, eight regional epidemiology or surveillance staff, and 6 staff from DSHS for a total possible sample size of 45.

4.2.2 Data Collection

Contact information for key informants at the local, regional, and state level was obtained from the DSHS SFE program coordinator or the DSHS website. Once all contact information was compiled, an email invitation requesting a 30-minute telephone interview was sent to each potential participant. When multiple supervisors or points of contact were listed, an interview was first attempted with the initial name listed online or in the database provided by the SFE program coordinator. Subsequent contacts were made if the first potential participant was unable to complete the key informant interview. Each key informant was contacted via email up to two times to set up a mutually agreeable time for a telephone interview. All interviews were recorded, with verbal consent, to ensure accurate information was collected and reported. A semi-structured questionnaire was used (Appendix B) and included the following components: strengths and weaknesses of SFEs, benefits to program areas, impact on disease surveillance,

roles and responsibilities, and barriers to adding SFEs in LHDs or within different regions or the entire state. All materials were reviewed by the Texas A&M University Institutional Review board (IRB#17-0366M) and determined to be exempt.

4.2.3 Analysis

Transcripts of the key informant interviews were content analyzed for key themes using inductive coding. This means that there were no predetermined themes, but that themes emerged from the data through review and comparison. First, audio recordings were transcribed using ATLAS.ti Version 8.0 (Berlin, Germany). Transcripts were then coded for themes. To increase the reliability of coding, content was coded independently by two researchers and themes identified were compared, reconciled, and compiled (Burnard et al. 2008). Reconciled themes and summary statements were copied into a Microsoft Word® (Redmond, WA) document for analysis. Themes were reported in categories and supporting quotations for each category were collected.

4.3 Results

Of the 45 key informants identified, 20 (44%) participated in a telephone interview, 42% from LHDs, 50% from HSRs, 50% from EAIDB (Figure 4.1). Respondents reported a range of experience in public health or epidemiology ranging from 18 months to 36 years (mean = 6.8 years; median = 4 years). Job titles of respondents included epidemiologist, lead epidemiologist, chief epidemiologist, surveillance coordinator, program coordinator, manager, and public health director. LHD non-respondents were similar to respondents across several categories including LHD size, being in a rural or urban jurisdiction, whether the LHD received SFEs in the first or

second phase of the program, and number of infectious disease case investigations. Five themes were identified from the inductive coding of the key informant interview transcripts: *1.Increased overall epidemiological capacity, 2.Timeliness in disease reporting, 3. Quality and thoroughness in disease investigation, 4. Community relationships, and 5. Communication across state*. Each theme is described in detail below with specific supporting quotes. A list of summarized weaknesses and recommendations for the SFE program are also included.

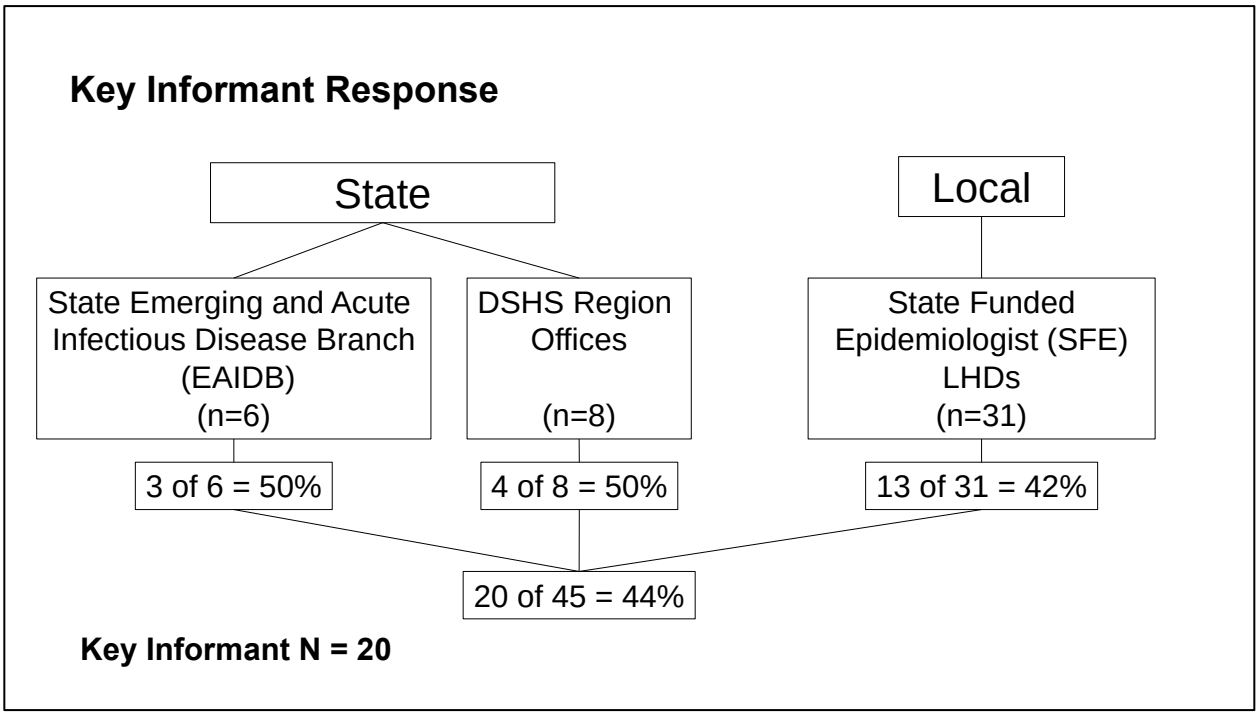

Figure 4.1 Key informant response from state and local participants.

4.3.1 Increased Overall Epidemiology Capacity

All participants in local, regional, and state health departments described ways in which the SFEs have increased epidemiology capacity in Texas LHDs. SFEs in LHDs do the bulk of infectious disease surveillance activities, from case investigation to data entry to outbreak response. Participants agreed these positions have improved overall epidemiology capacity within the health department, noting that having a position dedicated primarily to infectious disease surveillance and response was the most significant of the SFE program. Other staff, including department epidemiologists, are now able to expand the overall amount of epidemiological work done within the LHD by reporting data and supporting analysis for other health department programs (e.g., chronic disease, maternal and child health). For example, one LHD participant said:

"having a dedicated person for infectious disease, it grows our overall epidemiology capacity with data reports and data analysis for other LHD programs."

Another participant noted,

"The position has enabled other staff members to do more of their primary roles."

Outbreak response capacity was also noted as being significantly improved by the addition of these positions. SFEs offer LHDs the resources to respond to outbreaks through fieldwork, such as active surveillance and case finding. Before the program, LHDs were constrained in their responses to outbreaks, most notably by only being able to provide guidance over the telephone. Now with SFEs, dedicated staff can respond in-person if necessary and more

in-depth outbreak response is possible. State and regional health department participants agreed that SFEs have improved epidemiology capacity locally and throughout the state, specifically around public health surveillance activities.

Since most SFEs have at least a master's level degree and training in epidemiology, the program has brought additional skills and expertise that increase capacity to LHDs. Several LHDs mentioned that SFEs have either started or assisted in starting new surveillance systems for Zika virus infections. Having epidemiologists with more academic training in surveillance methods enabled LHDs to build these new systems for monitoring and tracking. Data analysis and report writing was also noted as a strength of the SFEs. SFEs provide expertise by constructing outbreak detection systems and mapping disease in local jurisdictions using Geographic Information Systems (GIS). These skills have enabled LHDs to provide data analysis and other types of reports to local public information officers, enhancing the LHD's ability to communicate with the public about specific disease threats.

4.3.2 Timeliness in Disease Reporting

All participants in this study agreed that timeliness in disease reporting had improved with the addition of SFEs in LHDs. Local level respondents articulated how having dedicated staff for disease surveillance had improved their timeliness. Having required deliverables for the SFEs including in the contracts from DSHS was seen as a contributor for improving timeliness within LHDs. For example, one of DSHS's deliverables for SFE LHDs was to complete a disease investigation and report to DSHS within 30 days. Prior to these contracts and the addition of the SFE positions in LHDs, the 30 days requirement was not in place. LHD staff described

that having these positions dedicated to conducting disease investigations quickly has improved their internal surveillance systems. One LHD manager said:

"The contract deliverables have helped us standardize our systems so it's helped in that department, we are doing a good job meeting those deliverables. Without the contracts, we wouldn't have put as much focus on these."

Regional staff indicated that disease reports come to the regional offices more quickly and that LHDs have better response times now with SFEs, especially in LHDs that had no epidemiologist prior to the SFE position. Central health department staff also confirmed that disease investigations and reporting timeliness had improved since adding the SFEs.

