EPIDEMIOLOGY
CAPACITY ASSESSMENT

2021 Epidemiology Capacity Assessment Report

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The Council of State and Territorial Epidemiologists (CSTE) completed this assessment with cooperation from state and territorial health departments. CSTE acknowledges the contributions of Elizabeth Daly, Robert Harrison, Erica Smith, Sherri Davidson, Sharon Watkins, Kenneth Komatsu, Catherine Brown, Joseph McLaughlin, Tracy Miller and Laura Williamson to inform the development and fielding of the 2021 Epidemiology Capacity Assessment. Contributing CSTE National Office Staff members are Sarah Auer, Jessica Arrazola, Amanda Masters, Jennifer Lemmings, Janet Hamilton, Jeffrey Engel, Dhara Shah, Becky Lampkins, Mia Israel, Matt Cone and Matt Masiello.

For more than seven decades, CSTE and the US Centers for Disease Control and Prevention (CDC) have worked together to improve the public's health by supporting the efforts of epidemiologists working at the state, territorial, and local levels by promoting the effective use of epidemiologic data to guide public health practice and improve health. CSTE and its members represent two basic components of public health – epidemiology and surveillance. This publication was supported in part by the CDC cooperative agreement number 1 NU38OT000297-02. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of CDC.

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EXECUTIVE SUMMARY

Executive Summary

Background

Since 2001, the Council of State and Territorial Epidemiologists (CSTE) has periodically assessed the numeric and functional capacity of epidemiology programs in the United States and its territories. Seven Epidemiology Capacity Assessments (ECAs) have been undertaken: 2001, 2004, 2006, 2009, 2013, 2017, and 2021. This report does not include numbers for Big Cities Health Coalition members, local, or tribal health department capacity.

These assessments serve a wide range of stakeholders, including state and national public health leaders and schools and programs of public health. Workforce data, for example, inform government planning for the provision of public health services with respect to staffing, salary levels, and relative state and federal funding levels. For schools and programs of public health, which train much of the epidemiology workforce, the ECA provides information about the skills and program area expertise needed to respond to public health priorities, such as data analytics, genomics, and mental health.

The COVID-19 pandemic required an immediate response from state health departments and challenged the workforce's ability to track the spread of COVID-19 and disease outcomes and respond accordingly. The 2021 ECA included questions to measure the pandemic's effects on epidemiologic capacity and staffing within state, District of Columbia (DC), and territorial health departments. Although the pandemic might have impacted results for the 2021 ECA, the added questions were intended to enable the reader to incorporate the pandemic's effects particularly on trending analyses from previous ECAs.

Public health has entered a period of rapid change as enhanced funding opportunities arise and the landscape of the field transforms. Furthermore, addressing emerging public health topics, such as genomics and informatics, requires specialized knowledge and skills. Increased understanding of the current status of the workforce and the perceived challenges facing health departments is essential to identify what can be done to adjust to the changing landscape.

One of the most important recent changes has been a move toward updating the Ten Essential Public Health Services (EPHS) to reflect current practices. The EPHS are the national standard for public health activities. CDC released an updated version of the EPHS in September 2020. Three of the EPHS relate directly to epidemiology: EPHS 1 (monitoring health status), EPHS 2 (investigating health problems and hazards), and EPHS 9 (research and evaluation). Previous ECAs used EPHS 1 (monitor), 2 (assess), 9 (research), and 10 (evaluation). The updated EPHS combines research and evaluation into EPHS 9. Therefore, to ensure continuity and the ability to measure trends, the 2021 ECA measures EPHS 1, 2, and 9.

The 2021 ECA was launched in January 2021 and completed in April 2021. Building on recommendations from the 2017 ECA, the 2021 ECA was designed to achieve 5 goals:

1. Enumerate and describe the applied epidemiology workforce;
2. Describe the training needs of the applied epidemiology workforce;
3. Describe the funding supporting the applied epidemiology workforce;
4. Describe the level of epidemiology capacity in state and DC health departments; and
5. Assess the impact of the COVID-19 pandemic on epidemiologic capacity and staffing.

Methods

The assessment was developed in an online format using Qualtrics® software and was piloted in October 2020 in 3 states. After revision, the assessment was distributed to the State Epidemiologist in the remaining states, DC, and the 8 US territories.

Most of the questions were short-answer, multiple choice, scales, or matrix tables. Wherever possible, questions, response categories, and definitions remained identical to previous ECA questions to ensure comparability with previous data. The 2021 ECA added generalist and COVID-19 response as program areas. The 2021 ECA included epidemiologists employed by the state, DC, and territorial health departments; epidemiologists working at the state level who are federal assignees, contract employees, contractors from schools of public health to work at the health department, fellows, or state employees assigned to work at the local or regional level. For the purpose of this assessment, jurisdictions were asked to count only COVID-19 response staff serving as an epidemiologist or performing functions consistent with those of an epidemiologist. Contact tracers or case investigator staff were not included. The 2021 ECA also included 4 open-ended qualitative questions.

Quantitative data were analyzed in Excel 2008 and SAS 9.4 statistical software. For most questions, results were tabulated separately for the 50 states and DC and for the 4 participating territories (American Samoa, Guam, Northern Mariana Islands, and Puerto Rico). The territories were analyzed separately because they differed substantially from the 50 states and DC in their organization of epidemiology services, hiring practices, and salary scales. For some analyses, data were stratified by population size: small (<2 million; 14 states and DC), medium (2–6 million; 17 states), or large (>6 million; 19 states) and by region (Northeast, South, Midwest, and West). Qualitative data from the open-ended questions were coded and grouped thematically by CSTE staff during analysis, and illustrative quotations were selected for inclusion.

Results and conclusions

The response rate for the states and DC was 100%; 4 (50%) US territories responded. Overall, the 2021 ECA shows that the epidemiology workforce continues to grow; however, ongoing unmet need exists in both well-established areas, such as infectious disease, and emerging program areas, such as genomics and mental health. Compared with 2017, capacity decreased for EPHS 1 (monitoring health status), from 84% to 76% reporting substantial to full capacity and for EPHS 2 (investigating health problems and hazards), from 92% to 88%. Capacity in EPHS 9 (research and evaluation) increased from 39% to 43% reporting substantial to full capacity; however, capacity is still substantially lower than capacity for EPHS 1 and EPHS 2. Participants cited job interests/fulfillment, job benefits, and the opportunity for a flexible schedule as current assets for recruiting and retaining a qualified workforce, but the need remains to reform civil service job categories to include more competitive salaries and advancement opportunities and career ladders to attract a diverse applicant pool. Similar to 2017, most states and DC also noted the need for training in data analytics. As state health departments continue to rely heavily on federal funds, there is less flexibility for prioritizing emerging needs and increased workplace insecurity.

Key findings

Number of epidemiologists

The number of epidemiologists continues to increase.

- A total of 4135 epidemiologists work in the 50 states and DC, a 23% increase over the 3370 reported in 2017 and the highest number observed in the ECA.
- The number of epidemiologists per 100,000 population increased 21% since 2017, from 1.04 to 1.26/100,000. This composite value continues to mask low rates (<1/100,000) in 15 states. The program area with the greatest absolute and relative increase from 2017 to 2021 was informatics, for which 102 epidemiologists were added, a 107% increase.
- For infectious disease, the number of epidemiologists decreased by 340 since 2017; however, 36% (1498) of the workforce

remains concentrated in infectious disease and 24% (978) in COVID-19 response. The decrease in epidemiologists in certain program areas, particularly infectious disease, might reflect the need to reallocate personnel during the COVID-19 response. The number of epidemiologists in chronic disease and maternal and child health also decreased since 2017.

The need for additional staffing remains, even in large program areas that have the majority of epidemiologists.

- State Epidemiologists expressed the need for nearly 2196 additional epidemiologists to reach full capacity in the 3 EPHS, representing a 53% increase over the 4135 current number, for a total of 6331 epidemiologists.
- The greatest number of positions needed were in infectious disease (562), COVID-19 response (454), chronic disease (153), maternal and child health (135), and environmental health (135).
- Although states expressed the need for additional capacity in areas such as genomics and mental health, the total number of positions needed in these areas was relatively small. Genomics needs an additional 46 epidemiologists (a 922% increase), and mental health needs an additional 57 epidemiologists (a 656% increase).

EPHS capacity

States continue to have substantial capacity for monitoring and assessing health problems but lack capacity for research and evaluation.

- In 2021, the percentages of states and DC with substantial to full capacity for EPHS 1 (monitoring health status) was 76%, a decrease from 84% in 2017.
- The percentages of states and DC with substantial to full capacity for EPHS 2 (investigating health problems and hazards) was 88%, a decrease from 92% in 2017.
- The percentages of states and DC with substantial to full capacity for EPHS 9 (research and evaluation) was only 43% in 2021. However, research and evaluation were assessed separately in 2017 with EPHS 9 and EPHS 10. In 2017, 39% of states and DC reported substantial to full capacity in EPHS 9 (research and evaluation), whereas only 22% reported substantial to full capacity in EPHS 10 (evaluation).

Training priorities

Similar to 2017, data analytics remains a top training priority among states.

- Thirty-four states mentioned data analytics as the top training priority; 16 states also mentioned software skills (statistical software, such as Epi Info, SPSS, and R), and 14 mentioned systems thinking (systems development, change management, strategic planning) as training needs.

Access to peer-reviewed literature that is not open-access remains limited in many states.

- Timely access to peer-reviewed literature is essential to respond to emerging threats and to ensure that ongoing activities are evidence-based. A quarter of all states and DC have access to peer-reviewed literature within 24 hours of requesting it. Although overall access has increased significantly since 2017, 14% of states and DC still do not have access to peer-reviewed literature, and >40% of states had to wait >24 hours after a request to gain access.

Funding

Federal funding continues to pay for most epidemiology activities and personnel and limits adequate coverage of underserved program areas.

- Federal funds constituted 83% of funding for all epidemiologic activities in state programs and included COVID-19 funds provided by the federal government. States contributed an average of 12%, and other sources accounted for only a small percentage of the total in most states.
- Similar to epidemiology activities, federal funds constituted 83% of funding for personnel, including COVID-19 funds. States contributed an average of 15%, and other sources accounted for a small percentage of the total in most states.
- Federal grants constitute the vast majority of funds for virtually all program areas; only for vital statistics and generalist program areas did state funding contribute >50% of funding.

Recruitment and retention

The key assets for recruiting and retaining the epidemiology workforce include job interest and fulfillment, job benefits, and job security.

- The median low and high salaries for the State Epidemiologist position were $119,000 (range $47,000–$239,000) and $175,000 (range $81,000–$327,000), respectively. Most salary increases in career-level categories did not surpass the 7.9% inflation rate from 2017 to 2021, and many states struggled to stay competitive because their salaries ranged well below the national average.
- Epidemiologists are starting at inadequate base salaries and often not receiving regular increases to cope with inflation and the increased cost of living. In an era of increasing education costs and student debt, the salaries offered by health departments are likely to be even less competitive than in the past.
- The most cited assets for recruiting and retaining epidemiologists were job interest and fulfillment, benefits, security, and a flexible schedule. States also cited the opportunity for skills training as an important strategy for retaining epidemiologists.
- In qualitative responses, states also noted the need for standard position descriptions and career ladders that define clear opportunities for advancement.
- Minimum and maximum salaries in the 50 states and DC increased with educational attainment, and physician pay was considerably higher than pay for PhDs and DVMs. Salaries also increased by career level, although the more managerial positions of Deputy State Epidemiologist and State Epidemiologist had substantially higher median salary ranges than those at and below senior level. No consistent pattern emerged in minimum and maximum salary levels for the 5 career levels by state size or by region.
- Participating states cited allowing a flexible schedule, encouraging taking paid leave, and promoting awareness of mental health as major strategies for minimizing burnout. Epidemiologists struggle with burnout because of the lack of capacity in state health departments and an inability to take adequate paid time off.

Epidemiology leadership

A high proportion of epidemiologists are new to their positions, and others are likely to retire in the upcoming years.

- State Epidemiologists have been on the job for a median of 4 years, down from 5.8 years in 2017. This is the second lowest median recorded for the State Epidemiologist position since it was added to the ECA and indicates a high amount of turnover for this role.
- One in 6 epidemiologists have been in their position for <1 year, and 41% have served in their current position for at least 5 years.
- New epidemiologists are faced with learning technical aspects of the job, navigating hiring and administrative practices, and obtaining funding to support epidemiologic activities. In addition, epidemiologists need to be able to navigate political challenges and manage large incoming funding, such as Epidemiology and Laboratory Capacity and other grants. These challenges are further exacerbated by epidemiologists transitioning into the role during the COVID-19 pandemic.
- Leadership training and mentoring might be important in states with new State Epidemiologists, and succession planning might be important for states in which State Epidemiologists will be retiring soon.

The number of states with program area leads has increased for almost all areas, but most states still lack leads in areas such as oral health, mental health, and genomics.

- The greatest increase in program area leads occurred in informatics, where the percentage of jurisdictions with a lead epidemiologist nearly doubled, a significant increase from 37% to 71%.
- Despite overall gains in the number of states with program area leads, more than half of states and DC lacked program leads in oral health, mental health, and genomics.
- Lack of a lead affects a state's capacity to monitor and investigate health problems in the program area and to compete for funding in these areas.

Case-based surveillance and outbreak management systems

Nearly all states implemented an additional contact-tracing system for the COVID-19 response; however, most states were unsure whether they would continue using the system after the pandemic.

- Seventy-eight percent of states and DC reported also using an Outbreak Management System, defined as a system that "supports the initial characterization, investigation, response, and containment of outbreaks through the collection and analysis of data." This is a notable increase from the 69% of states reporting use in 2017.
- When asked about contact tracing systems, 94% of states implemented an additional contact tracing system for the COVID-19 response. States that were not going to continue use of the system cited issues of long-term sustainability and problems integrating the system into their surveillance plan.
- When asked to rate their case-based surveillance system's ability to adapt for COVID-19 based on a scale of poor, fair, or good, nearly half of the states and DC rated their system's adaptability as fair.

Recommendations

Infrastructure

Systems need to be in place to ensure connectivity and critical coordination between clinicians, laboratorians, and public health professionals for timely standardized data collection and analysis to accurately describe the health of communities and to prevent disease. Faxing case reports and duplicate data entry are antiquated and negatively impacts the validity of public health data. Shifting to electronic data collection and management is vital to support the infrastructure transformation resulting in timely and accurate data. Frequently epidemiologists use outdated computers with limited software licenses, which significantly slows the processing and analysis of data. The technology available to support epidemiology activities needs to be upgraded to ensure electronic data collection and timely data analysis and reporting.

Recommendations

- Create and maintain coordinated, interoperable data systems that provide timely, complete, useful, and accurate data from collection through dissemination.
- Adopt national standards for electronic data collection and reporting to ensure comparisons between providers and jurisdictions.
- Ensure public health providers have adequate equipment and software for field work and data analysis.