4.3.3 Quality and Thoroughness in Disease Investigation

The quality and thoroughness of disease investigation in LHDs was improved according to most participants from each level of government. HSR staff emphasized how disease investigations from LHDs have improved in their quality and completeness since the program was initially funded. One HSR participant stated,

"SFE positions provide the ability and strength to keep up with changing case definitions and make time for follow up and confirmation of cases."

All LHD participants agreed, describing how their public health surveillance and disease investigations were now of higher quality and more exhaustive. One LHD staff member mentioned that with the SFE position:

"We are far more proactive, we have additional staff to do the work. We have more opportunity to do thorough surveillance."

Another LHD participant said,

"We now have accurate and complete reporting, better investigations… before it was just getting done, now there is someone who can look deeper to see if there are links or clusters or outbreaks."

EAIDB and LHD staff also noted that SFEs are improving the quality and depth of multi-state outbreak investigations. One of the deliverables in SFE contracts to LHDs is to investigate clusters of Salmonellosis cases with extended data collection during the investigation and for those clusters to be reported in a timely manner. The interviews suggest that more comprehensive investigations are being completed with the SFEs in LHDs, which is improving the overall surveillance capacity of the public health system. Responses also noted LHDs have now put in place internal surveillance systems to meet the deliverables for these cluster investigations and apply these requirements to other conditions beyond Salmonellosis. One LHD described their investigations now that they have a SFE,

"Now that this position on board, we are able to complete full 3-day food histories and other risk factor information on our main foodborne illnesses. These are not required by the state, but before this position, our epidemiology department could only complete the basic level investigation to report to the state."

4.3.4 Community Relationships

By increasing local epidemiology and surveillance capacity, LHD staff noted the positive impact SFEs have had on building community relationships, especially with disease reporting entities such as health care providers. Both local and regional staff described how SFEs are involved with community outreach and education with providers. One HSR staff member said,

"The strengths of having local epidemiologists is making local relationships. A bigger impact in the small and medium health departments by building the relationships with reporting and surveillance and building capacity locally."

A LHD respondent echoed this, explaining that the SFEs,

"have been able to start stakeholder meetings with providers for increased surveillance reporting, build stronger ties and relationships with providers."

Another way SFEs have improved community relationships with health providers locally is the dissemination of disease data reports. Providing stakeholders with outputs from their reports supports stronger relationships as providers see that the data they report is being used in a

meaningful way. Overall, SFEs are able to interact more closely with local stakeholders and providers, helping put a face on the LHD when reporting questions arise.

4.3.5 Communication Across State

Participants from local, regional, and state public health explained how having SFEs locally provides more points of contact for both the regional offices and DSHS. Because SFEs work closely with both HSRs and EAIDB, they provide quick access to what is going on locally with infectious disease related work. They also increase the reach for health advisories issued by DSHS through the strength and breadth of their local relationships. For example, when DSHS issues a health advisory, SFEs can relay those messages to their local networks of providers. One regional staff member said,

"More providers are now reached with information and reporting. The network has increased in the region for health advisories."

Another respondent from the state added,

"Having the local point of contact is beneficial for coordinating surveillance and communication."

Similar to HSR and EAIDB staff, LHD participants agreed saying,

"We have a better relationship and expanded communication with DSHS and the region, and better surveillance because of it."

4.3.6 Difficulties, Weaknesses, and Recommendations for Improvement

Overall, only 40 percent of participants reported weaknesses or difficulties with the SFE program. However, of those who did report weaknesses, there were several strong themes. First, the SFE program provides contract-based funding for positions in LHDs. This type of funding brings uncertainty to some of the LHDs about the program's stability and concern about whether or not the positions will continue to be funded. This constrains some LHDs in terms of planning beyond the two-year contract term. HSR and EAIDB perceived that uncertainty about continued funding also impacted the SFEs themselves in some LHDs. However, several LHDs who received an FSE disagreed, stating that the contract funds are actually more secure and reliable than some of the local funds available for epidemiologists, making the SFE positions more desirable locally. Small and medium sized LHDs also struggle with the recruitment of qualified epidemiologists. Each LHD has different compensation packages and those that offer lower wages and benefits due to local administrative constraints have a difficult time recruiting qualified applicants for their departments. Once recruited, it can also be difficult to retain highly qualified individuals in these positions.

In addition to these specific potential challenges, key informant interviews provided four recommendations for overall improvement of the SFE program locally, regionally, and statewide. These included:

1. Keep current funding of program and add funding for more local SFEs and regional SFEs.
2. Make workforce development a priority. Provide more applied training to SFE workforce.

3. Improve coordination and training between HSRs and the SFEs located in local jurisdictions within their regions.
4. Consider restructuring current contract deliverables to more closely monitor the day-to-day work of SFEs to provide a better representation of their impact.

4.4 Discussion

Contract epidemiologist programs are not a new concept, but they have traditionally been used to address specific disease control efforts. The Texas SFE program is unique in that state funds were allocated to build local epidemiology and surveillance capacity for a broad spectrum of infectious diseases in a decentralized state public health system, where local jurisdictions offer the majority of essential public health functions.

The advantages of the SFE program to LHDs were described by participants in this study from each level of government, local, regional, and state. One recommendation from key informants at all levels is to keep funding the program, and if possible, increase funding for additional positions locally and new positions regionally. In a 2017 report on LHDs across the U.S., NACCHO found that LHDs have eliminated 55,590 jobs since 2008 (NACCHO 2017). In the NACCHO report, medium sized LHDs were more likely to experience job losses in the coming year while large LHDs were least likely. Our key informant interviews supported these findings, stating that without the SFE program, the work that these positions do would simply not be done because of the lack of resources and capacity locally. Another possible reason behind respondent's unanimous recommendation to keep funding the program is that it is estimated that one third of all LHDs anticipate budget cuts from local sources in the upcoming year (NACCHO 2017).

In this study, one difficulty consistently identified by small and medium LHDs was the recruitment of qualified epidemiologists. This is was especially true in rural jurisdictions. This also supports national estimates from NACCHO, which show that recruiting epidemiologists to work in LHDs is the most difficult position to fill other than clinical positions (NACCHO 2017). Contributing factors include a lack of competitive pay, location, and LHD size. Participants noted that because of local restrictions, they sometimes have difficulty hiring qualified epidemiologists because of their inability to offer competitive pay. Our LHD participants mentioned that pay was a barrier, but only part of the challenge of finding qualified applicants in general. According to NACCHO, over 50% of all LHDs have difficulty in hiring specialized positions due to candidate-related insufficiencies, in other words, not having qualified applicants (NACCHO 2017). One participant in this study pointed out that local residents and existing LHD staff who applied for the SFE position were not eligible because they lacked the recommended academic qualifications.

Respondents at all levels pointed to turnover as a challenge to staffing the SFE positions in LHDs. Large LHDs had less turnover compared to small to medium sized LHDs; turnover was especially prevalent in LHDs where the SFE was the only epidemiologist on staff. It is widely recognized that recruitment and retention of healthcare workers is more difficult in rural setting compared to urban (MacDowell et al. 2010). The public health workforce is similar, especially in specialized fields such as epidemiology. According to a 2013 CSTE report, state health department epidemiologists with at least a master's degree had an 11 percent turnover rate. Despite turnover in the SFE positions, it was noted that LHDs have adapted and put systems in place to keep surveillance activities going during staff transitions by cross training other staff and developing procedures for training and bringing in new SFEs. Therefore, even with high

turnover and the difficulties associated with retaining SFEs, public health surveillance and epidemiology capacity locally is still improved with the SFE contracts with LHDs.

This study has several limitations. The information collected from key informant interviews represents only the qualitative impressions of a sample of participants in the SFE program and may not represent the thoughts and experiences of all who are associated with the program or the public health system it affects. In an effort to mitigate this, invited and participating informants represented a range of experience and public health roles to ensure that the qualitative information can still be of value to a broader audience of public health managers and decision makers. The majority of key informant interviews (20 of 45) were attempted with LHD representatives who manage the SFE contracts with DSHS, presenting the potential for response bias. To address this, participants from HSRs and EAIDB were also included and completed the same semi-structured questionnaire. In this study, the themes identified in LHD interviews were consistently included in regional and state-level responses, providing a confirmation of the perceptions of LHD staff. Another potential limitation is the difference between respondents and non-respondents from the regional and state levels. The populations served and volume of case investigations varied between respondents and non-respondents presenting potential bias in their responses. To our knowledge, this is the first qualitative study to examine the impact of a contract epidemiology program within LHDs. These interviews provide a depth of information not found in a structured questionnaire and similar types of interview data has been used to identify potential shortfalls in health delivery or modifiable procedures along with program strengths and benefits (DeSantis and Ugarriza 2000; Farquhar et al. 2006; Tong, Sainsbury, and Craig 2007).