Workforce

Additional epidemiologists in state health departments are clearly needed, as evidenced by the substantial gap between current and ideal numbers to maintain current operations. The workforce requires personnel with the appropriate skills to bolster capacity across program areas and enable departments to continue sustained projects and address emerging issues.

Recommendations

- Create and fill designated positions in health departments to support robust epidemiology activities, including Deputy State Epidemiologist, Data Coordinators to oversee data modernization efforts spanning program areas, and leads for every program area.
- Create standardized career ladders for use across departments that demonstrate clear paths for advancement. Use these career ladders to support the classification of epidemiologists within human resource systems and set competitive salary ranges.
- Provide flexible spending allocations that enable health departments to prioritize their jurisdictional needs for personnel and technology.
- Enhance hiring to increase the number of epidemiologists across program areas, particularly areas with high need, such as genomics and mental health.
- Promote strategic recruitment and hiring of epidemiologists with specialized skills, such as genomics, data analytics, and research and evaluation.
- Incorporate epidemiology into middle and high school curricula, and expand postgraduate training experiences, including the Applied Epidemiology Fellowship, to attract professionals to work in public health

and serve their communities instead of choosing careers in academia, clinical care, or the private sector.
- Prioritize having a minimum of 1.26 epidemiologists per 100,000 population with an ideal goal of 5 epidemiologists per 100,000 for public health transformation.

Recruitment and hiring

Faced with less competitive salaries and funding restrictions, many health departments struggle to recruit and hire a workforce with the appropriate skills. To attract and fill positions with qualified candidates, states need standard position descriptions and updated Applied Epidemiology Competencies (AECs) that reflect the changing public health landscape. In addition, hiring teams need to incorporate strategies that focus on recruiting a workforce with diverse backgrounds and diverse skills.

Recommendations
- Update the AECs to incorporate emerging areas of practice and specialized skills.
- Create and update position descriptions using the AECs that describe the skills and responsibilities of epidemiology personnel by position type (entry, mid-level, senior manager, and senior scientist), and update pay scales to be competitive with other public health sectors.
- Foster collaboration between states and human resources departments to facilitate recruitment planning and hiring that focuses on obtaining a workforce with diverse backgrounds, subject-area expertise, and skills.

Retention

State health departments continue to struggle to retain epidemiologists, particularly mid- and senior-level epidemiologists. The inability to retain epidemiologists results in frequent turnover, loss of institutional knowledge, and lack of consistent program management. Training to improve job engagement and agency investment through upskilling of the current workforce is needed.

Recommendations
- Create opportunities for advancement within the state health department that enable epidemiologists to obtain career growth.
- Enable states to self-assess current salary ranges and increase salaries to be competitive with surrounding states and geographic areas and to other industries, including academia, clinical care, and the private sector.
- Provide on-the-job training that will upskill the existing workforce to meet emerging needs, including data analytics, software skills, and leadership development.
- Support cross-training between epidemiologists, preparedness personnel, and laboratory staff to update response plans and enhance future response efforts.
- Bolster succession planning to preserve institutional knowledge, including the creation and maintenance of mentorship programs.
- Provide resources to personnel that focus on managing and minimizing burnout, especially during public health emergencies.

Collaboration

Collaboration is fundamental for achieving change and including all relevant stakeholders in decision making. Epidemiologists in state health departments are fundamental to public health and need to have a voice with federal partners. In addition, state health departments should form academic partnerships to increase access to literature, enhance learning opportunities for students, and ensure relevant training for emerging epidemiologists.

Recommendations
- Foster collaboration between CDC and state health departments that enables inclusion of State Epidemiologists in predecision meetings and provides important feedback and context to decision makers.
- Initiate collaboration with local providers for the smooth onboarding of Electronic Laboratory Reporting, Electronic Case Reporting and syndromic surveillance systems.
- Partner with academic institutions for increased access to peer-reviewed literature, applied learning opportunities for students, surge capacity support by academic epidemiologists, and assurance that current public health curricula meet the emerging needs of the field.
- Particularly in larger state health departments, establish mechanisms to assure collaboration and communication among epidemiologists across program areas.

Future assessments

Future assessments are critical for measuring the progress of the applied epidemiology workforce over time. Additional ECAs should be considered to evaluate the progress in data modernization efforts, assess changes in infrastructure, and monitor progress toward creating a more representative and diverse public health workforce and the field's response to structural racism. Future assessments should also incorporate metrics to evaluate surveillance systems and data completeness, accuracy, and timeliness.

Recommendations

- Conduct additional ECAs that assess ongoing data modernization efforts in state health departments and focus on changes in infrastructure.
- Conduct field assessments that measure surveillance systems' ability to produce complete, accurate, and timely data.
- Assess and monitor public health's progress toward creating a more representative and diverse public health workforce and the field's ongoing response to structural racism as a public health issue.

BACKGROUND

Background

The public health field aims to improve population health by preventing disease. Achieving this aim involves a multitude of participants from many different sectors of society, including government agencies, non-governmental organizations, clinicians, and the private sector (Frieden, 2015).

State and local public health agencies play a critical role in conducting surveillance and assessing the needs of communities (National Consortium for Public Health Workforce Development, 2017). Surveillance produces essential information to create effective and efficient public health services and generate information for decision making, policy implementation, and necessary intervention (Groseclose & Buckeridge, 2017), whereas community needs assessments permit better targeting of priorities and groups at risk. Epidemiologists are fundamental to the support of public health surveillance capacity (Drehobl, Roush, Stover, & Koo, 2012) and to the evaluation of community needs.

Understanding the current workforce situation in epidemiology is critical to state and national public health leaders and schools of public health. Leaders need timely data on the workforce needed to plan the execution of core public health functions and evaluate their progress. Other critical information includes how many public health epidemiologists are currently working in their jurisdictions and how they are distributed by program area. Leaders also need to understand how their jurisdiction compares to others with respect to levels of staffing, ability to carry out key epidemiologic competencies, salary, hiring, and retention. Schools of public health, which are responsible for much of the training of the epidemiology workforce, need to know what skills their graduates need to join and contribute to the public health workforce. Understanding which program areas need more epidemiologists, the skills that need further strengthening in health departments, and the educational and experiential qualifications required for hiring are essential in the design of curricula and counseling of public health students.

Public health has entered a period of rapid change because of large influxes of funding from the COVID-19 pandemic and greater visibility on the importance of public health infrastructure. Although sustainable funding is still lacking, the public health workforce is faced with a growing focus on accountability, changes in the overall health system, and new technologies (Trust for America's Health, 2013). In addition, emerging public health topics, such as informatics, health care reform, and emerging high-throughput technologies, require specialized skill sets involving systems thinking, change management, and working with diverse populations (Brownson et al., 2015; Kaufman et al., 2014). In this context, understanding the status of the workforce and the perceived challenges facing health departments is essential to identify ways to adjust to these rapid changes. Before the COVID-19 pandemic, State Epidemiologists cited the need for an additional 1200 epidemiologists to deliver public health services in the 2017 Epidemiology Capacity Assessment (ECA) (CSTE, 2017). Over half of the epidemiology workforce was concentrated in infectious disease and funding was often built in response to public health emergencies (CSTE, 2017). Current public health infrastructure often reflects the siloed historic funding designated for certain program areas instead of holistic community needs.

One of the most important recent developments has been a move toward updating the Ten Essential Public Health Services (EPHS) to reflect current practices. The EPHS are the national standard for public health activities (Centers for Disease Control and Prevention [CDC], 2020). CDC released an updated version of the EPHS in September 2020 (CDC, 2021). Three of the EPHS relate directly to epidemiology: EPHS 1 (monitoring

health status), EPHS 2 (investigate health problems and hazards) and EPHS 9 (research and evaluation). Previous ECAs used EPHS 1 (monitor), 2 (assess), 9 (research), and 10 (evaluation). The updated EPHS combines research and evaluation into EPHS 9. Therefore, to ensure continuity and the ability to measure trends, the 2021 ECA measures EPHS 1, 2 and 9. The 2017 ECA found that program areas with a greater number of epidemiologists had greater perceived EPHS capacity. However, most epidemiologists were concentrated in only 3 subject areas: infectious disease, maternal and child health, and chronic disease. Other areas, such as substance use, occupational health and mental health, demonstrated both low EPHS capacity and significantly fewer epidemiologists. Finally, the assessment demonstrated that at least 1200 additional epidemiologists were needed to reach adequate capacity to successfully perform the EPHS (ECA, 2017). However, whether these additional epidemiologists have been hired and whether the current ability to meet these 3 critical public health services has changed is unknown.

In November 2001, the Council of State and Territorial Epidemiologists (CSTE) conducted the first comprehensive nationwide assessment of core epidemiology capacity in state and territorial health departments. This ECA was conducted in part to collect baseline information for monitoring progress with Healthy People 2010 Public Health Infrastructure objective (CDC, 2003). Building on interest generated by the 2001 ECA and the need for additional detail, CSTE conducted additional ECAs in 2004, 2006, 2009, 2013, and 2017. All states and the District of Columbia (DC) responded. Since its creation in 2001, the ECA has revealed several trends in the applied epidemiology workforce, including a continued need for additional epidemiologists to achieve ideal capacity, increased capacity in well-established program areas while emerging areas lagged behind, increased need for competency-based training, stagnant salaries for epidemiologists that do not keep up with inflation, and an increasing reliance on federal funding (CSTE, 2006; CSTE, 2009; CSTE, 2013; Hadler et al., 2013; CSTE, 2017). In addition, epidemiologists are needing to leverage available technology as it evolves, particularly in informatics, to be able to measure growth and become more effective and efficient. The current ECA does not capture individual level data as that is captured in the Public Health Workforce Interest and Needs Survey (PH WINS), which was first fielded in 2014 (de Beaumont and Association of State and Territorial Health Officials [ASTHO], 2017).

PH WINS was conducted in 2017 by the ASTHO and the de Beaumont Foundation. PH WINS explored the demographics of the public health workforce, identified training needs, and examined job satisfaction amongst state and local health department employees, including epidemiologists (de Beaumont and ASTHO, 2017). Results demonstrated that nearly 25% of the workforce planned to leave their organization in the next year for reasons other than retirement, many citing low salaries and lack of advancement opportunities (de Beaumont and ASTHO, 2017). Also needed is additional job analyses that can be coupled with the Applied Epidemiology Competencies (AECs) to create standardized job classifications for epidemiologists nationwide (Daly, 2020).

Building on the recommendations from the 2017 ECA and the 2017 PH WINS, the 2021 ECA was conducted to better understand the current applied epidemiology workforce and applied epidemiology capacity. A metric added in 2021 was understanding state health departments' tactics for successfully recruiting and retaining epidemiologists. In addition, the COVID-19 pandemic generated supplemental funding to support the applied epidemiology capacity, but its impact on the workforce was not clear.

The 2021 ECA was designed to achieve 5 goals:

1. Enumerate and describe the applied epidemiology workforce;
2. Describe the training needs of the applied epidemiology workforce;
3. Describe the funding supporting the applied epidemiology workforce;
4. Describe the level of epidemiology capacity in state health departments; and
5. Assess the impact of the COVID-19 pandemic on epidemiologic capacity and staffing.

This report presents the key findings from the 2021 ECA.

METHODS

Methods

Instrument development and distribution

In Fall 2020, CSTE staff held two focus groups, the first with CSTE national office staff and the second with CSTE members, to identify the purpose, value, desired outcomes, and diffusion of the 2021 ECA. In addition, these focus groups discussed assessment content, including removal, editing, and addition of new questions and the training required to prepare State Epidemiologists to complete the assessment. CSTE staff also consulted partners, including the Association of State and Territorial Health Officials (ASTHO), National Association of County and City Health Officials, the Center for Disease Control and Prevention's (CDC's) Center for Surveillance, Epidemiology and Laboratory Services, CDC's Epidemiology and Laboratory Capacity for Prevention and Control of Emerging Infectious Diseases, and the de Beaumont Foundation.

On the basis of participant responses, 8 items that were included in the previous 2017 ECA were excluded from the 2021 ECA to avoid duplication and minimize respondent burden during the COVID-19 pandemic. Therefore, the 2021 ECA did not ask about the following topics: whether the State Epidemiologist is an appointed position, state's needs and priorities to improve the EPHS by program, access to overall training and cross-training in informatics, epidemiology training opportunities in collaboration with other organizations, career path trajectory and the AECs, recruitment settings for epidemiologists, minimum hiring requirements for entry-level positions, and tactics for retaining institutional knowledge.

Concurrently, 14 questions were added to the 2021 ECA, and a literature review was conducted to inform question development and language for these items. A number of the new questions pertained specifically to state health departments' response to the COVID-19 pandemic. These questions included turnover of epidemiologists, surge staffing strategies, tactics for minimizing burnout among staff, and departments' use of Outbreak Management Systems and contact tracing systems. The 2021 ECA also included an open-ended question on state's needs to adequately support data modernization activities and departments' strategies for recruiting a diverse workforce.

Additional modifications were made to the 2021 ECA. Two new program areas were added: "Generalist" and "COVID-19 Response" and "Substance Abuse" was updated to "Substance Use" to be more culturally appropriate. Furthermore, the 2021 ECA used the recently released EPHS. Previous ECAs measured epidemiology capacity using EPHS 1, 2, 9, and 10. The updated EPHS combined research and evaluation into EPHS 9. Therefore, the 2021 ECA measured EPHS 1, 2, and 9. In an effort to focus on the strengths of state health departments, the questions pertaining to the recruitment and retainment of epidemiologists were altered to refocus on tactics and strategies instead of barriers and problems (Coghlan, Preskill & Catsambas, 2003). Finally, when measuring vacancies for contractors and civil service employees, the question no longer stipulated to count only positions at the "master's degree level and above."

The final questions were assembled into a single core instrument to be completed by State Epidemiologists and their designees. The resulting assessment was developed into an online format using Qualtrics software. It was piloted in October 2020 by 3 states (Montana, Iowa, and Nebraska). The assessment was revised on the basis of their feedback. The revised assessment (Appendix A) contained 10 sections:

- Section 1: Epidemiology leadership within the state health department;

- Section 2: COVID-19 surveillance within the state health department;
- Section 3: Epidemiology and surveillance capacity within the state health department;
- Section 4: Epidemiology funding sources and staffing within the state health department;
- Section 5: Civil service annual salary ranges for epidemiologists in the state health department;
- Section 6: Recruiting the epidemiology workforce;
- Section 7: Vacancies and retention of the state epidemiology workforce;
- Section 8: Leadership feedback; and
- Section 9: Review of the assessment.

Most of the questions were short-answer, multiple-choice, scales (e.g., none, minor problem, moderate problem, major problem), or matrix tables, such as the fraction of full-time equivalent positions by program area and funding source. The ECA also included open-ended questions pertaining to innovative recruitment strategies, data modernization needs, and critical issues faced by State Epidemiologists.