5. CONCLUSION

5.1 Summary

The purpose of this project was to assess the impact of a state-funded epidemiologist (SFE) program designed to improve foodborne illness surveillance and surge capacity for high-consequence infectious disease response in Texas. The study had three aims. First, to describe local health department epidemiology capacity in Texas local health departments (LHDs) who received an SFE. Second, to evaluate changes in public health surveillance, specifically the timeliness and completeness of communicable disease reporting, potentially associated with the provision of epidemiology surge capacity. Third, to describe the impact of SFEs in LHDs in Texas using qualitative methods. Using three distinct data sources, one for each aim, the summary of results and conclusions are presented in the following sections.

5.1.1 Local Health Department Epidemiology Capacity

A cross-sectional survey utilizing the Council for State and Territorial Epidemiologists (CSTE) Epidemiology Capacity Assessment (ECA) quantified the number of LHD epidemiologists who were part of the SFE program and described their general roles, epidemiologic competency, and training needs. The Texas SFE workforce is now characterized and compared to the national epidemiology workforce. The SFEs reported higher levels of epidemiology specific training compared to national estimates, particularly when considering the number of SFEs with an MPH. Overall, the SFE workforce has more formal academic epidemiology training than the national estimates. These results provide evidence that the SFE program is meeting the goals described in the Applied Epidemiologist Competencies (AECs) and

2013 CSTE report for improving competencies with basic epidemiological methods and skills (CDC & CSTE, 2008). These competencies are built into accredited MPH programs that have a concentration in epidemiology.

An estimated ratio of 0.87 epidemiologists per 100,000 population work in state health departments nationally (Hadler et al. 2015). Findings from this study indicate that among LHDs who have SFE contracts in Texas, LHDs that serve medium sized populations have 0.73 epidemiologists per 100,000 people and LHDs that serve large populations have 0.46 per 100,000, both lower than the national state health department average. However, without the SFE program, the LHDs in this study would only have 0.28 per 100,000, far below the national estimates in state health departments and below CSTE ECA reported need for increased ratios to meet the demand of epidemiologic services required. Overall, an estimated 0.47 epidemiologists per 100,000 people are in Texas LHDs. SFE positions make up approximately 40 percent of the large LHD epidemiologic workforce and 56 percent of medium sized LHD epidemiology staff. By funding this program, DSHS has increased epidemiology capacity almost two-fold from 0.28 to 0.47 epidemiologists per 100,000 people.

Tier-based competencies were assessed among SFEs as well. Similar to national estimates, as the tier-level of the epidemiologist assessed increased, the reported competency also increased. However, with the finding of this study contradict national estimates in reported training needs. SFEs reported needing more training as their tier-level and level of competency increased, as opposed to the national estimates, where training needs decreased as competency level increased. This phenomenon could be due to self-efficacy, where in this case all tier levels are interested in increasing their knowledge, especially those who report already high competency (Hoffmann 1999; Hoogveld, Paas, and Jochems 2005).

5.1.2 Public Health Surveillance

One of the goals of the SFE program was to improve infectious disease surveillance, particularly surveillance of foodborne illnesses. This study indicates that infectious disease reporting timeliness and completeness improved in both SFE and non-SFE LHDs from 2012, before the SFE program was implemented, to 2016, when it was fully functional. Both the time interval between receiving a report to starting an investigation at the LHD and the time interval from investigation start to report to the state decreased from 2012 to 2016 were reduced in both SFE and non-SFE LHDs. Improvements in median days of report processing and completeness between 2012 and 2016 were noted in this study, but the proportion and magnitude of cases that improved in these jurisdictions is noteworthy. The SFE program aided local jurisdictions who have the highest burden of disease improve timeliness even as disease counts increased. The SFE program also improved the completeness of foodborne illness reporting (although not high-consequence infectious diseases and vaccine preventable diseases), which is important since the first group of SFEs were hired specifically to focus on improving foodborne disease surveillance and investigation.

Another important element of this program is the effect of SFEs on the shared burden of disease investigation at the local and regional health department level. In Texas, Health Service Regions (HSRs) provide public health services to jurisdictions that do not have a LHD and provide support and guidance to those jurisdictions that do have a LHD. In LHDs that do not have an epidemiologist or a disease surveillance program, HSRs provide those essential public health services. The SFE program placed epidemiologists in jurisdictions where there were previously no epidemiologist or disease investigation staff. In addition to increasing capacity at

the local level, the SFE program also improved capacity of HSRs to help other jurisdications without SFEs. This effect can be seen in this data since non-SFE LHDs also saw improvements in timeliness and completeness over the study period.

5.1.3 Local Impact of Surge Epidemiologists

Through key informant interviews with local, regional, and state health department epidemiologists, information was collected about the impact SFE positions have in LHDs and on public health surveillance in Texas. All participants in local, regional, and state health departments described ways in which the SFEs have increased epidemiology capacity in Texas and agreed that epidemiology and disease surveillance programs are stronger with SFE positions. In addition to benefits of the SFE program on LHD surveillance, challenges and recommendations for improvement were also noted in the key informant interviews. Overall, five themes emerged from interviews on how SFEs impacted LHDs.

1. Increased overall epidemiology capacity in local health departments;
2. Improved timeliness of infectious disease reporting
3. Improved quality and thoroughness of disease investigations
4. Improved community stakeholder relationships with LHDs
5. Improved communications across local, regional, and state public health agencies

Evidence of improvements in overall capacity, timeliness, and quality of infectious disease investigations were not surprising findings, given that the SFE positions were designed to improve each of these. The improvements in community relationships with the addition of SFEs

was not anticipated, but can surely been seen as an important positive unintended outcome of the program. The SFE positions were consistently described as being critical to building relationships with community stakeholders, especially disease reporting entities in their respective communities. Another surprising positive impact of the SFE positions is the way they have increased communication and relationships between local, regional, and state levels in notifiable condition programs. Having an SFE in a LHD provides another point of contact for disease surveillance, especially in smaller LHDs where there was no epidemiologist before. Communication between each level of the public health system is critical for accurate and timely disease surveillance and outbreak detection.

5.2 Future Study

5.2.1 Local Level Epidemiology Capacity

In this study, 32 of the 40 filled SFE positions were assessed for epidemiology competencies across different tier-levels of experience and responsibility. Additionally, the 31 LHDs that received at least one SFE position were assessed for epidemiology capacity by counting the number of epidemiologic staff and describing the proportion of time spent doing different epidemiologic duties. These findings, although useful in estimating LHD epidemiology capacity for the entire state, only capture capacity associated with those in the SFE program, not all LHDs in Texas. To best estimate the epidemiology capacity at the local level in Texas, all LHDs should be assessed using the CSTE ECA tools. In this study, not all aspects of the ECA tools were used; rather, only the individual assessment tool, a section of the overall ECA tool from CSTE was given to each SFE. This allowed for the collection of data related to roles, duties, and competency measurements for each SFE position. To better understand the LHD

epidemiology workforce in Texas, each LHD could receive a capacity assessment and provide each individual epidemiologist within each LHD the individual assessment. Doing this would provide a clearer picture of the overall epidemiology capacity within LHDs in Texas and may provide data and information to aid in the most efficient dissemination of funds to improve epidemiology capacity.

5.2.2 Confirmation of Timeliness and Completeness in Disease Reporting Improvements

Timeliness and completeness were assessed for improvements over the implementation period of the SFE program. The findings from this study indicate improvements in timeliness and completeness from both SFE and non-SFE LHDs. To better estimate the true impact of the SFE positions on timeliness, additional electronic disease reporting data variables could be used to model changes over time. Additional variables that may better access improvements in timeliness are exact dates each SFE began disease surveillance activities and when positions were vacant, as well as how many staff in the LHD work on disease surveillance and whether that number changed with the new SFE positions. To better estimate completeness, having all investigation fields available for analysis would allow for a complete accounting of the number of additional investigation fields that are filled in and completed per case as opposed to what this study used, a binary measure of whether it was acceptable or not. Not all investigation fields are required to be deemed acceptable. Having these extra data fields would provide the opportunity to better account for changes and possible improvements to the investigation work by SFEs.

5.2.3 Confirmation of Local Impact from State-Funded Epidemiologist Positions

Qualitative data from this study provided unique local, regional, and state level perspectives and insights into how SFEs impact local epidemiology capacity. Interview participants in this study recommended a re-examination of the contract deliverables to be able to quantitatively assess and document the impact of SFEs in LHDs. One plausible way to accomplish this would be to hold focus group meetings with SFEs, LHD leadership, regional epidemiologists, and state epidemiologists to explore already existing metrics that could be used to better document SFEs work. Developing new metrics for tracking could be burdensome and deter time spent doing epidemiologic work. Holding meetings with stakeholders from each level of the public health surveillance system in Texas might provide alternative ways to use existing metrics to evaluate work by SFEs and provide new deliverables. This would provide a framework to confirm the results from the qualitative findings.

REFERENCES

Beck, Angela J., Matthew L. Boulton, and Fátima Coronado. 2014. "Enumeration of the Governmental Public Health Workforce, 2014." *American Journal of Preventive Medicine* 47 (5): S306–13. https://doi.org/10.1016/j.amepre.2014.07.018.

Beck, Angela J., Michael Meit, Megan Heffernan, and Matthew L. Boulton. 2015. "Application of a Taxonomy to Characterize the Public Health Workforce:" *Journal of Public Health Management and Practice* 21: S36–45. https://doi.org/10.1097/PHH.0000000000000295.

Bevington, Frances. 2014. "Are Preparedness Funding Cuts Impacting the Capability of Local Health Departments to Respond to Global Health Security Threats?" *NACCHO Preparedness Brief* (blog). September 30, 2014. http://nacchopreparedness.org/are-preparedness-funding-cuts-impacting-the-capability-of-local-health-departments-to-respond-to-global-health-security-threats-like-ebola/.

Burnard, P., P. Gill, K. Stewart, E. Treasure, and B. Chadwick. 2008. "Analysing and Presenting Qualitative Data." *British Dental Journal* 204 (8): 429–32. https://doi.org/10.1038/sj.bdj.2008.292.

CDC. 2017a. "Public Health Emergency Preparedness Cooperative Agreement | State and Local Readiness." 2017. https://www.cdc.gov/phpr/readiness/phep.htm.

———. 2017b. "CDC - ELC Cooperative Agreement - DPEI - NCEZID." August 3, 2017. https://www.cdc.gov/ncezid/dpei/epidemiology-laboratory-capacity.html.

CDC, and CSTE. 2008. "Applied Epidemiology Competencies: Competencies for Applied Epidemiologists in Governmental Public Health Agencies (AECs)."

http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/Workforce/CompleteAECDocument.pdf.

Center for Disease Control and Prevention. 2012. “Principles of Epidemiology in Public Health Practice, Third Edition: An Introduction to Applied Epidemiology and Biostatistics.” U.S. Department of Health and Human Services. http://www.cdc.gov/ophss/csels/dsepd/ss1978/ss1978.pdf.

———. 2016. “National Notifiable Disease Surveillance System.” 2016. https://wwwn.cdc.gov/nndss/.

———. 2017a. “Public Health System and the 10 Essential Public Health Services.” November 6, 2017. https://www.cdc.gov/stltpublichealth/publichealthservices/essentialhealthservices.html.

———. 2017b. “National Public Health Performance Standards.” November 14, 2017. https://www.cdc.gov/stltpublichealth/nphps/index.html.

Chapple-McGruder, Theresa, Jonathon P. Leider, Angela J. Beck, Brian C. Castrucci, Elizabeth Harper, Katie Sellers, Jessica Arrazola, and Jeff Engel. 2017. “Examining State Health Agency Epidemiologists and Their Training Needs.” *Annals of Epidemiology* 27 (2): 83–88. https://doi.org/10.1016/j.annepidem.2016.11.007.

Chughtai, Sarah, Katrina DeVore, Lilly Kan, and Laura C. Streichert. 2016. “Assessment of Local Health Department Utility of Syndromic Surveillance: Results of the 2015 Biosurveillance Needs Assessment Survey.” *Journal of Public Health Management and Practice: JPHMP* 22 Suppl 6, Public Health Informatics (December): S69–74. https://doi.org/10.1097/PHH.0000000000000469.

CSTE. 2012. “2013 Individual Epidemiology Capacity Assessment.” Council for State and Territorial Epidemiologists.

———. 2014. “2013 National Assessment of Epidemiology Capacity: Findings and Recommendations.” Atlanta (GA). http://www.cste2.org/2013eca/CSTEEpidemiologyCapacityAssessment2014-final2.pdf.

———. 2017. “2017 Local Epidemiology Capacity Assessment.” Council for State and Territorial Epidemiologists.

Davis, Jonathan R., Jonathan R. Davis, and Joshua Lederberg. 2000. *Epidemiological Investigation - Public Health Systems and Emerging Infections: Assessing the Capabilities of the Public and Private Sectors: Workshop Summary*. National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK100248/.

Department of State Health Services. 2017. “Texas Notifiable Conditions.” 2017. https://www.dshs.texas.gov/idcu/investigation/conditions/.

Digital Bridge. 2018. “About | Digital Bridge.” 2018. http://www.digitalbridge.us/about/.

Dixon, Brian E., P. Joseph Gibson, and Shaun J. Grannis. 2014. “Estimating Increased Electronic Laboratory Reporting Volumes for Meaningful Use: Implications for the Public Health Workforce.” *Online Journal of Public Health Informatics* 5 (3): 225. https://doi.org/10.5210/ojphi.v5i3.4939.

Dixon, Brian E., Zuoyi Zhang, Patrick T. S. Lai, Uzay Kirbiyik, Jennifer Williams, Rebecca Hills, Debra Revere, P. Joseph Gibson, and Shaun J. Grannis. 2017. “Completeness and Timeliness of Notifiable Disease Reporting: A Comparison of Laboratory and Provider Reports Submitted to a Large County Health Department.” *BMC Medical Informatics and Decision Making* 17 (June). https://doi.org/10.1186/s12911-017-0491-8.

Doyle, Timothy J., M. Kathleen Glynn, and Samuel L. Groseclose. 2002. “Completeness of Notifiable Infectious Disease Reporting in the United States: An Analytical Literature Review.” *American Journal of Epidemiology* 155 (9): 866–74. https://doi.org/10.1093/aje/155.9.866.

Enanoria, Wayne T. A., Adam W. Crawley, Jennifer C. Hunter, Jeannie Balido, and Tomas J. Aragon. 2014. “The Epidemiology and Surveillance Workforce among Local Health Departments in California: Mutual Aid and Surge Capacity for Routine and Emergency Infectious Disease Situations.” *Public Health Reports (Washington, D.C.: 1974)* 129 Suppl 4: 114–22.

Farquhar, Stephanie Ann, Edith A. Parker, Amy J. Schulz, and Barbara A. Israel. 2006. “Application of Qualitative Methods in Program Planning for Health Promotion Interventions.” *Health Promotion Practice* 7 (2): 234–42. https://doi.org/10.1177/1524839905278915.

Garza, Eric. 2016. “Local Health Department Contract Overview.” Oral Presentation presented at the Texas Department of State Health Services: Epidemiology and Laboratory Capcity Workshop, Austin, Texas, October. https://www.dshs.texas.gov/IDCU/EpiWorkshop/ELC/2016/LHD-Contract-Overview/.

Gebbie, Kristine M., and Bernard J. Turnock. 2006. “The Public Health Workforce, 2006: New Challenges.” *Health Affairs* 25 (4): 923–33. https://doi.org/10.1377/hlthaff.25.4.923.

Gensheimer, K. F., K. Fukuda, L. Brammer, N. Cox, P. A. Patriarca, and R. A. Strikas. 1999. “Preparing for Pandemic Influenza: The Need for Enhanced Surveillance.” *Emerging Infectious Diseases* 5 (2): 297–99.

Hadler, James L., Rebecca Lampkins, Jennifer Lemmings, Meredith Lichtenstein, Monica Huang, Jeffrey Engel, and Centers for Disease Control and Prevention (CDC). 2015. "Assessment of Epidemiology Capacity in State Health Departments - United States, 2013." *MMWR. Morbidity and Mortality Weekly Report* 64 (14): 394–98.

Haveman-Nies, A., S. C. Jansen, M. van Oers, and P. van 't Veer. 2011. "Epidemiology in Public Health Practice." *American Journal of Epidemiology* 174 (7): 871–72. https://doi.org/10.1093/aje/kwr255.

Healthy People 2020. 2017. "Healthy People 2020 [Internet]." Department of Health and Human Services, Office of Disease Prevention and Health Promotion. https://www.healthypeople.gov/2020/topics-objectives/topic/public-health-infrastructure/objectives.

Hoffmann, Terrence. 1999. "The Meanings of Competency." *Journal of European Industrial Training* 23 (6): 275–86. https://doi.org/10.1108/03090599910284650.

Hoogveld, Albert W. M., Fred Paas, and Wim M. G. Jochems. 2005. "Training Higher Education Teachers for Instructional Design of Competency-Based Education: Product-Oriented versus Process-Oriented Worked Examples." *Teaching and Teacher Education* 21 (3): 287–97. https://doi.org/10.1016/j.tate.2005.01.002.

Horney, Jennifer A., ed. 2017. *Disaster Epidemiology: Methods and Applications*. 1 edition. London, United Kingdom San Diego, CA, United States: Academic Press.