On January 11, 2021, CSTE distributed electronic instructions and individual assessment links to each State Epidemiologist in all 50 state health departments, DC, and 6 US territories (American Samoa, Federated States of Micronesia, Guam, Northern Mariana Islands, Puerto Rico, and the US Virgin Islands). CSTE accepted responses through the online tool. The online assessment also was converted into an editable PDF and attached to the instructional email. In addition, 2 worksheets were created and attached to the email to assist with gathering information from other staff in the state health department, namely program area leads and human resources directors. Instructions for using the worksheets were included in the assessment instructions within the online tool. The PDF version of the online assessment and worksheets are included in the appendices.

Each State Epidemiologist was provided a unique link and was asked to complete the online assessment by February 26, 2021. States and territories were given the email address and telephone number of CSTE staff to contact with questions during business hours. In addition, CSTE hosted a "How to Complete the 2021 ECA Webinar" on January 19, 2021, and held 2 virtual ECA office hours sessions on January 28 and February 9. Each state or territory was also provided with a copy of its 2017 ECA State Reports results to ensure responses considered previous staff enumeration methods. On request, CSTE emailed states their exact responses from 2017.

CSTE extended the deadline because not all states were able to complete the assessment by February 26. All responses were collected by April 1. All 50 states and DC participated, as did 4 of the 6 territories. Data were cleaned to identify any errors or incomplete responses. CSTE staff emailed states to request necessary revisions for data validation and to address incomplete responses.

Definitions and response options

Epidemiologist

As in previous years, State Epidemiologists were instructed to count as epidemiologists "all those employed by the state; all those working at the state level who are either federal assignees (e.g., EISO, CEFO, PHAP) or contract employees (e.g. CSTE trainee, contracted from school of public health to work at or for the State Health Department); and state employees assigned to work at a local or regional level (e.g. to conduct investigations for a region of the state)." The instructions also added that "[when] considering who should be counted, please focus on the functions performed by the individual rather than the job title. Reference the AECs for examples of epidemiology job functions if you need assistance in determining the status of an employee."

A link containing additional information about the definition of who should be counted as an epidemiologist was included as a pop-up tab link within the assessment instructions. This link opened to a PDF document referencing John M. Last's definition (2001): an epidemiologist is "an investigator who studies the occurrence of disease or other health-related conditions or events in defined populations. The control of disease in populations is often also considered to be a task for the epidemiologist." The document also defined epidemiology as the "study of the distribution and determinants of health-related states or events in specified

populations, and the application of this study to control of health problems."

In some states, epidemiologists are employed by separate agencies in the state. For example, occupational health is sometimes in the department of labor. In such cases, the epidemiologists working at separate state agencies outside of the state health department were excluded from this analysis.

Capacity in the EPHS
Adequate epidemiological capacity was defined as the state health department's ability to lead activities; provide subject-matter expertise; and apply for, receive, and manage resources to conduct key activities. The following scale was used to describe capacities in providing the 3 indicated EPHS overall and by specific program area.

- None: 0% adequate epidemiologic capacity to provide this/the 3 EPHS.
- Minimal: 1%–24% adequate epidemiologic capacity to provide this/the 3 EPHS.
- Partial: 25%–49% adequate epidemiologic capacity to provide this/the 3 EPHS.
- Substantial: 50%–74% adequate epidemiologic capacity to provide this/the 3 EPHS.
- Almost full: 75%–99% adequate epidemiologic capacity to provide this/the 3 EPHS.
- Full: 100% adequate epidemiologic capacity to provide this/the 3 EPHS.

Vacancies
The following definition was used to describe vacancies in epidemiology/surveillance positions in the state health department: "A vacancy is defined as a position to be filled at the State Health Department that meets the following conditions: (1) there is work available for the position and (2) the job could start within 30 days." Previous ECAs captured vacancies for positions requiring a master's degree or above. Data from the 2017 ECA revealed that nearly half of epidemiology positions did not require a master's degree. Therefore, the 2021 ECA collects data on all epidemiology positions, regardless of the degree required.

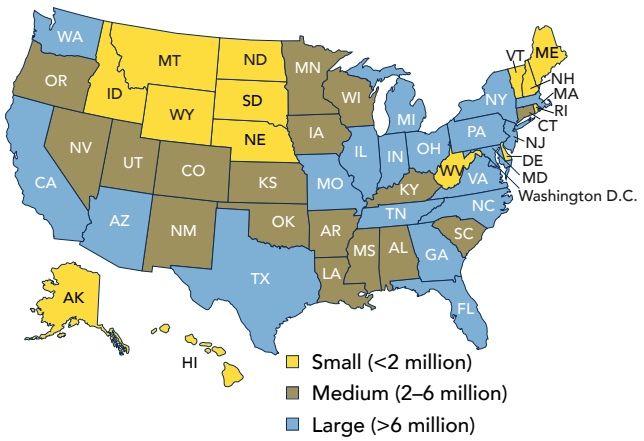
Intend to fill positions
Intend to fill positions were a subset of the vacancies and consisted of positions that human resources were working actively to fill.

Analytic Techniques

Data were analyzed using SAS 9.4 and Microsoft Excel 2008. Results were tabulated for each question among the responding jurisdictions (the 50 states; DC; and the 4 participating US territories of American Samoa, Northern Mariana Islands, Puerto Rico, and Guam). The territories, which range in population from approximately 55,000 (American Samoa and Northern Mariana Islands) to 3.2 million (Puerto Rico) differed substantially from the 50 states and DC in their organization of epidemiology services, hiring practices, and salary scales. Thus, unless otherwise noted, the data for the states and DC were analyzed separately from the data for the 4 territories. Data referencing "the states" comprises the 50 states and DC.

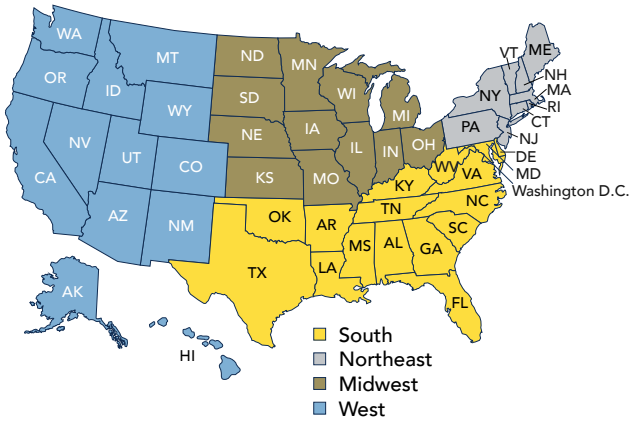
Select analyses were stratified by state population size. Population size was based on 2019 Census figures for states and 2015 Census figures for territories (US Census Bureau, 2019; US Census Bureau, 2015). The 3 categories were small (<2 million; 15 states), medium (2–6 million; 17 states), or large (>6 million; 19 states) (Figure 1). In addition, some variables were examined by region using standard census categories (Northeast, South, Midwest, and West) (Figure 2).

Figure 1 Categories based on state size



As in previous assessments, 2 methods were used to calculate the number of epidemiologists per 100,000 population by state population size and by region. In the first, expressed as epidemiologists per 100,000, the total number of epidemiologists in the subgroup (e.g., all epidemiologists in Midwestern states) was divided by the total population of that subgroup (total population of the Midwest). In the second method, referred to as median number of epidemiologists per 100,000 population, the number of epidemiologists per 100,000 was first calculated for each individual state, and the median for all the states in each subgroup was identified.

Figure 2 Categories based on U.S. census regions



Trends in certain key findings were assessed using data from the 5 ECAs in the past 13 years: 2004, 2006, 2009, 2013, and 2017; for other variables, only the findings for 2017 and 2021 were examined. The 2001 data were excluded because only 39 states participated, making temporal comparisons of data problematic. Where relevant, prevalence rate ratios, chi-square tests, Fisher exact tests, and the Kruskal-Wallis tests were used to examine differences between groups.

With respect to the 4 open-ended questions, data for the questions about recruitment strategies, critical issues, and data modernization are presented in this document. For the analysis, CSTE staff coded the responses and grouped them thematically. The separate analyses were compared for intercoder reliability. The differences in coding were discussed and addressed with coding revisions and updating the codebook.

RESULTS

Results

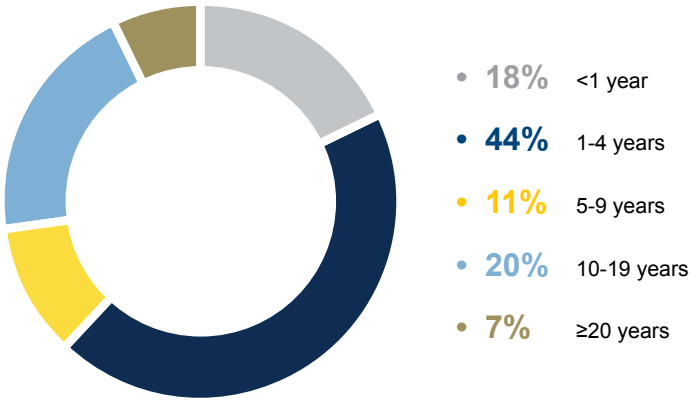
Epidemiology leadership within the health department

Response rates and characteristics of participating State Epidemiologists

The State Epidemiologists from the 50 states and DC responded to the 2021 ECA; 4 territories (American Samoa, Guam, the Northern Mariana Islands, and Puerto Rico) also participated.

The median number of years State Epidemiologists had served in their current position was 4 years (range <1 year to 27.5 years). The tenure of leaders is lower than in 2017, when the median time in this position was 5.8 years. Almost half (44%) of State Epidemiologists have been in their position for 1–4 years (Figure 3).

Figure 3 Number of years in current position among State and Territorial Epidemiologists, ECA 2021 (n=55)

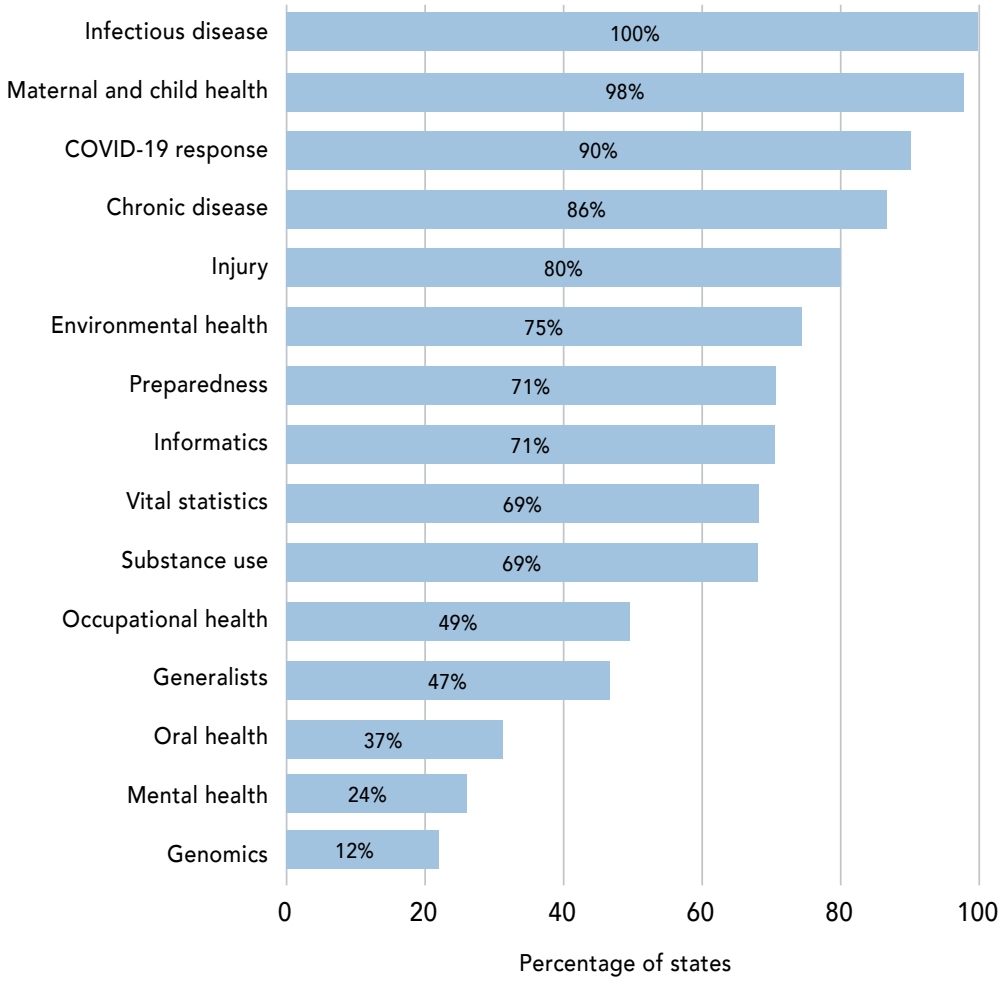


One in 6 State and Territorial Epidemiologists have been on the job <1 year, and 38% have served in their current position for at least 5 years.

Program area lead epidemiologists

All (100%) of the 50 states and DC had a lead epidemiologist in infectious disease, and most states had leads in maternal and child health (98%) and chronic disease (86%) (Figure 4). Injury, environmental health, informatics, vital statistics, substance use, and preparedness all had coverage >50%; coverage was somewhat lower in oral health, occupational health, and generalists and was <15% for genomics (12%). No significant relationship was found between state size (<2 million, 2–6 million, and >6 million population) and presence of a lead epidemiologist, except for environmental health, for which 55% of small states had lead epidemiologists compared with 71% for medium states and 95% for large states (p = 0.002). Program area leads were largely lacking in the participating territories.