Horney, Jennifer A., Eric G. Carbone, Molly Lynch, Z. Joan Wang, Terrance Jones, and Dale A. Rose. 2017. "How Health Department Contextual Factors Affect Public Health Preparedness (PHP) and Perceptions of the 15 PHP Capabilities." *American Journal of Public Health* 107 (Suppl 2): S153–60. https://doi.org/10.2105/AJPH.2017.303955.

Hyde, Justeen K., and Stephen M. Shortell. 2012. “The Structure and Organization of Local and State Public Health Agencies in the U.S.: A Systematic Review.” *American Journal of Preventive Medicine* 42 (5 Suppl 1): S29-41. https://doi.org/10.1016/j.amepre.2012.01.021.

Jajosky, Ruth Ann, and Samuel L. Groseclose. 2004. “Evaluation of Reporting Timeliness of Public Health Surveillance Systems for Infectious Diseases.” *BMC Public Health* 4: 29. https://doi.org/10.1186/1471-2458-4-29.

Johnson, Matthew G., Jean Williams, Anthony Lee, and Kristy K. Bradley. 2014. “Completeness and Timeliness of Electronic vs. Conventional Laboratory Reporting for Communicable Disease Surveillance--Oklahoma, 2011.” *Public Health Reports (Washington, D.C.: 1974)* 129 (3): 261–66. https://doi.org/10.1177/003335491412900308.

Jones, D. S., Richard Dicker, Robert Fontaine, Amy Boore, Jared Omolo, Rana Ashgar, and Henry Bagett. 2017. “Building Global Epidemiology and Response Capacity with Field Epidemiology Training Programs.” *Emerging Infectious Diseases* 23 (13). https://doi.org/10.3201/eid2313.170509.

López, Augusto, and Victor M. Cáceres. 2008. “Central America Field Epidemiology Training Program (CA FETP): A Pathway to Sustainable Public Health Capacity Development.” *Human Resources for Health* 6 (1): 27. https://doi.org/10.1186/1478-4491-6-27.

Lurie, Nicole. 2004. “Local Variation In Public Health Preparedness: Lessons From California - ProQuest.” 2004. https://search.proquest.com.ezproxy.library.tamu.edu/docview/204644737?pq-origsite=gscholar.

Lurie, Nicole, Jeffrey Wasserman, and Christopher D. Nelson. 2006. “Public Health Preparedness: Evolution Or Revolution?” *Health Affairs* 25 (4): 935–45. https://doi.org/10.1377/hlthaff.25.4.935.

MacDowell, M, M Glasser, M Fitts, K Nielsen, and M Hunsaker. 2010. “A National View of Rural Health Workforce Issues in the USA.” *Rural and Remote Health* 10 (3): 1531.

Moehrle, Carol. 2008. “Who Conducts Epidemiology Activities in Local Public Health Departments?” *Public Health Reports (Washington, D.C.: 1974)* 123 Suppl 1: 6–7. https://doi.org/10.1177/00333549081230S103.

Moser, Michael, Kalpana Ramiah, and Michel Ibrahim. 2008. “Epidemiology Core Competencies for Master of Public Health Students.” *Public Health Reports* 123 (Suppl 1): 59–66.

NACCHO. 2014. “Local Health Department Budget Cuts and Job Losses: Findings from the 2014 Forces of Change Survey.” National Association of County and City Health Officials. http://archived.naccho.org/topics/research/forcesofchange/upload/Budget-Cuts.pdf.

———. 2016a. “NACCHO Profile Study.” 2016. http://nacchoprofilestudy.org/.

———. 2016b. “Workforce Recruitment | NACCHO Profile Study.” 2016. http://nacchoprofilestudy.org/forces-of-change/chapter-4/.

Nguyen, Trang Quyen, Lorna Thorpe, Hadi A. Makki, and Farzad Mostashari. 2007. “Benefits and Barriers to Electronic Laboratory Results Reporting for Notifiable Diseases: The New York City Department of Health and Mental Hygiene Experience.” *American Journal of Public Health* 97 (Suppl 1): S142–45. https://doi.org/10.2105/AJPH.2006.098996.

O'Keefe, Kaitlin A., Shira C. Shafir, and Kimberley I. Shoaf. 2013. "Local Health Department Epidemiologic Capacity: A Stratified Cross-Sectional Assessment Describing the Quantity, Education, Training, and Perceived Competencies of Epidemiologic Staff." *Frontiers in Public Health* 1: 64. https://doi.org/10.3389/fpubh.2013.00064.

Overhage, J. Marc, Shaun Grannis, and Clement J. McDonald. 2008. "A Comparison of the Completeness and Timeliness of Automated Electronic Laboratory Reporting and Spontaneous Reporting of Notifiable Conditions." *American Journal of Public Health* 98 (2): 344–50. https://doi.org/10.2105/AJPH.2006.092700.

Painter, Ian, Debra Revere, P. Joseph Gibson, and Janet Baseman. 2017. "Leveraging Public Health's Participation in a Health Information Exchange to Improve Communicable Disease Reporting." *Online Journal of Public Health Informatics* 9 (2): e186. https://doi.org/10.5210/ojphi.v9i2.8001.

Porta, Miquel, ed. 2008. *A Dictionary of Epidemiology*. Fifth Edition. Oxford; New York: Oxford University Press.

"PRESS CONFERENCE BY UN SYSTEM SENIOR COORDINATOR FOR AVIAN, HUMAN INFLUENZA | Meetings Coverage and Press Releases." 2005. September 29, 2005. http://www.un.org/press/en/2005/050929_Nabarro.doc.htm.

Rutz, H. J., Sb Wee, and K. A. Feldman. 2016. "Characterizing Lyme Disease Surveillance in an Endemic State." *Zoonoses and Public Health*, July. https://doi.org/10.1111/zph.12275.

Samoff, Erika, Mary T. Fangman, Aaron T. Fleischauer, Anna E. Waller, and Pia D. M. Macdonald. 2013. "Improvements in Timeliness Resulting from Implementation of Electronic Laboratory Reporting and an Electronic Disease Surveillance System." *Public*

Health Reports (Washington, D.C.: 1974) 128 (5): 393–98. https://doi.org/10.1177/003335491312800510.

Segal, Laura, and Alejandra Martin. 2017. "A Funding Crisis for Public Health and Safety: State-by-State Public Health Funding and Key Health Facts, 2017 - Trust for America's Health." Trust for America's Health. http://healthyamericans.org/report/136/.

Shah, Gulzar H., Jiali Ye, Carolyn J. Leep, and Jonathon P. Leider. 2016. "Local Health Departments' Approaches to Deal With Recession: What Strategies Are Used to Minimize the Negative Impact on Public Health Services to Community?" *Journal of Public Health Management and Practice* 22 (6): 537–41. https://doi.org/10.1097/PHH.0000000000000260.

Silk, Benjamin J., and Ruth L. Berkelman. 2005. "A Review of Strategies for Enhancing the Completeness of Notifiable Disease Reporting." *Journal of Public Health Management and Practice: JPHMP* 11 (3): 191–200.

Stier, Daniel D., and Richard A. Goodman. 2007. "Mutual Aid Agreements: Essential Legal Tools for Public Health Preparedness and Response." *American Journal of Public Health* 97 Suppl 1 (April): S62-68. https://doi.org/10.2105/AJPH.2006.101626.

Texas Administrative Code. 2018. "TAC Title 25 Chapter 97." Control of Communicable Diseases. 2018. http://texreg.sos.state.tx.us/public/readtac$ext.ViewTAC?tac_view=4&ti=25&pt=1&ch=97.

Texas Department of State Health Services. 2016. "Texas Reported Cases: 2016." 2016 Texas Annual Report. 2016. https://www.dshs.texas.gov/IDCU/data/annual/2016-Texas-Annual-Report/2016.pdf.

Tong, Allison, Peter Sainsbury, and Jonathan Craig. 2007. “Consolidated Criteria for Reporting Qualitative Research (COREQ): A 32-Item Checklist for Interviews and Focus Groups.” *International Journal for Quality in Health Care* 19 (6): 349–57. https://doi.org/10.1093/intqhc/mzm042.

U.S. Census Bureau. 2016. “U.S. Census Bureau QuickFacts Selected: Brazos County, Texas.” 2016. https://www.census.gov/quickfacts/fact/table/brazoscountytexas/PST045216.

Vogt, Richard L., Robyn Spittle, Alicia Cronquist, and Jennifer L. Patnaik. 2006. “Evaluation of the Timeliness and Completeness of a Web-Based Notifiable Disease Reporting System by a Local Health Department.” *Journal of Public Health Management and Practice: JPHMP* 12 (6): 540–44.

Witte, Kathleen. 2016. “Hundreds of Brazos Co. Residents Sick with Flu or Flu Symptoms.” 2016. http://www.kbtx.com/content/news/Hundreds-of-Brazos-Co-residents-sick-with-flu-or-flu-symptoms-391807221.html.