Figure 4 Presence of lead epidemiologists by program area, 50 states and DC, ECA 2021

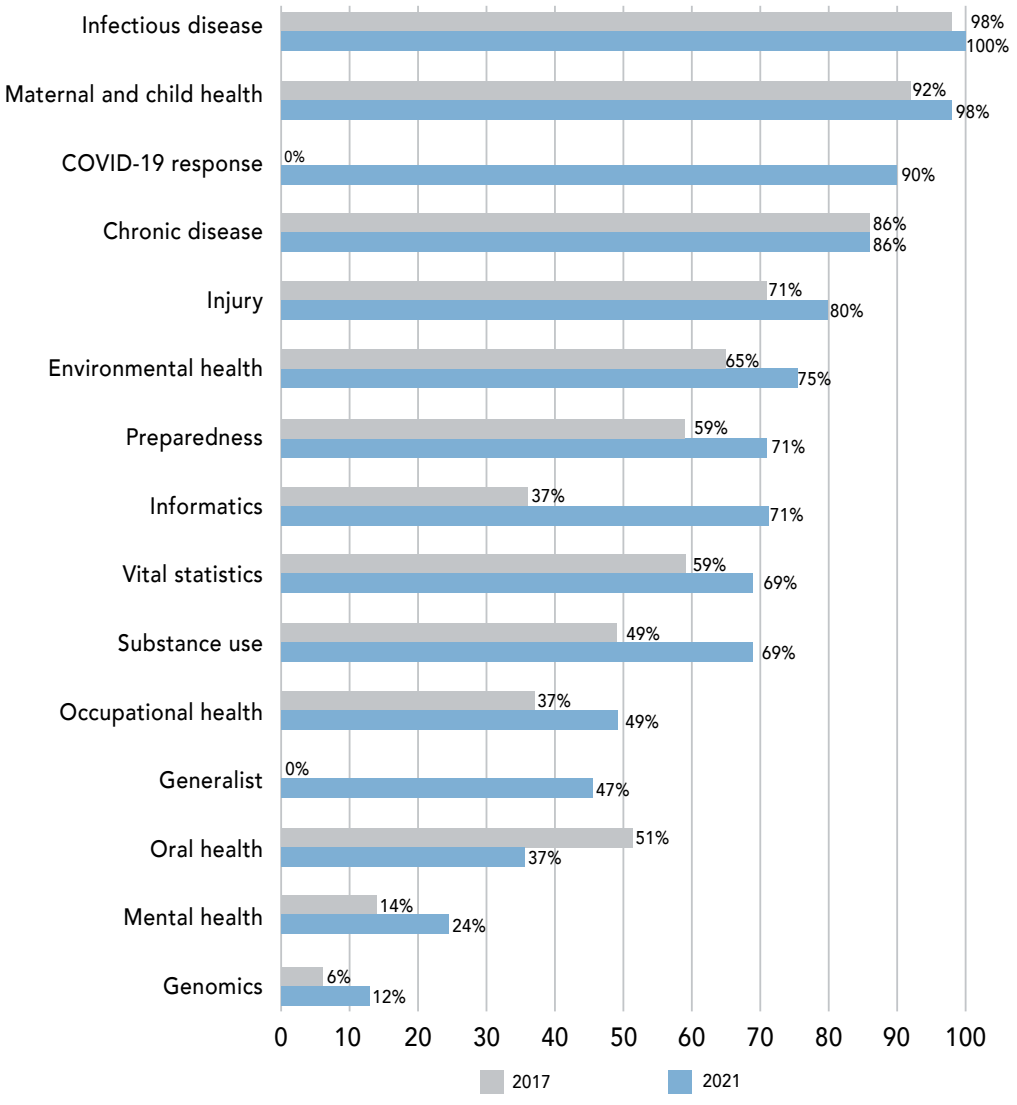


Trends in the presence of program area leads

The greatest increases in the presence of program leads were in informatics, where the percentage of jurisdictions with a lead epidemiologist nearly doubled, from 37% to 71% (p = 0.0002) (Figure 5).

The only decrease in lead epidemiologists occurred in oral health, from 51% to 37%, although this decrease was not statistically significant. Substance use also experienced an increase, from 49% to 69% (p = 0.03). There is no comparative data for COVID-19 response or generalist because they were collected for the first time in 2021.

Figure 5 Trends in presence of program area leads, 50 states and DC, ECA 2017 and 2021



The greatest increases in the percentage of states with program leads were in informatics, substance use, and mental health. By contrast, the presence of program leads decreased in oral health.

Epidemiology staffing and funding within health departments

Staffing

Numbers of epidemiologists and rates per 100,000 population

A total of 4135 epidemiologists were counted in the 50 states and DC. An additional 73 were reported by the 4 participating territories. Compared with 2017, the number of epidemiologists in the 50 states and DC increased 23%, from 3370 epidemiologists. The number of epidemiologists per state and DC ranged from 4 to 255. Overall, the number of epidemiologists per 100,000 population was 1.26, 21% higher than the rate of 1.04/100,000 obtained in 2017.

More populous states had higher median numbers of epidemiologists, although the ranges varied widely and overlapped between the 3 categories (Small, Medium, Large)(Table 1). The number of epidemiologists per 100,000 population decreased with increasing state population. Comparison of the number of epidemiologists per 100,000 by state size indicated that small states had 3.5 times as many epidemiologists per 100,000 as did the large states, and medium-sized states had 2.1 times as many. The South had a greater median number of epidemiologists per state, but the Northeast had a higher median rate of epidemiologists, at 2.7/100,000.

Table 1 Number of program area epidemiologists, medians, range and rates/100,000 by geographic area and state size, 50 states and DC, ECA 2021

Area	Number of states	Number of epidemiologists	Range, number epidemiologists/ state	Median number/ state	Rate/ 100,000*	Median rate/ 100,000†
United States	51	4135	4-255	65	1.3	N/A
State size‡						
Small#	15	542	13-63	36	3.2	3.0
Medium	17	1329	4-165	81	1.9	2.1
Large	19	2264	48-255	103	0.9	0.9
Geographic area						
Northeast	9	836	36-175	76	1.5	2.7
Midwest	12	799	22-165	50	1.2	1.3
South	17	1520	37-167	80	1.2	2.0
West	13	981	4-255	61	1.3	2.3

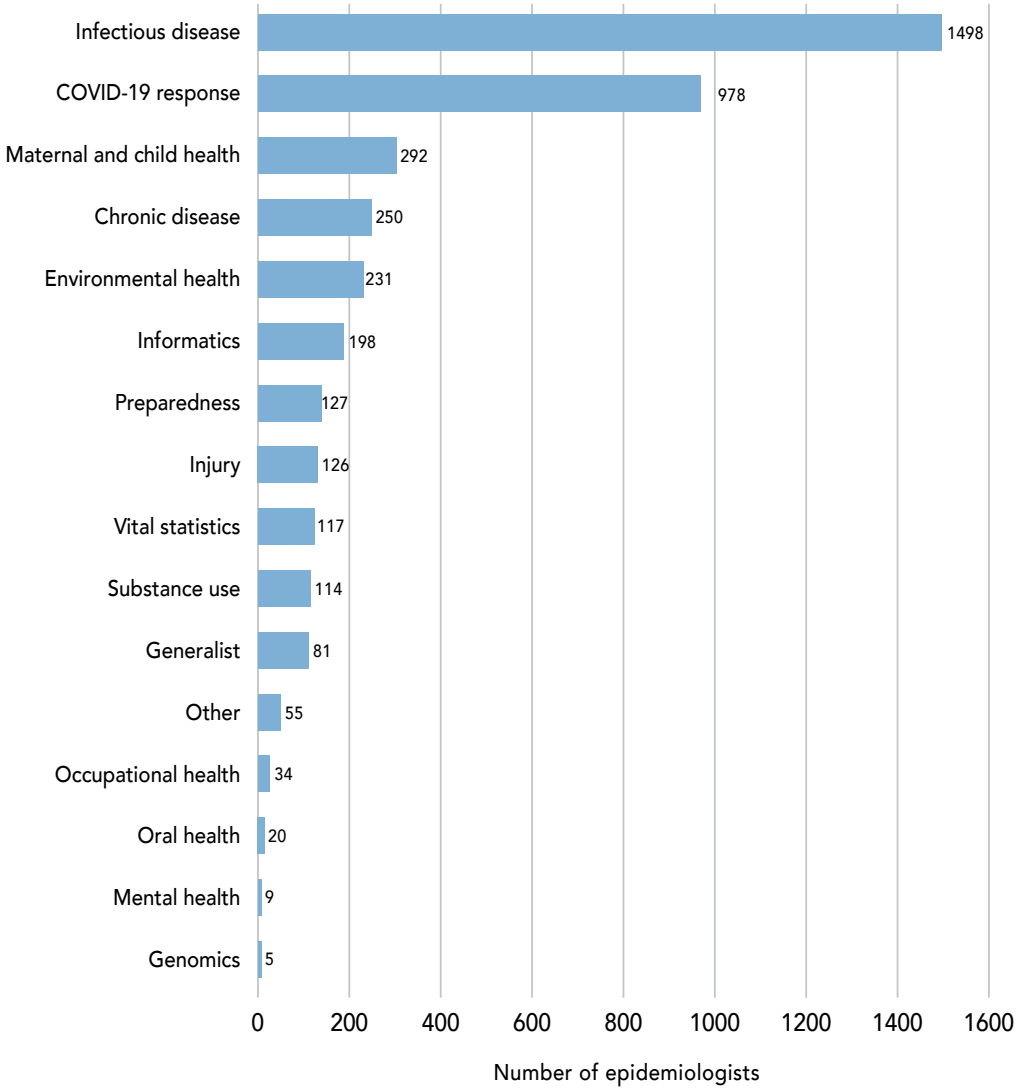
*Based on sum of all epidemiologists within a category and total population in that category
†Median of state-specific rates/100,000
‡Small: <2 million, medium: 2-6 million; large: >6 million; see Figure 1 for map. Population figures from 2019 US Census estimates.
#Kruksal-Wallis for difference between median rate/100,000 = 0.002 for small compared to large states and .0356 for small compared to medium states.

Number of epidemiologists by program area

The greatest number of epidemiologists worked in infectious disease (1498) (Figure 6); positions in this area accounted for 36% of the total number of epidemiologists counted by the states and DC and COVID-19 response epidemiologists accounted for 24% of the total. By contrast, substance use, occupational health, oral health, genomics, and mental health combined represented 4% of the total.

The number of epidemiologists increased by 23% from 2017 to 2021, and the number per 100,000 population increased 21%.

Figure 6 Number of epidemiologists by program area, 50 states and DC, ECA 2021



The greatest absolute and relative increase from 2017 to 2021 was in informatics, for which 102 positions were added, a 107% increase. Infectious disease, by contrast, lost 340 epidemiologists, a 19% decrease, and chronic disease lost 54 epidemiologists, an 18% decrease. Maternal and child health also lost 29 epidemiologists, a 9% decrease since 2017.

Table 2 Number of epidemiologists by program area in 2017 and 2021, 50 states and DC, ECA 2021

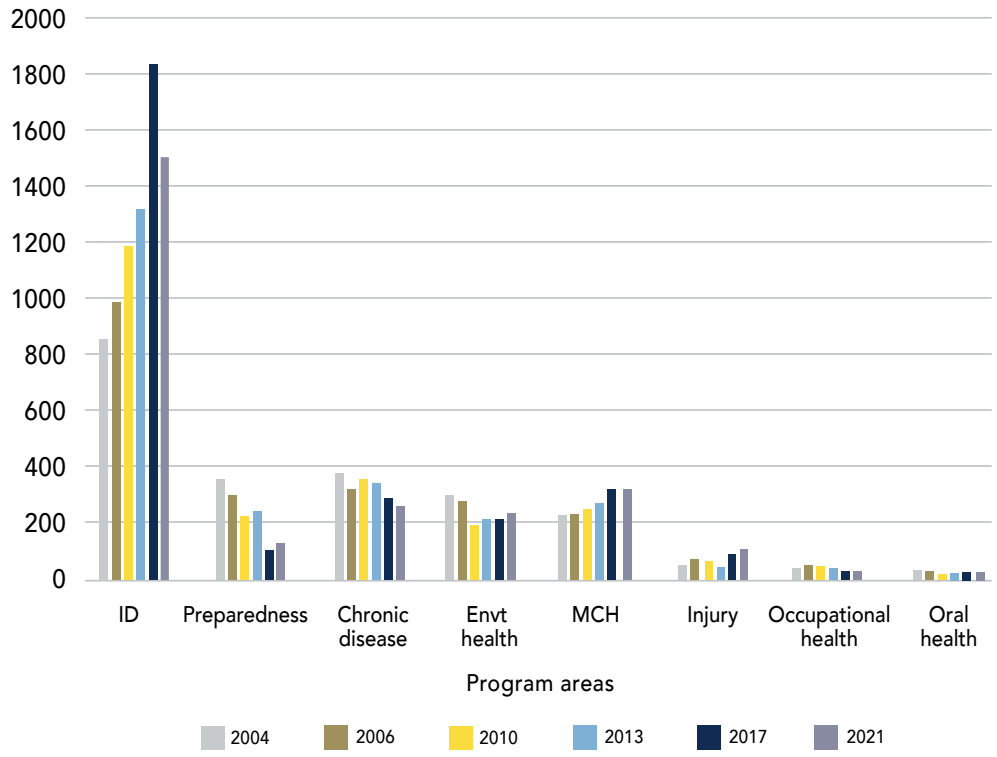
Program area	Number of Epidemiologists, 2017	Number of Epidemiologists, 2021	Difference, no.	Difference, %
Infectious disease	1838	1498	- 340	- 19%
COVID-19 response	–	978	–	–
Maternal and child health	321	292	- 29	- 9%
Chronic disease	304	250	- 54	- 18%
Environmental health	222	231	9	4%
Informatics	96	198	102	107%
Preparedness	118	127	9	8%
Injury	103	126	23	22%
Vital statistics	111	117	6	5%
Substance use	59	114	55	93%
Generalist	–	81	–	–
Other	143	55	- 88	- 61%
Occupational health	28	34	6	21%
Oral health	18	20	2	12%
Mental health	4	9	5	118%
Genomics	4	5	1	25%

A total of 36% of all epidemiologists work in infectious disease, and 24% work in COVID-19 response. Staffing in infectious disease, maternal and child health, and chronic disease decreased since 2017.

Trends in the number of epidemiologists by program area

Longitudinal data were available for 8 of the program areas for which data have been consistently collected since 2004. Infectious disease had been steadily increasing since 2004 but sharply declined from 2017 to 2021 (Figure 7). By contrast, preparedness (formerly bioterrorism and emergency response) had been declining since first measured in 2004 but slightly increased from 2017 to 2021. Although maternal and child health had been gradually increasing, it showed a small decline in 2021. The number of injury epidemiologists, after gradually declining, is higher than at any time in the past. Chronic disease and environmental, occupational, and oral health have remained stable or declined over time.

Figure 7 Trends in number of epidemiologists by program area, 50 States and DC, ECA 2004-2021



The number of dedicated infectious disease, chronic disease and maternal and child health epidemiologists declined from 2017 to 2021.

Additional and ideal number of epidemiologists needed to achieve full capacity

Total additional and ideal positions

Participating epidemiologists were asked to estimate the number of additional epidemiologists needed to reach full capacity in each program area. Overall, epidemiologists from the 50 states and DC indicated a need for an estimated additional 2196 epidemiologists in all the program areas combined to provide basic public health services. The territories reported needing 48 additional epidemiologists. The greatest number of positions needed were in infectious disease (562), COVID-19 response (454), chronic disease (153), maternal and child health (135), and environmental health (135) (Table 2).

Three indicators were calculated to better understand the differences between the current and ideal situation:

- The ideal number of epidemiologists (current + additional positions),
- The percentage of need currently met (current/ideal positions), and
- The percentage increase in current positions needed to reach ideal levels (ideal—current positions)/current positions.

Overall, the ideal number of epidemiologists was 6331. The percentage of currently met need was 65%, and the ideal value constitutes a 53% increase over the current number of epidemiologists (Table 3). If the 2021 ideal were to be achieved, the number of epidemiologists per 100,000 population would be 1.9/100,000. Compared with 2017, the ideal number of epidemiologists was 4586, a

36% increase over the actual number of 3369 for a rate of 1.4/100,000 population.

State population size affected need for additional positions. The percentage increase to achieve the ideal number was greater for small states (67%) than for large (54%) and medium-sized (47%) states. For the territories, a 66% increase would be needed (73 current epidemiologists versus an ideal number of 121).

Table 3 Current, additional, and ideal numbers of epidemiologists overall and by program area, 50 states and DC, ECA 2021

Program area	Current	Additional	Ideal (current + additional)	Need currently met*	Increase needed to reach ideal†
Chronic disease	250	153	402	62%	61%
COVID-19 response	978	454	1432	68%	46%
Environmental health	231	135	366	63%	58%
Generalist	81	85	166	49%	104%
Genomics	5	46	51	10%	922%
Infectious disease	1498	562	2059	73%	37%
Informatics	198	166	364	54%	84%
Injury	126	66	192	66%	52%
Maternal and child health	292	135	428	68%	46%
Mental health	9	57	66	13%	656%
Occupational health	34	48	82	41%	143%
Oral health	20	31	52	39%	155%
Preparedness	127	74	201	63%	58%
Substance use	114	64	178	64%	56%
Vital statistics	117	62	179	65%	53%
Other	55	60	115	48%	108%
TOTAL	**4135**	**2196**	**6332**	**65%**	**53%**

*current/ideal *100
†(ideal-current)/current *100

Additional and ideal positions by program area

The greatest number of positions needed were in infectious disease (562), COVID-19 response (454), chronic disease (153), maternal and child health (135), and environmental health (135) (Table 3). In terms of the percentage increase over current positions needed to achieve the ideal levels of staffing, the greatest needs were in genomics (a 922% increase, from 5 to 51), mental health (a 656% increase, from 9 to 66), oral health (155%, from 20 to 51), and occupational health (143%, from 34 to 82).

Current civil service and contractor vacancies and intent to hire by program area

Beyond the number of positions needed, respondents also provided data on the number of current vacancies and positions for which they were actively recruiting (intent to hire) for civil service and contractor positions.

Vacancies were defined as positions for which work is available and could start within 30 days, and intent to hire added the requirement that human resources staff were actively recruiting for the position.

Participating jurisdictions were asked to report whether they used contractors to fill positions. Thirty-five states and DC (71%) reported using contractors, as did 1 of the 4 territories. Large states were more likely to use contractors (84%) than medium-sized (65%) or small (60%) states, and Midwestern states were more likely to use them (75%) than Southern, Western, and Northeastern states (71%, 69%, and 67%, respectively), but none of these differences were statistically significant.

Table 4 Vacant and intent-to-fill civil service and contractor positions, 50 states and DC, ECA 2021

	Civil Service		Contractor		Total Vacant	Total Intent to Fill	% Vacant with Intent to Fill
Program area	**Vacant**	**Intent to Fill**	**Vacant**	**Intent to Fill**			
Chronic disease	34	25	6	5	40	30	74
COVID-19 response	183	167	179	137	362	304	84
Environmental health	18	13	0	0	18	13	72
Generalist	7	3	0	0	7	3	46
Genomics*	2	4	1	1	3	5	167
Infectious disease	150	113	32	24	182	137	75
Informatics	37	30	8	7	45	37	81
Injury	8	6	2	2	10	8	79
Maternal and child health	31	23	9	4	40	27	68
Mental health	1	1	1	1	2	2	100
Occupational health	2	1	0	0	2	1	67
Oral health	2	0	0	0	2	0	0
Preparedness	10	10	0	0	10	10	97
Substance use	10	7	4	1	14	8	57
Vital statistics	11	8	2	2	13	10	80
Other	36	28	66	65	102	93	91
TOTAL	**542**	**438**	**310**	**248**	**851**	**687**	**81**

*The difference in the number of civil service vacant positions and positions they intend to fill for this program area are likely due to new positions that are going to be created versus existing vacancies.

If all currently vacant epidemiologist positions were filled, the gap between current and ideal numbers of epidemiologists would narrow by almost 25%.

Nationally, a total of 851 positions were vacant, including 542 civil service positions (64%) and 310 (36%) contractor positions (Table 4). Of the 851 vacancies, 687 (81%) were intended to be filled. The greatest number of vacancies were in COVID-19 response (362) and infectious disease (182), followed by other (102) and informatics (45). The 3 vacancies in the 4 territories were in infectious disease and preparedness.

Vacant positions were far less numerous than positions that the State Epidemiologists reported would be needed to meet full epidemiologic capacity (Table 4). Overall, the 851 vacant positions and 687 intend-to-fill positions represented 39% and 31%, respectively, of the perceived additional need of 2196 positions. The percentage of this unmet need for which positions were vacant was highest for COVID-19 response (80%) and infectious disease (32%), followed by maternal and child health (30%), informatics (27%), and chronic disease (26%). The percentage of this unmet need for which positions were vacant was lowest for preparedness (14%), environmental health (13%), generalist (9%), genomics (7%), oral health (6%), mental health (4%), and occupational health (3%).

Funding

Epidemiology activities

Federal funds constituted more than three quarters (85%) of funding for all epidemiologic activities in state programs (Table 5). Unlike previous ECAs, federal funding percentages in 2021 also include COVID-19 funds provided by the federal government. States contributed an average of 12% (0%–50%), and other sources accounted for only a small percentage of the total in most states. Values for funding of epidemiologic personnel were virtually identical to those for epidemiologic activities. Only 21 states and DC received funds from other sources for activities and 23 received such funds for personnel. The 4 participating territories received nearly 100% of their funding from the federal government.

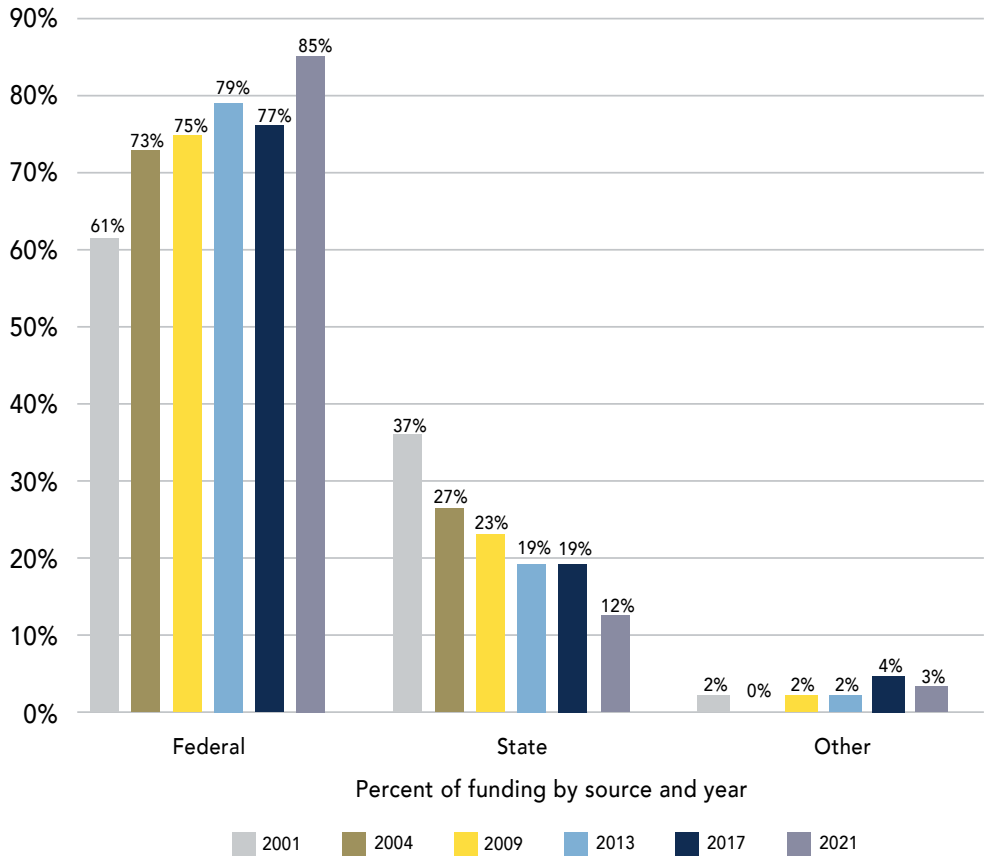
Table 5 Funding sources for epidemiology activities and personnel, 50 states and DC, ECA 2021

Funding Source	Epidemiology Activities		Epidemiology Personnel	
	Range	Mean	Range	Mean
Federal	0%-94%	46%	0%-94%	50%
COVID Federal	0%-97%	39%	0%-94%	33%
State	0%-50%	12%	0%-40%	15%
Other	0%-24%	3%	0%-20%	2%

Trends in funding, 2001-2021

The percentage of federal funds increased dramatically from 2001 to 2004 with an influx of federal funding for preparedness and rose gradually from 2004 to 2013 (Figure 8). In 2017, federal funding decreased slightly for the first time in many years; however, federal funding to states increased substantially from 2017 to 2021, from 77% to 85%. As federal funds increased over time, the state contribution has declined by nearly half, from a peak of 37% in 2001 to 12% in 2021. Funding from other sources decreased slightly, although they continue to represent <5% of total funds.

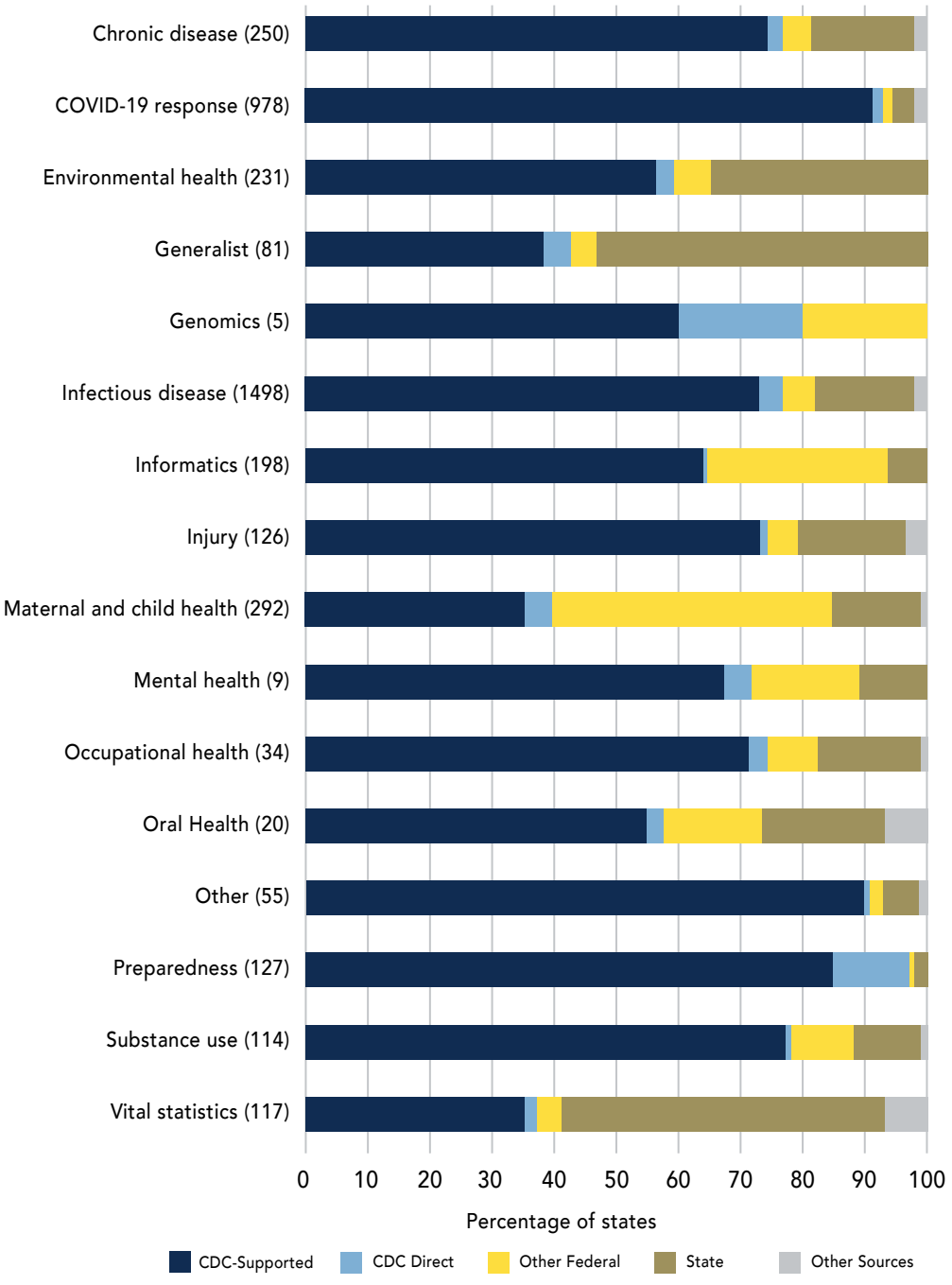
Figure 8 Trends in sources of funding for epidemiology activities, ECA 2001-2021



Sources of funding by program area for epidemiology personnel

State epidemiologists provided information about the source of funding for all epidemiology positions by program area. Overall, the federal government provided 83% of funding for epidemiology positions. Of the federal funding, 84% represented CDC-supported positions (e.g., positions funded by federal grants); 5% represented positions funded directly by CDC (e.g., federal assignees); and the remaining 11% represented other federal sources. Federal funding was highest for COVID-19 response, preparedness, and substance use (Figure 9), each of which received >85% of funding from federal sources. CDC funding was the primary source of federal funding, although the relative mix of the 3 federal sources varied by program area. For maternal and child health, other federal sources accounted for a substantial portion of personnel funding. Informatics, environmental health, generalist, and vital statistics, by contrast, received relatively more funding from state sources, with state funds accounting for >50% of funding for generalist and vital statistics program areas.

Figure 9 Source of funding for epidemiology personnel by program area, 50 states and DC, ECA 2021



In most program areas, the federal government, especially CDC, continues to support 3 of every 4 positions.