World Health Organization. 2008. *International Health Regulations (2005)*. Second Edition. World Health Organization.

APPENDIX A

EPIDEMIOLOGY CAPACITY SURVEY

Q1.1 You are invited to take part in a research study being conducted by **Kahler Stone**, a researcher from Texas A&M University School of Public Health. If you decide to take part in the study, you will be asked electronically in this online form if you want to participate in the study. If you decide you do not want to participate, there will be no penalty to you, and you will not lose any benefits you normally would have. The following information is provided for you to be informed about this study and to make an informed decision to participate. **Why Is This Study Being Done?** The purpose of this study is to gather information on the capacity, usefulness, and impact of new epidemiologist positions in local health departments and to describe the epidemiological workforce in Texas.

Why Am I Being Asked To Be In This Study? You are being asked to be in this study because you are a state-funded epidemiologist or a manager in a local health department who is familiar with the state-funded epidemiologist positions within your health department.

How Many People Will Be Asked To Be In This Study? No more than 50 people will be invited to participate in online surveys for this study.

What Are the Alternatives to being in this study? None, the alternative to being in the study is not to participate.

What Will I Be Asked To Do In This Study? You will be asked to participate in a 10 minute online questionnaire.

Will Photos, Video or Audio Recordings Be Made Of Me during the Study? No.

Are There Any Risks To Me? The things that you will be doing are no greater than risks than you would come across in everyday life. Although the researchers have tried to avoid risks, you may feel that some questions that are asked on the questionnaire or in the interview of you will be stressful or upsetting. You do not have to answer anything you do not want to.

Will There Be Any Costs To Me? Aside from your time, there are no costs.

Will I Be Paid To Be In This Study? You will not be paid for being in this study.

Will Information from This Study Be Kept Private? The records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only the principles investigators of this study will have access to the records. Information about you will be kept confidential to the extent permitted or required by law. People who have access to your information include the Principal Investigator and research study personnel. Representatives of regulatory agencies such

as the Office of Human Research Protections (OHRP) and entities such as the Texas A&M University Human Research Protection Program may access your records to make sure the study is being run correctly and that information is collected properly.

Who may I Contact for More Information? You may contact the Principal Investigator Advisor, Jennifer Horney, to tell her about a concern or complaint about this research at (979) 436-9391 or horney@sph.tamhsc.edu. For questions about your rights as a research participant, to provide input regarding research, or if you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office by phone at 1-979-458-4067, toll free at 1-855-795-8636, or by email at irb@tamu.edu.

What if I Change My Mind About Participating? This research is voluntary and you have the choice whether or not to be in this research study. You may decide to not begin or to stop participating at any time. If you choose not to be in this study or stop being in the study, there will be no effect on your relationship with Texas A&M University.

This survey aims to assess the individual epidemiology capacity from the perspectives of local health department staff members. Your responses will be kept confidential and shared online in de-identified, aggregate form.

Your participation in this questionnaire is completely voluntary and you may stop and exit the survey at any time. Do you wish to continue and participate in this study?

- ○ Yes, I would love to participate. (1)
- ○ No, I would prefer not to participate. (2)

Skip To: End of Survey If Q1.1 = No, I would prefer not to participate.

End of Block: Consent

Start of Block: Assessment Instructions

Q2.1 Please keep the following in mind as you navigate through the assessment: It is possible to move back and forth through the assessment. A limited number of questions will "request a response" before allowing you to move forward.

Please complete the entire assessment by ***COB Wednesday, January 10, 2018***.

For questions, contact **Kahler Stone**, Graduate Researcher at Texas A&M School of Public Health, at kstone@sph.tamhsc.edu.

Let's get started!

End of Block: Assessment Instructions

Start of Block: SFE Section

Q3.1 What is your current age in years?

_____

Q3.2 Which of the following best describes your race/ethnicity?

- ○ American Indian or Alaska Native (1)
- ○ Asian (2)
- ○ Black or African American (3)
- ○ Native Hawaiian or Other Pacific Islander (4)
- ○ White (5)
- ○ Hispanic or Latino (6)
- ○ Mixed (7)
- ○ Prefer not to answer (8)

Q3.3 Are you?

- ○ Male (1)
- ○ Female (2)
- ○ Prefer not to answer (3)

Q3.4 Which Local Health Department/District do you work in?

_____

Q3.5 In what program area(s) do you work and spend time? Please indicate the percentage of time to the nearest 10% (Total must sum to 100):

Bioterrorism/Emergency Response : _____ (1)

Environmental Health : _____ (2)

Injury : _____ (3)

Occupational Health : _____ (4)

Substance Abuse : _____ (5)

Chronic Disease : _____ (6)

Infectious Disease : _____ (7)

Maternal and Child Health : _____ (8)

Oral Health : _____ (9)

Mental Health : _____ (10)

Other - Please describe : _____ (11)

Total : _____

Q3.6 When working in the infectious disease program, please indicate the percentage of time you spend working on different elements to the nearest 10% (Total must sum to 100):

Case investigations : _____ (1)

Outbreak control : _____ (2)

NEDSS Based System (NBS) data entry : _____ (3)

Public health communication (report writing, educational material preparation, presentations, etc.) : _____ (4)

Other - Please describe : _____ (5)

Total : _____

Q3.7 What is the highest degree you have obtained?

- ○ MD, DO (1)
- ○ DDS, DMD (2)
- ○ DVM, VMD (3)
- ○ PhD, DrPH, other Doctoral (4)
- ○ MPH, MSPH, other master (5)
- ○ RN, any other nursing (6)
- ○ BA, BS, BSN, other bachelor (7)
- ○ Associate/No post high school degree (8)

Q3.8 What is the highest level of epidemiology training you have received?

- ○ 1. PhD, DrPH, other doctoral degree in Epidemiology (1)
- ○ 2. Professional background (e.g. MD) with a dual degree in Epidemiology (2)
- ○ 3. MPH, MSPH, other master degree in Epidemiology (3)
- ○ 4. BA, BS, other bachelor degree in Epidemiology (4)
- ○ 5. Completed formal training program in Epidemiology (e.g. EIS) (5)
- ○ 6. Completed some coursework in Epidemiology (6)
- ○ 7. Received on the job training in Epidemiology (7)
- ○ 8. No formal training in Epidemiology (i.e. epidemiologist does not fit into any of the above categories) (8)

Q3.9 How many years of experience as an epidemiologist do you have?

- ○ (1)
- ○ 2-4 (2)
- ○ 5-9 (3)
- ○ 10-14 (4)
- ○ 15-19 (5)
- ○ 20-24 (6)
- ○ 25+ (7)

Q3.10 In how many years (best estimate) do you plan to retire or change careers out of epidemiology?

- ○ (1)
- ○ 1-2 (2)
- ○ 3-4 (3)
- ○ 5-9 (4)
- ○ 10+ (5)

Q3.11 How many epidemiologists work at your local health department including yourself?

_____

Q3.12 During vacation leave, emergencies, outbreaks, or situations that require surge capacity outside of your routine duties, who is responsible for covering those tasks when you are involved in a response or on leave?

_____

_____

_____

_____

_____

Q3.13 Before the addition of the SFE position, do you know what position(s) in the LHD investigated and reported notifiable conditions? If yes, please state.

_____

_____

_____

_____

_____

Q3.14 Please select the Tier level that best fits your experience and position using the definitions below (Use this CSTE AEC Summaries as a reference):

- ○ Tier 1: Entry-level or basic epidemiologist (1)
- ○ Tier 2: Mid-level epidemiologist (2)
- ○ Tier 3a: Senior-level epidemiologist - Supervisor and/or manager (3)
- ○ Tier 3b: Senior scientist or subject area expert (4)

End of Block: SFE Section

Start of Block: Tier 1

Q4.1 **Tier 1 Epidemiologist:** Please use this form to indicate your level of understanding and ability to perform each of the following competencies. Again, this information is confidential

and will be shared in aggregate form only. Please indicate the appropriate level of competency for each skill domain listed below and the amount of additional training needed.