State health department capacity in EPHS, access to the literature, and presence of an outbreak management system

Overall capacity

In 1994, the American Public Health Association published the 10 EPHS (CDC, 2020). The 10 EPHS were updated in September 2020. Previous ECAs have measured EPHS 1 (assess), 2 (monitor), 9 (research), and 10 (evaluation). The updated EPHS combines research and evaluation into EPHS 9. Therefore, to ensure continuity and the ability to measure trends, the 2021 ECA measures EPHS 1, 2, and 9. The 3 Essential Public Health Services (EPHS) measured in the 2021 ECA are

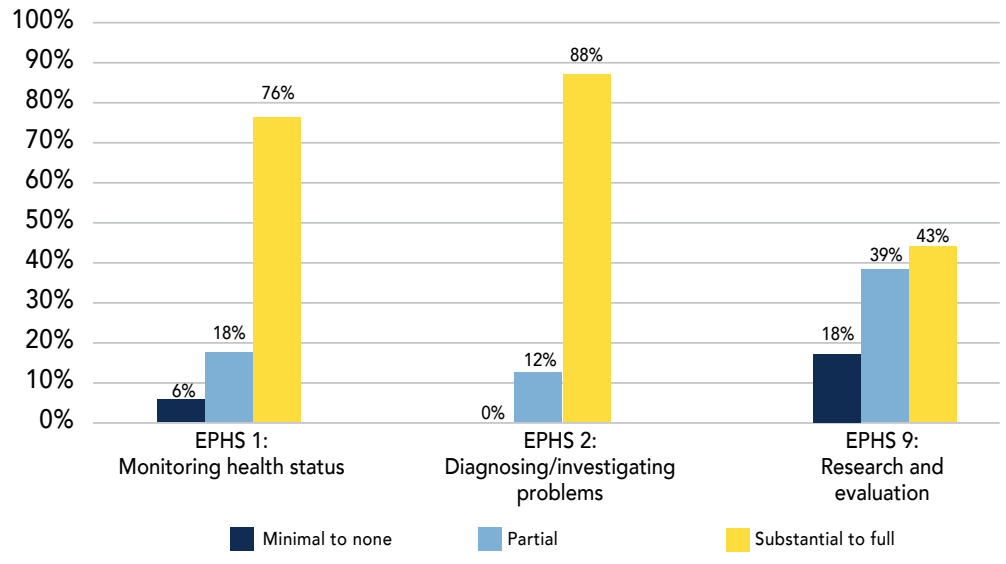
- EPHS 1: Assess and monitor population health status, factors that influence health, and community needs and assets.
- EPHS 2: Investigate, diagnose, and address health problems and hazards affecting the population.
- EPHS 9: Improve and innovate public health functions through ongoing evaluation, research, and continuous quality improvement.

State Epidemiologists were asked to rank their department's capacity to provide each of these services. Capacity was defined as "the ability to lead activities, provide subject-matter expertise, and apply for, receive, and manage resources to conduct the key activities for each EPHS."

The vast majority of states reported having substantial to full capacity to conduct EPHS 1 (76%) and EPHS 2 (88%) (Figure 10). By contrast, only 43% of states reported substantial to full capacity in EPHS 9, and 39% reported partial and 18% reported minimal to no capacity. Among the 4 territories, the patterns were similar: greater capacity for EPHS 1 and 2 but lower capacity for EPHS 9. No consistent or statistically significant pattern emerged on capacity for the 3 EPHS by either state size or region.

States continue to report substantial or better capacity in monitoring health status and diagnosing and investigating health problems but more limited capacity in evaluation and research.

Figure 10 EPHS capacities, 50 states and DC, ECA 2021



Compared with 2017, capacity decreased for EPHS 1 (monitoring health status), from 84% to 76% reporting substantial to full capacity, and for EPHS 2 (investigating health problems and hazards), from 92% to 88%. Capacity in EPHS 9 (research and evaluation) rose from 39% to 43% reporting substantial to full capacity; however, EPHS 9 now measures both research and evaluation unlike in 2017 when these areas were measured separately in EPHS 9 (evaluating effectiveness, accessibility, and quality of health services) (39%) and EPHS 10 (researching for new insights and innovative solutions to health problems) (22%).

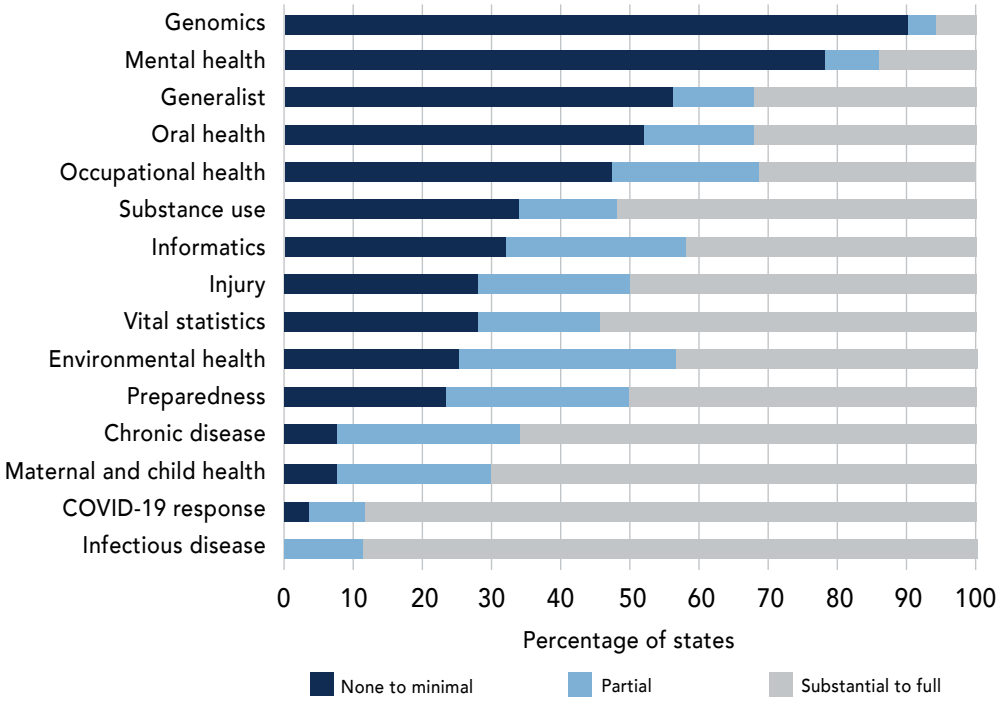
Capacity in monitoring health status and diagnosing/investigating problems declined from 2017 to 2021, although a minor increase occurred in capacity for research and evaluation.

Capacity in program areas

States were asked to report on the overall current epidemiologic capacity to provide the 3 EPHS in each program area; capacity again was defined as the ability to lead activities; provide subject-matter expertise; and apply for, receive, and manage resources to conduct key activities. States that did not have programs in an area within the state health department were considered to have no capacity in that area.

The areas for which the states reported the highest percentages of minimal to no capacity were genomics (90%), mental health (78%), and generalist (56%) (Figure 11). The percentage of states reporting substantial to full capacity was greatest for infectious disease (88%), followed by COVID-19 response (88%), maternal and child health (70%), chronic disease (66%), and preparedness (50%).

Figure 11 EPHS capacity by program area, 50 states and DC, ECA 2021



Capacity is high in well-established program areas, including infectious disease, maternal and child health, and chronic disease but remains lower for newer areas such as genomics and informatics, and for areas with low numbers of epidemiologists, such as mental health and oral health.

From 2017 to 2021, preparedness (–17%), chronic disease (–12%), and infectious disease (–8%) had the largest decreases in the percentage of states reporting substantial to full capacity (Table 6). On the other hand, substance use (36%), informatics (17%), mental health (12%), occupational health (10%), and oral health (10%) had the biggest increase in the percentage of states reporting substantial to full capacity from 2017 to 2021 (Table 6).

Table 6 Proportion of states reporting substantial to full EPHS capacity by program area 2017-2021, ECA 2021

Program area	Proportion of States with Substantial to Full Capacity, 2017	Proportion of States with Substantial to Full Capacity, 2021	Percent Change 2017 to 2021
Substance use	16%	52%	36%
Informatics	25%	42%	17%
Mental health	2%	14%	12%
Occupational health	22%	31%	10%
Oral health	22%	32%	10%
Vital statistics	45%	54%	9%
Injury	43%	50%	7%
Genomics	4%	6%	2%
Environmental health	43%	43%	0%
Maternal and child health	71%	70%	–1%
Infectious disease	96%	88%	–8%
Chronic disease	78%	66%	–12%
Preparedness	67%	50%	–17%

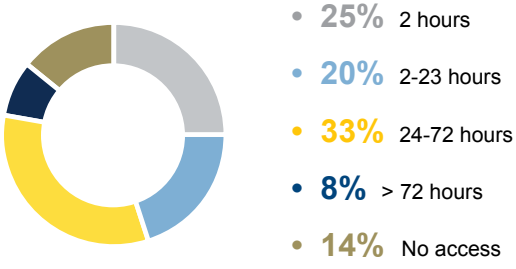
Access to the literature

Having ready access to non–open access peer-reviewed literature is essential for appropriate response to emerging and ongoing health issues and to implement evidence-based practices.

State Epidemiologists were asked whether they had access to such literature and, if so, how long it took to obtain requested articles. A total of 86% of the states and DC reported access to the literature, although the time required varied (Figure 12). This was a significant increase from 2017, when 75% of states reported access to the literature (p = 0.03).

Fewer than half of the states and DC had access to non–open access literature within 24 hours, and 14% had no access at all.

Figure 12 Time required to access literature, 50 states and DC, ECA 2021



Medium states were more likely to not have any access (29%) than large (11%) or small (0%) states, but the differences were not significant. Although all 12 Midwestern states reported having access to literature, 29% of the Southern states reported having no access; however, differences were not significant. Three of the 4 territories had no access to the peer reviewed literature, and the remaining territory had access but must wait at least 72 hours from the initial request to gain access.

Outbreak management system

State Epidemiologists were asked whether the state health department used an outbreak management system, defined as a system that "supports the initial characterization, investigation, response, and containment of outbreaks through the collection and analysis of data." A total of 78% of states and DC reported that they used such systems, as did 3 of the 4 participating territories. No significant differences were noted by state size or region. This finding represents a substantial but nonsignificant increase from the 69% of states reporting use of an outbreak management system in 2017.

Case-based surveillance system during the COVID-19 response

States were asked to rate the ability of their case-based surveillance system to adapt for the COVID-19 response on a scale of poor, fair, or good. Nearly half of states rated their system's adaptability as "fair"; 36% rated their systems as "good"; and 15% rated their systems as "poor." Nearly all states (94%) also implemented an additional contact tracing system for the COVID-19 response. However, at the time this assessment was fielded in spring 2021, most states were unsure whether they would continue using the contact tracing system after the COVID-19 response. States that were not going to continue use of the contact tracing system cited issues of long-term sustainability and problems integrating the system into their surveillance plan.

Salaries for civil service epidemiologists

Salaries by degree and career level

Each participating jurisdiction was asked to provide a civil service salary range for epidemiologists within its agency by degree and by career level based on the AECs. A minimum and a maximum value were requested for each category (Table 7). Not all states had epidemiology positions for each degree category or career level. Only 32 (63%) states have a Deputy State Epidemiologist position.

Minimum and maximum salaries increased with educational attainment, although physician pay was considerably higher than pay for PhDs and DVMs, who have a comparable number of years of education. Salaries also increased by career level; however, the more managerial positions of Deputy State Epidemiologist and State Epidemiologist had substantially higher median salary ranges than those at senior level and below. No consistent pattern emerged in minimum and maximum salary levels for the 5 career levels by state size or by region. Data were limited for the 4 participating territories, but in general, salaries were lower than for the states and DC.

Table 7 Median minimum, and maximum annual salaries and ranges, by degree title and career level, 50 states and DC, ECA 2021

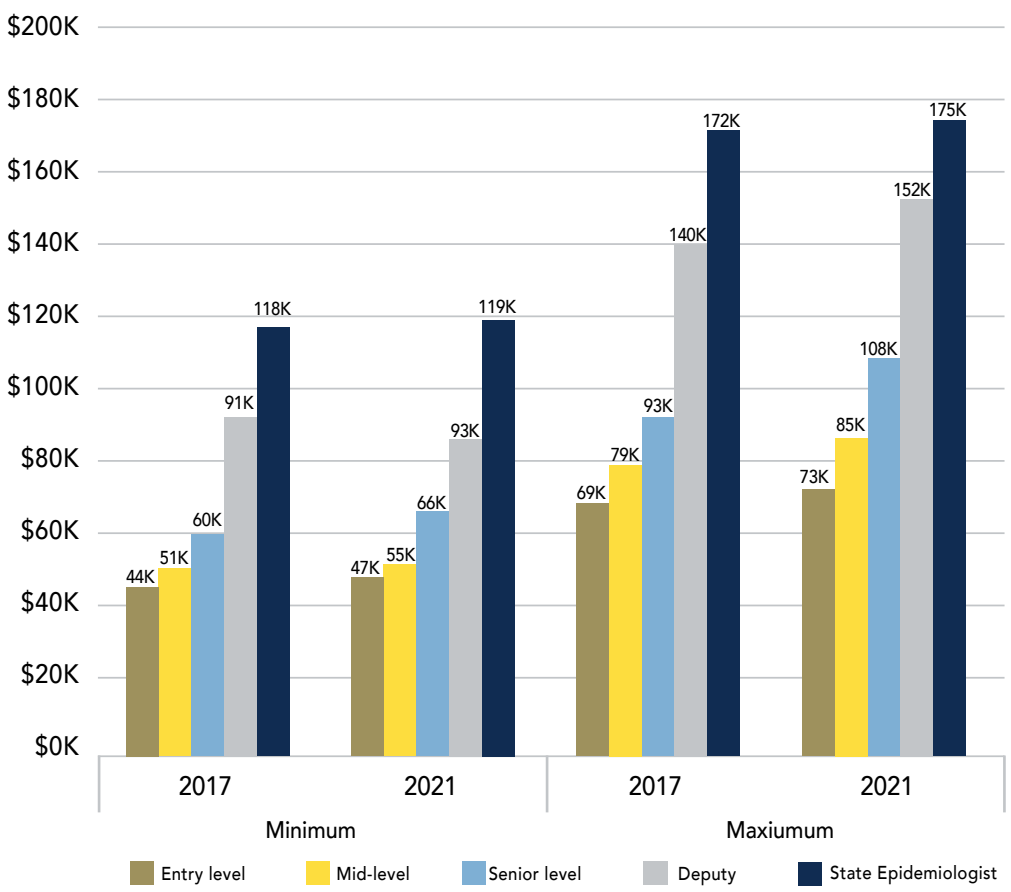
	Salary			
Category*	**Median minimum**	**Range, minimum**	**Median maximum**	**Range, maximum**
By degree title				
Associates (9)	$31K	$10K - $64K	$71K	$10K - $120K
Bachelors (32)	$45K	$31K - $82K	$82K	$48K - $200K
MPH (44)	$50K	$31K - $98K	$92K	$55K - $134K
PhD (43)	$63K	$31K - $175K	$110K	$72K - $200K
DVM (36)	$69K	$31K - $165K	$118K	$75K - $180K
DDS (18)	$64K	$31K - $138K	$121K	$81K - $228K
MD (43)	$113K	$31K - $239K	$186K	$66K - $327K
By career level				
Entry level (47)	$47K	$31K - $73K	$73K	$49K - $100K
Mid level (48)	$55K	$39K - $136K	$85K	$59K - $235K
Senior level (50)	$66K	$44K - $135K	$108K	$65K - $263K
Deputy (32)	$93K	$39K - $218K	$152K	$74K - $327K
State Epidemiologist (48)	$119K	$47K - $239K	$175K	$81K - $327K

*Number of responding jurisdictions shown in parentheses.

Changes in career-level salaries, 2017 and 2021

The minimum and maximum median salaries for entry-level positions increased by 6% and mid-level positions experienced a 7% increase in both minimum and maximum median salaries (Figure 13). Maximum values increased more substantially among senior-level positions (16%) and Deputy State Epidemiologists (10%). The least substantial change was among State Epidemiologist minimum and maximum salaries (increasing 1% and 2%, respectively). The US national level of inflation from 2017 to 2021 was 7.9% (Inflation Tool, 2021).

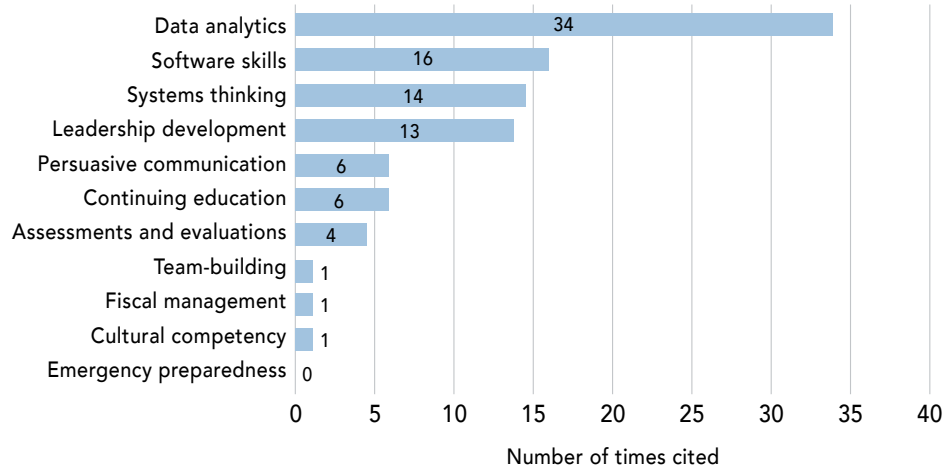
Figure 13 Minimum and maximum median salaries by career level, 2017 and 2021 ECA



Training priorities

Each State Epidemiologist was asked to list the top 2 most pressing staff training needs (Figure 14), such that there were 102 possible votes for the states and DC. Similar to 2017, the highest priority, by a considerable margin, was data analytics, defined as informatics and applying and translating public health data. Other training priority topics included software skills (Epi Info, SAS, SPSS, R), systems thinking (systems development, change management, strategic planning, and/or flexibility), and leadership development (identification of future leaders, coaching/mentoring programs, retention of current leaders), receiving 16, 14, and 13 votes, respectively. Team building, fiscal management, and cultural competency were mentioned by only 1 state each.

Figure 14 Top training needs identified by State Epidemiologists, 50 states and DC, ECA 2021



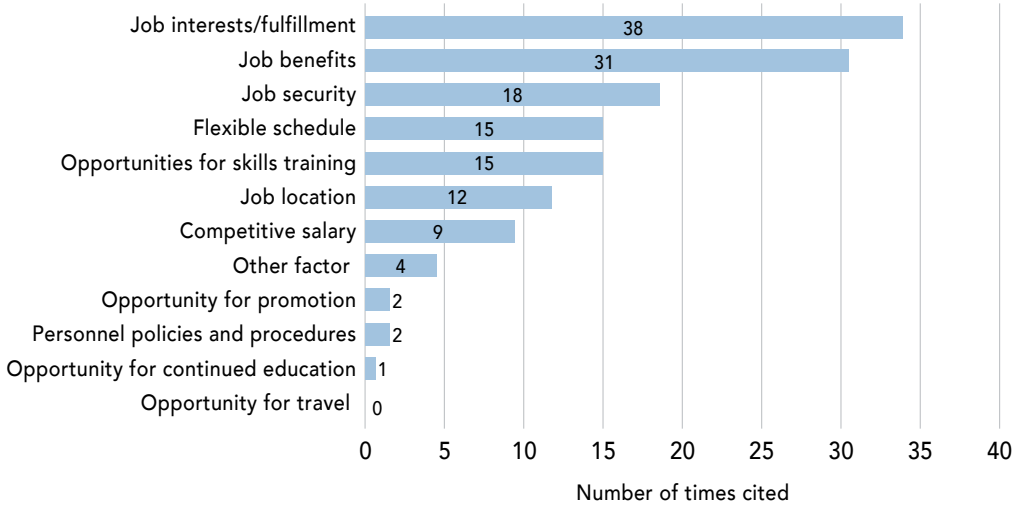
Training in data analytics remains an important priority for most states.

Existing practices and incentives aimed at strengthening the state epidemiology workforce

Strategies for recruitment

The State Epidemiologists were asked to identify assets for recruiting epidemiologists to the department (Figure 15). The assets most frequently cited were job interests/fulfillment, job benefits, opportunity for skills training, and ability to have a flexible schedule. By contrast, personnel policies and procedures, opportunity for promotion, and opportunity for continued education were cited less frequently, by ≤2 states. Three of the 4 territories cited competitive salary and job interest/fulfillment, and 2 territories cited job location and ability to have a flexible schedule as assets for recruitment.

Figure 15 Assets for recruiting at state health departments, 50 states and DC, ECA 2021



Recruiting a diverse workforce

The State Epidemiologists were asked to identify whether policies and procedures were in place to recruit a workforce with diverse backgrounds and skills. Of the 50 states and DC, 39% have a recruitment strategy that addresses race, ethnicity, and gender, and 43% have a strategy that addresses diverse skills and subject-matter expertise. Meanwhile, 43% of all states and DC do not have a recruitment strategy for diversity. Medium states had the highest rate of strategies that address diverse backgrounds (53%) and highest rate of strategies that address diverse skills and subject-matter expertise (47%). Midwestern states had the highest rate of strategies that address diverse backgrounds (58%), and Northeastern states had the highest rate of strategies that address diverse skills and subject-matter expertise (56%).

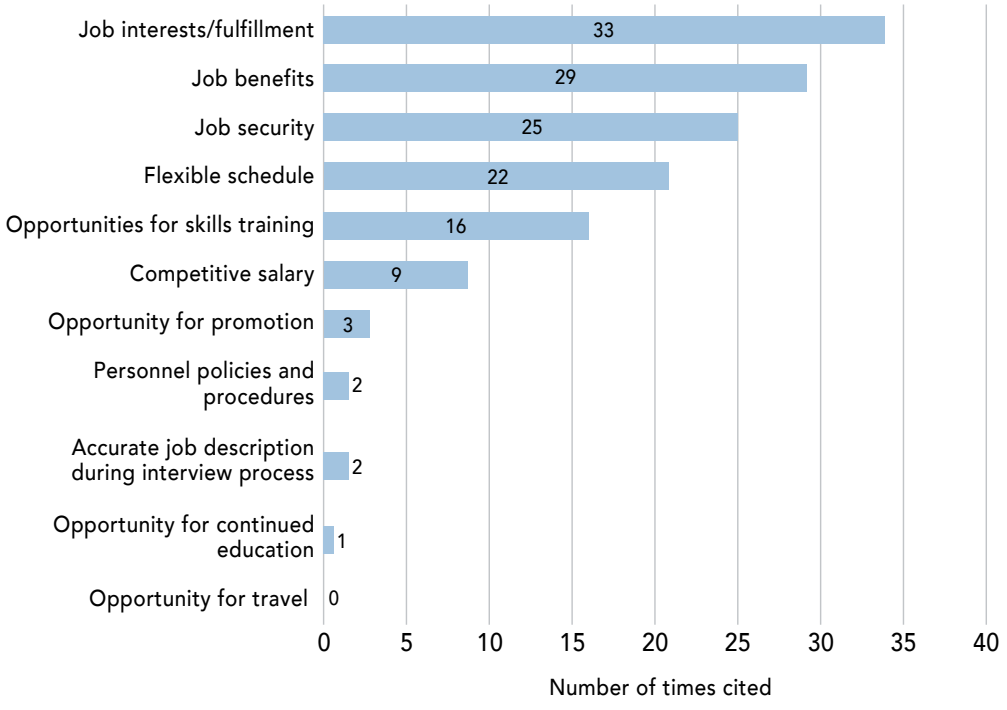
Job fulfillment, security, and benefits are commonly cited assets for recruiting epidemiologists to state health departments.

Retention and continuity planning

Assets for retention

State Epidemiologists were asked to identify assets for retaining epidemiologists at the state health department. The assets most frequently cited were job interests/fulfillment, job benefits, job security, and ability to have a flexible schedule (Figure 16). By contrast, personnel policies and procedures, accurate job descriptions, opportunities for continued education and opportunities for travel were cited by ≤2 states. These findings closely parallel the assets for recruitment. Three of the 4 territories cited job interest/fulfillment; 2 cited opportunities for skills training and competitive salary as assets for retaining epidemiologists.

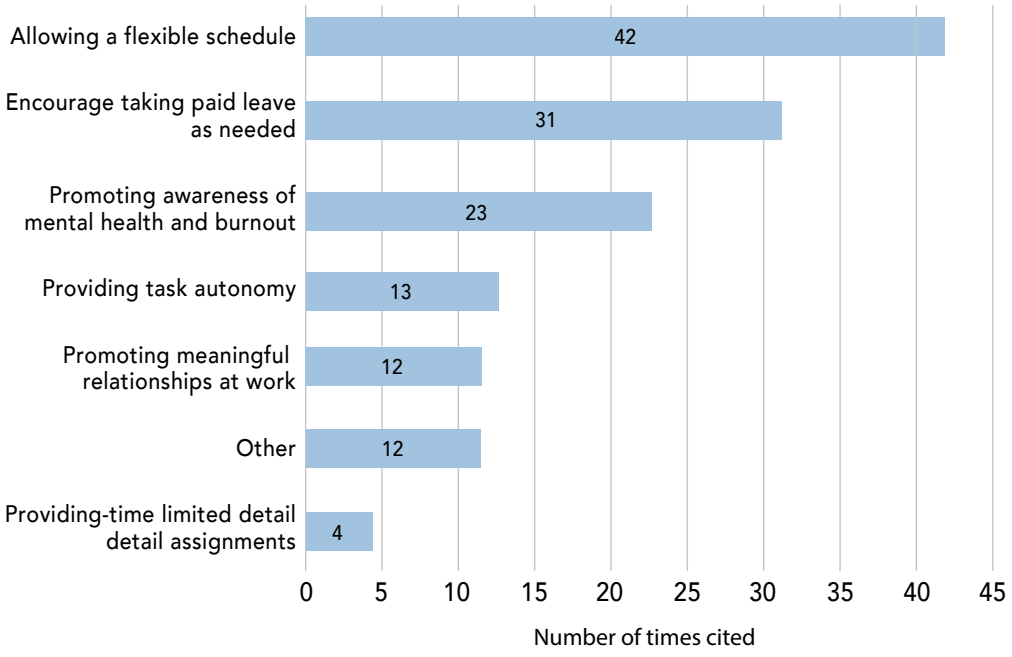
Figure 16 Assets for retaining epidemiologists at state health departments, 50 states and DC, ECA 2021



Strategies to minimize staff burnout

Because of the burden of the ongoing COVID-19 pandemic, epidemiologists were asked about their top 3 strategies for dealing with burnout in the department. The most cited strategies were allowing a flexible schedule, encouraging taking paid leave as needed, and promoting awareness of mental health and burnout (Figure 17).

Figure 17 Strategies for dealing with burnout, 50 states and DC, ECA 2021



Remarks from State and Territorial Epidemiologists

Although the quantitative information collected in the ECA provides objective data on the current situation and permits evaluation of trends, it does not fully capture the broader picture of what State and Territorial Epidemiologists believe is their greatest concerns. The 2021 ECA included 4 open-ended questions to inquire about recruitment strategies, critical issues faced by State Epidemiologists, data modernization efforts, and any additional comments from respondents. Several themes emerged from their answers, including strategies and challenges for recruitment and retention, developing and maintaining a competent and qualified workforce, addressing emerging issues, securing funding and responding to unfunded mandates, and leadership. The comments in this section reinforce the quantitative findings and provide additional details concerning the magnitude and seriousness of many of these issues. In this section, we summarize some of the responses and provide illustrative quotes.

"As the State Epidemiologist, what are the most critical issues you face?"

Recruitment of high-quality epidemiology staff remains elusive.
State Epidemiologists frequently mentioned lack of competitive salaries or benefits to attract applicants and the inability to hire quickly as major barriers for recruitment. The pay scale at many state health departments is not competitive with the private sector and lacks standardized salary ranges or regular salary increases. Not only are departments unable to attract a diverse pool of qualified applicants, they also are unable to compensate or reward hard-working personnel, often contributing to turnover and burnout. States also reported difficulties recruiting skilled epidemiologists, especially those with knowledge of informatics or specific clinical expertise.

> *"Our state salaries are a challenge when it comes to recruiting and retaining skilled and valuable employees."*

> *"[We have] difficulty recruiting specialized staff, both permanent state [employees] and contractors."*

> *"We currently do not have an "official" State Epidemiologist in place. The position is currently vacant and not easy to fill, especially during a public health crisis."*

> *"We have challenges to recruiting and retaining qualified staff, in part due to the inability to offer state employees merit-based raises or promotions."*

Retaining skilled epidemiology staff continues to be a challenge.
State health departments regularly experience turnover for epidemiology positions, resulting in loss of institutional knowledge and an increased burden on the remaining workforce. States expressed not being able to retain staff because of burnout and inadequate salaries. States are losing trained epidemiologists to better paying jobs, resulting in a limited number of experienced mid- and senior-level epidemiologists and a reduction in subject-matter experts.

> *"[We have] high turnover in entry-level and mid-level epi[demiology] positions; once they are trained they work a short time and leave for higher paying positions."*

> *"The state pay range for epidemiologists is very low compared with other state jobs and compared with epidemiologists in local health departments. This creates a system where epidemiologists seek other jobs within the agency, at local health departments, or in the private sector. We train the epi[demiologist]s, only to lose them to better paying jobs once they have some work experience."*

State health departments are struggling with employee burnout from the COVID-19 response.
State health departments have been pivotal in the COVID-19 pandemic response, resulting in many epidemiologists working long hours for extended periods of time. At the time the ECA was fielded, states reported contending with employee exhaustion from the response and ongoing efforts to reduce employee hours back to normal.

"Currently we're still trying to keep our heads above water with the COVID-19 response. We are working hard to get employees' hours back down to a normal level to decrease burnout."

"There are unrealistic national expectations for ongoing COVID-19 case-based surveillance. There is a lack of a national plan to streamline COVID-19 surveillance activities resulting in dramatic burnout and turnover in our staff."

"Epi[demiology] staff are stressed and tired of working on COVID-19 response. They would like to get back to working on their own program areas."