Epidemiology Competency*: the competency states below are abbreviated from the comprehensive competency statements in the Applied Epidemiology Competencies document compiled by County, State, and Territorial Epidemiologists (CSTE).*

Competency:

1 = Minimal or none: You have no training or experience

2 = Basic: You have received basic training

3 = Intermediate: You have had repeated sucessful experiences

4 = Advanced: You can perform the actions associated with this skill without assistance

5 = Expert: You are known inside or outside the organization as an expert

Training:

1-5 scale, where 1 = less training needed, 5 = more training needed

---

Q4.2 1A-1. Recognize the existence of a public health problem

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q4.3 1A-3. Collaborate with others inside and outside the agency to identify the problem

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.4 1B - 2. Identify surveillance data needs

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.5 1B - 3,4. Implement new or revise existing surveillance system and report key surveillance findings

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.6 1B - 5. Support evaluation of surveillance systems

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.7 1C - 4,5. Assist in design of an investigation, including hypothesis generation

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)

Q4.8 1D - 1. Follow ethics guidelines and principles when planning studies; conducting research, and collecting, disseminating, and using data

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.9 1D - 4,5. Describe human subjects research, and apply Institutional Review Board (IRB) processes, as directed

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.10 1,D-7. Apply knowledge of privacy laws to protect confidentiality, including Health Insurance Portability and Accountability Act (HIPAA) and applicable state and local privacy laws

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.11 1,E-2. Maintain databases

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.12 1,F-1,2. Use analysis plans and analyze data

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.13 1,G-3. Identify key findings from the study

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.14 1,H-1. Define cultural/social/political framework for recommended interventions

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.15 1,I Assist in evaluation of programs

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.16 2, A. Know how causes of disease affect epidemiologic practice

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.17 2, A-2. Apply understanding of human and environmental biology and behavioral sciences and principles to determine potential biological mechanisms of disease.

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.18 2, B. Identify the role of laboratory resources in epidemiologic activities

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.19 2, C. Use identified informatics tools in support of epidemiologic practice

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.20 3, A. Prepare written and oral reports and presentations that communicate necessary information to agency staff

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.21 3, B. Recognize the basic principles of risk communication

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.22 3, C-1. Demonstrate ability to listen effectively when epidemiologic findings are presented or discussed

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.23 3, D. Use effective communication technologies

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.24 4. Provide epidemiologic input for community planning processes

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.25 5. Practice culturally sensitive epidemiologic activities

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.26 6. Apply appropriate fiscal and administrative guidelines to epidemiology practice

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.27 7, B. Support the organization's vision in all programs and activities

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.28 7, D. Promote ethical conduct in epidemiologic practice

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.29 7, E. Practice professional development

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

Q4.30 8, A-1. Describe how policy decisions are made within the agency

Competency (1)	Minimal or none (1)	Basic (2)	Intermediate (3)	Advanced (4)	Expert (5)
Additional Training Needed (2)	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)

End of Block: Tier 1

Start of Block: Tier 2

Q5.1 **Tier 2 Epidemiologist:** Please use this form to indicate your level of understanding and ability to perform each of the following competencies. Again, this information is confidential and will be shared in aggregate form only. Please indicate the appropriate level of competency for each skill domain listed below and the amount of additional training needed.

Epidemiology Competency*: the competency states below are abbreviated from the comprehensive competency statements in the Applied Epidemiology Competencies document compiled by County, State, and Territorial Epidemiologists (CSTE).*

Competency:

1 = Minimal or none: You have no training or experience

2 = Basic: You have received basic training

3 = Intermediate: You have had repeated sucessful experiences

4 = Advanced: You can perform the actions associated with this skill without assistance

5 = Expert: You are known inside or outside the organization as an expert

Training:

1-5 scale, where 1 = less training needed, 5 = more training needed

---

Q5.2 **1A-1. Use critical thinking to determine whether a public health problem exists**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.3 **1,A-2. Articulate the need for further investigation or other public health action from literature review and assessment of current data**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.4 **1,A-3. Collaborate with others inside and outside the agency to identify the problem and form recommendations**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.5 **1,B-1,2. Design surveillance for a public health issue and identify surveillance data needs**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.6 **1,B-3,4. Implement new or revise existing surveillance system and identify key surveillance findings**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.7 **1,B-5. Conduct evaluation of surveillance systems**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.8 **1,C-1,2. Conduct a community health assessment and recommend priorities of potential public health problems to be addressed.**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.9 **1,C-4,5. Assist in design of an investigation, including hypothesis generation**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.10 **1,D-1. Follow ethics guidelines and principles when planning studies; conducting research; and collecting, disseminating, and using data.**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.11 **1,D-3. Describe differences between public health practice and public health research**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.12 **1,D-4,5. Describe human subjects research, and apply Institutional Review Board (IRB) processes, as necessary**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.13 **1,D-7. Apply knowledge of privacy laws to protect confidentiality, including Health Insurance Portability and Accountability Act (HIPPA) and applicable state and local privacy laws**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.14 **1,E-1,2. Define database requirements, and manage a database**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.15 **1,F-1,2. Create analysis plans and conduct analysis of data**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.16 **1,G-1. Apply knowledge of epidemiologic principles and methods to make recommendations regarding the validity of epidemiologic data**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.17 **1,G-2. Assess the need for special analyses**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.18 **1, H-1. Establish cultural/social/political framework for recommendations or interventions**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.19 **1,H-2. Use scientific evidence in preparing recommendations for action or interventions**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.20 **1,I-1. Assist in the development of measurable and relevant goals and objectives**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.21 **1,I-2. Assist in the development of program logic models and theories of action**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.22 **2,A. Use current knowledge of causes of disease to guide epidemiologic practice**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.23 **2,A-2. Apply understanding of human and environmental biology and behavioral sciences and principles to determine potential biological mechanisms of disease**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.24 **2,B** **Use laboratory resources to support epidemiologic activities**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.25 **3,A-3. Communicate epidemiologic information through giving oral presentations or contributing to the development of written documents to nonprofessional audiences**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.26 **3,B. Demonstrate the basic principles of risk communication**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.27 **3,D. Use effective communication technologies**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.28 **4. Provide epidemiologic input for community planning processes**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.29 **5. Practice culturally sensitive epidemiologic activities**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.30 **6. Apply appropriate fiscal administrative guidelines to epidemiology practice**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.31 **7,D. Promote ethical conduct in epidemiologic practice**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q5.32 **7&8. Use leadership and systems thinking in epidemiologic planning and policy development**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

End of Block: Tier 2

Start of Block: Tier 3a

Q6.1 **Tier 3a Epidemiologist:** Please use this form to indicate your level of understanding and ability to perform each of the following competencies. Again, this information is confidential and will be shared in aggregate form only. Please indicate the appropriate level of competency for each skill domain listed below and the amount of additional training needed.

Epidemiology Competency*: the competency states below are abbreviated from the comprehensive competency statements in the Applied Epidemiology Competencies document compiled by County, State, and Territorial Epidemiologists (CSTE).*

Competency:

1 = Minimal or none: You have no training or experience

2 = Basic: You have received basic training

3 = Intermediate: You have had repeated sucessful experiences

4 = Advanced: You can perform the actions associated with this skill without assistance

5 = Expert: You are known inside or outside the organization as an expert

Training:

1-5 scale, where 1 = less training needed, 5 = more training needed

Q6.2 **1,A. Ensure identification of public health problems pertinent to the population**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.3 **1,B. Oversee surveillance activities**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.4 **1,C. Ensure investigation of acute and chronic conditions or other adverse outcomes in the population**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.5 **1,D. Ensure study design and data collection, dissemination, and of use ethical and legal principles**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.6 **1,E. Ensure management of data from surveillance, investigations, or other sources**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.7 **1,F. Evaluate analysis of data from an epidemiologic investigation or study**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.8 **1,G. Evaluate conclusions and interpretations from investigations**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.9 **1,H. Determine evidence-based interventions and control measures in response to epidemiologic findings**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.10 **1,I. Ensure evaluation of programs**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.11 **2. Use basic public health sciences in epidemiologic practice**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.12 **2,A-2. Ensure the application of understanding of human and environmental biology and behavioral sciences and principles to determine biological mechanisms of disease**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.13 **2,B. Ensure the use of laboratory resources to support epidemiologic activities**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.14 **2,C. Ensure application of principles of informatics, including data collection, processing, and analysis, in support of epidemiologic practice**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.15 **2,D. Develop and manage information systems to improve effectiveness of surveillance, investigation, and other epidemiologic practices**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.16 **3,A&B. Ensure preparation of written and oral reports and presentations to professional and nonprofessional audiences and ensure basic principles of risk communications are followed**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.17 **3,C. Model interpersonal skills in communication with agency personnel, colleagues, and the public**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.18 **3,D-2. Enforce policies that address security, privacy, and legal considerations when communicating epidemiologic information**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.19 **4. Lead community public health planning processes**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.20 **5. Practice culturally sensitive epidemiologic activities**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.21 **6,A. Create operational and financial plans for future epidemiologic activities**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.22 **6,B. Formulate a fiscally sound budget that will support the activities defined in the operational plan and is consistent with the financial rules of the agency**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.23 **6,C. Oversee implementation of operational and financial plans**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.24 **6,D. Develop requests for extramural funding to support additional epidemiologic activities and special projects**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.25 **6,E. Use management skills**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.26 **6,F. Promote collaborations, strong partnerships, and team-building to accomplish epidemiology program objectives**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.27 **7,A. Promote the epidemiologic perspectives in the agency strategic planning process**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.28 **7,B. Lead the creation of the epidemiologic program's vision in the context of the agency's plan**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.29 **7,C. Use performance measures to evaluate and improve program effectiveness**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.30 **7,D. Promote ethical conduct in epidemiology practice**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.31 **7,E. Ensure professional development of epidemiology workforce**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.32 **7,F. Lead epidemiology unit in preparing for emergency response**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q6.33 **8,A. Bring epidemiologic perspectives in the development and analysis of public health policies**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

End of Block: Tier 3a

Start of Block: Tier 3b

Q7.1 **Tier 3b Epidemiologist:** Please use this form to indicate your level of understanding and ability to perform each of the following competencies. Again, this information is confidential and will be shared in aggregate form only. Please indicate the appropriate level of competency

for each skill domain listed below and the amount of additional training needed.

Epidemiology Competency*: the competency states below are abbreviated from the comprehensive competency statements in the Applied Epidemiology Competencies document compiled by County, State, and Territorial Epidemiologists (CSTE).*

Competency:

1 = Minimal or none: You have no training or experience

2 = Basic: You have received basic training

3 = Intermediate: You have had repeated sucessful experiences

4 = Advanced: You can perform the actions associated with this skill without assistance

5 = Expert: You are known inside or outside the organization as an expert

Training:

1-5 scale, where 1 = less training needed, 5 = more training needed

Q7.2 **1,A. Validate identification of public health problems pertinent to the population**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.3 **1,B. Organize surveillance**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.4 **1,C. Design investigation of acute and chronic conditions or other adverse outcomes in the population**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.5 **1,D. Synthesize principles of good ethical/legal practice for application to study design and data collection, dissemination, and use**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.6 **1,E. Manage data from surveillance, investigations, or other sources**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.7 **1,F. Evaluate data from an epidemiologic investigation or study**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.8 **1,G. Evaluate results of data analysis and interpret conclusions**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.9 **1,H. Formulate new interventions on the basis of evidence, when available, and control measures in response to epidemiologic findings**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.10 **1,I. Evaluate programs**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.11 **2. Use basic public health sciences in epidemiologic practice**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.12 **2,A-2. Ensure the application of understanding of human and environmental biology and behavioral sciences and principles to determine biological mechanisms of disease**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.13 **2,B. Develop processes for using laboratory resources to support epidemiologic activities**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.14 **2,C. Apply principles of informatics, including data collection, processing, and analysis, in support of epidemiologic practice**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.15 **3,A. Organize preparation of written and oral presentations that communicate necessary information to professional and nonprofessional audiences, policymakers, and the general public**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.16 **3,C. Model interpersonal skills in communication with agency personnel, colleagues, and the public**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.17 **3,D-2. Develop as-needed policies that address security, privacy, and legal considerations when communicating epidemiologic information**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.18 **4. Lead community public health planning processes**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.19 **5. Practice culturally sensitive epidemiologic activities**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.20 **6,A. Conduct epidemiologic activities within the financial and operational plan of the agency**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.21 **6,B. Describe financial and budgetary processes of the agency**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.22 **6,C. Implement operational and financial plans for assigned projects**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.23 **6,D. Prepare proposals for extramural funding for review and input from managers**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.24 **6,F. Use skills that foster collaborations, strong partnerships, and team-building to accomplish epidemiology program objectives**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.25 **7,A. Promote the epidemiologic perspectives in the agency strategic planning process**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.26 **7,B. Promote the organization's vision in all epidemiologic program activities**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.27 **7,C. Use performance measures to evaluate and improve program effectiveness**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.28 **7,D. Promote ethical conduct in epidemiology practice**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.29 **7,E. Promote epidemiology workforce development**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.30 **7,F. Prepare for an emergency response**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

Q7.31 **8,A. Bring epidemiologic perspectives in the development and analysis of public health policies**

Competency (1)	○ Minimal or none (1)	○ Basic (2)	○ Intermediate (3)	○ Advanced (4)	○ Expert (5)
Additional Training Needed (2)	○ 1 (1)	○ 2 (2)	○ 3 (3)	○ 4 (4)	○ 5 (5)

End of Block: Tier 3b

APPENDIX B

SURGE CAPACITY STUDY INTERVIEW QUESTIONNAIRE

Epi Surge Capacity Study – Interview Questionnaire

Hello, my name is Kahler Stone. Thank you for agreeing to talk with me today. The purpose of this interview is to obtain information about state funded epidemiolgoists in your local health department and how it relates to epidemiologic capacity. Do you understand the purpose of this interview?

Your participation in this interview is voluntary; you may stop the interview at any time. To ensure that your thoughts and opinions are accurately captured, we will be taking notes and tape recording our discussion. You may request at any time that we stop taking notes or turn off the tape recorder. We will not use your name in any results of the study, and will keep your individual comments confidential and stored separately from the summary statements and the final report. Do I have your permission to tape record and take notes about your responses to the interview questions? Do you have any questions before we get started?

Subject agree to participate in the study and interview and allow for tape recording?

____YES _____NO

Subject agree to participate in the study and interview but NOT tape recording?

____YES _____NO

For LHD epidemiology managers or public health managers:

1. Describe your involvement with and/or role within your epidemiology department or program.

2. Describe your involvement and work with your LHDs SFE position.

3. How long have you been in your current position/role?

4. How long have you been at the local health department?

5. Since adding the SFE position(s), has the number of epidemiologist positions increased within your health department? In other words, has the SFE increased your number of epidemiologists??

6. How has the addition of your SFE position impacted public health surveillance at your health department?

7. Which programs in your health department does the SFE work with and support?

8. What are the benefits, if any, of adding your SFE position?

9. What, if any, are the strengths of your SFE position?

10. What, if any, are the difficulties of adding your SFE position?

11. What, if any, are the weaknesses of your SFE position?

12. What tangible outcomes have occurred in relation to your SFE? Please discuss. (increased reporting timelines, more investigations being completed, improvements in quality of surveillance records, etc.)

13. Has your SFE assisted other LHDs or the region/state during their tenure through mutual aid or other forms of epi aid? If so, please describe.

14. If not, and the Texas Department of State Health Services (DSHS) asked for the SFE to provide epidemiology surge capacity to surrounding jurisdictions in the event of a major statewide or regional outbreak or disaster, as per the contract, what steps do you envision would have to occur so that your SFE could assists?

15. When the SFE is on vacation, involved with emergencies, outbreaks, or situations that require surge capacity outside of their routine duties, is back up provided to cover the SFE's tasks? And if so, what position(s) would provide that back up coverage?

16. Anything else regarding the SFE program or your SFE in your LHD?

For regional epidemiology managers or epidemiologist staff:

1. Describe your involvement with and/or role within your epidemiology department or program.

2. Describe your involvement and work with LHD SFEs in your region.

3. How long have you been in your current position/role?

4. How long have you been at the regional health department?

5. Since adding the SFE positions in your region, has the number of epidemiologist positions increased within the region?

6. How has the addition of SFE positions impacted public health surveillance within your region?

7. Which programs in your region do the SFE positions work with and support? (foodborne, VPD, zoonosis, etc.)

8. What are the benefits, if any, of adding SFE positions to the region?

9. What, if any, are the strengths of the SFE positions in the region?

10. What, if any, are/were the difficulties of adding SFE positions to within region?

11. What, if any, are the weaknesses of the SFE positions in within the region?

12. What tangible outcomes have occurred in relation to the SFE positions within the region? Please discuss. (increased reporting timelines, more investigations being completed, improvements in quality of surveillance records, etc.)

13. Has SFE assisted other LHDs or the region/state during their tenure through mutual aid or other forms of epi aid? If so, please describe.

14. Anything else regarding the SFE program or SFE positions within the region

For EAIDB epidemiology managers or epidemiologist staff:

1. Describe your involvement with and/or role within your department or program.

2. Describe your involvement and work with LHD SFEs in your program.

3. How long have you been in your current position/role?

4. How long have you been at the state health department?

5. Do SFE positions work with and support surveillance activities in your program area?

6. How has the addition of SFE positions impacted public health surveillance within your program?

7. What are the benefits, if any, of adding SFE positions in LHDs that work in your program area?

8. What, if any, are the strengths of the SFE positions?

9. What, if any, are/were the difficulties of adding SFE positions?
10. What, if any, are the weaknesses of the SFE positions?

11. What tangible outcomes have occurred in relation to the SFE positions within your program area? Please discuss. (increased reporting timelines, more investigations being completed, improvements in quality of surveillance records, etc.)

12. Has SFE assisted other LHDs or the region/state during their tenure through mutual aid or other forms of epi aid? If so, please describe.

13. Anything else regarding the SFE program or SFE positions?