Because of budgetary and human resources system restraints, many health departments do not have opportunities for employee advancement.
Advancement opportunities are essential for retaining epidemiologists and promoting career growth within the organization. Many state health departments cited the inability to offer promotion opportunities because of budgetary restrictions or rigid human resources systems and policies that inhibit advancement.

"[Our] personnel system makes it difficult to advance without changing jobs, causing lots of job movement within the department."

"The state is in a budget crisis and making substantial budget cuts. Because of the budget crisis, there are very minimal opportunities to reward, promote, or compensate employees for excellence or working overtime."

"[We have] limited opportunities to offer career advancement for epidemiologists."

State health departments are dealing with increasingly large amounts of data and need upgraded technology and adequate support staff.
The COVID-19 pandemic saw the onset of enhanced case-based surveillance and an influx of data to state health departments. States need a robust data system that is interoperable across program areas and streamlines the gateway between data collection and dissemination. Personnel with specialized skills in informatics are needed to transform the data for the public and dedicated IT support staff are necessary for maintaining these data systems over time.

"The most critical issue faced is our information and data systems. We are working toward a more robust statewide surveillance and disease reporting system, but in the interim data exist in multiple systems and are not easily merged and analyzed."

"There is a huge demand for information including data and trends. The amount of information flowing into the agency and the need to quickly analyze that information and formulate recommendations for state and agency leadership requires most epidemiologists to work long hours and meet daily and sometimes hourly deadlines."

"Many epidemiologists are stuck in the rut of churning numbers the same way they have always been done. Microsoft Excel is the most commonly employed analytic tool."

"[We need] more IT support so that epidemiologists can focus on doing epidemiology and not data entry."

Funding remains a major concern for State and Territorial Epidemiologists.
Most funding for epidemiology personnel and activities continues to come from federal sources, often creating prescriptive siloes of money that are earmarked for certain activities and don't always meet the specific needs of the individual health departments. States cite the inability to fill all their available positions because of funding restrictions and a lack of job security because of intermittent funding. Lack of job security creates uncertainty in the workforce and might directly affect workforce retention.

"Local funding is critical for sustainability. However, the amount of funding for epidemiology program activities is minimal. The expectation is that we should be able to take advantage of federal funding to conduct our activities. The problem is that there are certain positions that we cannot easily find funding for through our federal grants, like the position of grants specialist."

"Almost all of the funds for the recruitment of epidemiologists come from federal grants and cooperative agreements, so the epidemiologists are a kind of irregular employees without any kind of job benefit. There is not job security."

Staffing restrictions and antiquated data systems make it difficult for state health departments to deal with emerging health issues.

Due to the immediacy of the COVID-19 response, state health departments were quickly inundated with requests and a need for additional personnel to adequately respond. During the response, many departments have faced restrictions on who could be hired or deployed during the pandemic and were contending with outdated systems unable to adequately deal with the influx of time-sensitive data requests, resulting in unnecessary delays in response activities.

"Most epi[demiologist]s working for the state health department are contractors, which means the health department may have a limited say on how they can be deployed in an emergency (such as a pandemic)."

"[One of the most critical issues we face is] maintaining our operational integrity while trying to respond to COVID-19 in the face of public pressures."

"[One of the most critical issues we face is] collecting and presenting relevant data to drive science-based COVID policy development in real time. Surveillance data do not always have the quality needed for this."

Many program areas have been neglected over the last year during the COVID-19 response.

During the COVID-19 pandemic, many epidemiologists were reallocated from their designated program areas to assist with the response for a prolonged period of time. However, the COVID-19 response demonstrated that as emergent issues arise, the leadership and workforce in state health department do not have the bandwidth or training to support regular activities and respond to emerging issues and funding wasn't always flexible enough to enable the reassignment of personnel to adequately respond to priority needs.

"Needs also exist outside of COVID which should be funded and staffed better."

"Other program areas have suffered and surveillance and response for other reportable conditions and outbreaks have been negatively impacted."

"[The] sole focus of current job has been on COVID-19, in our current structure [the] State Epi[demiologist] oversees infectious disease, but as other urgent epi issues emerge (e.g., VAPI [Vaping-associated Pulmonary Injury], opioid use, etc.) there hasn't been resources and epidemiologists trained to do surveillance in these other areas of public health. Currently also the challenge of ensuring any attention can be paid to oversight for all of the continuity of operations of other infectious disease programs and issues."

"What does your department need to support data modernization efforts?"

Departments require flexible, sustainable funding to implement data modernization efforts and obtain appropriate personnel.
States require sustainable funding that will support updating existing data systems and the necessary, skilled personnel to maintain them. Flexible funding would enable states to build and maintain systems that meet their individual needs, creating efficiency and streamlining data sharing between federal, state, and local health systems.

> *"[We need] funding for rebuilding our aging infrastructure and hiring of IT personnel to maintain it. Adequate funding for informaticians is also needed."*

> *"[We need] additional funding dedicated to the assessment, implementation, and sustainability of data modernization activities."*

> *"[We need] sustained funding in a flexible manner that allow for thoughtful building of what we need and not just what we assume we will have money for in the long run. [They can't expect] that large influxes of money for short periods of time will fix the issue."*

> *"[We need] additional funding and experienced IT staff to help assess current systems and provide strategic oversight to improve data collection and analysis systems together with other local, state, and national partners."*

Data systems must be evaluated and upgraded to be more efficient and interoperable.
State health departments are consistently processing large amounts of data and need to translate and display this data for the public. However, many departments are working with aging data systems that lack interoperability and standardization, often creating inefficiencies and duplication of efforts. These challenges were exacerbated by the influx of data from the COVID-19 response, and many systems were hurriedly updated or abandoned without consulting states or considering implications for sustainability or interoperability with the existing infrastructure. To combat this issue, states noted the need for an evaluation of all systems to understand their current capability and interoperability capacity. To move these efforts forward, a coordinated strategy is needed that incorporates federal, state, territorial, and local leadership.

> *"[We need] an analysis across all our systems to assess existing Health Information Systems infrastructure/capacity (including IT and Informatics), current and future needs, interoperability of systems, and other key elements of the Data Modernization Initiative (DMI)."*

> *"There remains a large disconnect between CDC program areas and national surveillance activities. States consistently submit multiple duplicate data streams to CDC and have for decades."*

There is a commitment to data modernization efforts, but comprehensive training initiatives are needed to upskill the current workforce.
As data systems continue to be updated and infrastructure built for data modernization efforts, comprehensive training is needed to upskill the current workforce. For personnel to capitalize on CDC's Data Modernization Initiative, they need on-the-job training that provides the necessary skills to use updated software and systems and complements staff's epidemiology backgrounds with training in informatics and data analytics.

> *"We know that CDC has a training program for informaticians. Though we have made use of the training before, the staff that were trained left immediately after their training for other lucrative jobs."*

> *"We need technical training and building out staff capacity to fully utilize data modernization activities."*

> *[We need] education for the state epidemiologist and others in the Division of Epidemiology on what data modernization would look like.*

[We need] additional staff with both epidemiology and information technology credentials.

"Please share any additional context and details about your recruitment strategies."

State health departments consistently leverage academic partnerships to recruit epidemiologists and expose public health students to applied epidemiology.
When asked about strategies for recruiting new epidemiologists to state health departments, numerous states cited partnerships with academic institutions. Many epidemiologists are adjunct faculty or guest lecturers with local universities and schools of public health, as well as host student interns and support practicum experiences. These relationships enable students to gain exposure to the health department and aid in recruiting a diverse workforce.

"The agency has contracts with local universities, as well as the local School of Public Health, to expose and integrate students into the field of public health. This is done through academic work (practicums, preceptors), internships, externships, and volunteer opportunities. The agency also collaborates with these partners by providing guest lecturers and many of the employed epidemiologists are adjunct faculty in academic institutions."

"We [have a program where we] hire students as employees (Part-Time) [and] these students later apply for entry level positions and work their way up."

"We do host student interns from the public health schools in the area which serves as a great pipeline for future employees and assists in recruiting a diverse workforce."

Health departments use postgraduate training programs to recruit new epidemiologists to the field.
Postgraduate training programs, including the CSTE Applied Epidemiology Fellowship and the CDC Epidemic Intelligence Service (EIS) program, enable recent public health graduates to obtain field experience and enhance their skills. Many states cited these training programs as important pipelines for recruiting new applied epidemiologists.

"[Our state's] EIS Program trains college graduates in the different specialty areas within [our state's] Department of Public Health. The program lasts 2-years and students who complete the training are hired in the different areas."

"We host EIS officers, interns, and fellows from various programs."

States are actively working to implement policies to recruit a workforce with diverse backgrounds and skills.
As the landscape of public health transforms, a diverse workforce is more important than ever. States reported implementing strategies that encourage hiring a workforce with diverse backgrounds and skills, including emphasizing experience and not just education in the job description, collaborating with local community partners, blind application reviews, implementing diversity, equity and inclusion trainings and allowing for remote work options.

"Strategies that we have implemented include but not limited to: switching around the qualifications to promote experience and not just education; advocating for hiring committees to send out applications to local community partners and business affiliations; utilizing blind application reviews; diversifying hiring committees and providing training around bias before reviewing applications/ interviewing; reviewing interview questions for bias."

"[We are] adding diversity and inclusion team members to the hiring team."

"It can be challenging in a rural state to attract candidates with diverse skill sets and who are subject-matter experts (SMEs). We are exploring out-of-state remote work options for interested candidates who do not want to come to the state."

DISCUSSION

Discussion

The 2021 ECA describes important issues of workforce development among State Epidemiologists that are relevant for leaders at state health departments, public health partners, the federal government, and academic institutions. All 50 states and DC participated, and 4 territories also responded. Data quality was high, and the open-ended questions yielded additional richness to the quantitative findings.

Overall, the 2021 ECA shows that, although the epidemiology workforce continues to grow, there is ongoing unmet need in both well-established areas such as infectious disease, and emerging program areas, such as genomics and mental health. Compared with 2017, capacity has decreased for EPHS 1 (monitoring health status), from 84% to 76% reporting substantial to full capacity and for EPHS 2 (diagnosing/investigating health problems), from 92% to 88%. Capacity in EPHS 9 (research and evaluation) rose from 39% to 43% reporting substantial to full capacity, however, it remains substantially lower than capacity for EPHS 1 and EPHS 2. Participants cited job interests/fulfillment, job benefits, and the opportunity for a flexible schedule as current assets for recruiting and retaining a qualified workforce, but there remains a need for more competitive salaries and advancement opportunities to attract a diverse applicant pool. Similar to 2017, most states and DC also noted the need for training in data analytics. As state health departments continue to rely heavily on federal funds, there is less flexibility for prioritizing emerging needs and added workplace insecurity. These issues are presented in greater detail in the discussion.

Key findings

Number of epidemiologists

- **Although the number of epidemiologists has increased since 2017, most new epidemiologists can be attributed to the COVID-19 response.** The total number of epidemiologists working in the 50 states and DC is 4135, a 23% increase over the 3370 counted in 2017 and the highest number yet observed in the ECA. The number of epidemiologists per 100,000 population increased 21% since 2017, from 1.04 to 1.26/100,000. Infectious disease lost 340 epidemiologists since 2017; however, 36% (1498) of the workforce remains concentrated in infectious disease, and 24% (978) are in COVID-19 response. The decrease in epidemiologists in certain program areas, particularly infectious disease, might reflect the need to reallocate personnel during the COVID-19 response. The reallocation of staff might have been particularly detrimental in areas such as substance use, injury, and mental health, as community rates of mental illness and substance use increased during the pandemic but staffing capacity remained limited in departments (Czeisler et al., 2020). Most new epidemiologists in 2021 can be attributed to the COVID-19 response, which might indicate the workforce may not have grown substantially without the pandemic. The increase in epidemiologists does not accurately represent the long-term capacity of the applied epidemiology workforce, especially because there are 851 epidemiology vacancies nationwide and high levels of turnover amongst staff.
- **A need for additional staffing remains, even in program areas that already have numerous epidemiologists.** State Epidemiologists expressed the need for nearly 2196 additional epidemiologists to reach full capacity to deliver the 3 EPHS, representing a 53% increase over the 4135 current number for a total of 6331

epidemiologists. The greatest number of positions needed were in infectious disease (562), COVID-19 response (454), chronic disease (153), maternal and child health (135), and environmental health (135). Although states expressed the need for additional capacity in areas such as genomics and mental health, the total number of positions needed in these areas was relatively small. Genomics needs an additional 46 epidemiologists (a 922% increase), and mental health needs an additional 57 epidemiologists (a 656% increase). Recruiting for program areas, such as genomics, can be particularly challenging because they require personnel with specialized skills and clinical expertise. Although 2196 epidemiologists are required to fulfill basic public health needs, nearly 8000 additional epidemiologists might be needed for transformation across state, local, tribal, and territorial health departments to bolster systems and build sustainable public health infrastructure.

Training Priorities

- **Similar to 2017, data analytics remains a top training priority among states.** Data analytics was the top training priority mentioned by 34 states, and 16 states also mentioned software skills (statistical software like Epi Info, SPSS, and R), and 14 mentioned systems thinking (systems development, change management, strategic planning) as training needs. States need to both upskill the existing workforce and recruit trained individuals into departments. Fellowship programs and internships are excellent opportunities to expose qualified persons to the field of public health and are an important pipeline of new epidemiologists. Opportunities for partnership can be explored to build data analytics and systems thinking skills, especially with academic institutions and entities with experience in workforce training in systems management. Focus also should be placed on ensuring the emerging workforce has adequate training in data modernization and health equity because they are vital facets to public health.
- **Access to peer-reviewed literature that is not open-access remains limited in many states.** Timely access to peer-reviewed literature is essential to respond to emerging threats and to ensure ongoing activities are evidence-based. A quarter of all states and DC have access to peer-reviewed literature within 24 hours after requesting it. Although overall access has increased significantly since 2017, 14% of states still do not have access to peer-reviewed literature and >50% of states had to wait >24 hours to gain access. States with slow or limited access should consider university partnerships or participation in the National Network of Libraries of Medicine.

EPHS Capacity

- **States continue to have substantial capacity for monitoring and assessing health problems but lack capacity for research and evaluation.** In 2021, the percentage of states and DC with substantial to full capacity for EPHS 1 (monitoring health status hazards) was 76%, a decrease from 84% in 2017. The percentage of states and DC with substantial to full capacity for EPHS 2 (investigating community health problems and hazards) was 88%, a decrease from 92% in 2017. The percentage of states and DC with substantial to full capacity for EPHS 9 (research and evaluation) was only 43% in 2021. However, research and evaluation were evaluated separately in 2017 with EPHS 9 and EPHS 10. In 2017, 39% of states reported substantial to full capacity in EPHS 9 (research), whereas only 22% reported substantial to full capacity in EPHS 10 (evaluation). Because of a lack of infrastructure and funding stipulations, states might be unable to conduct research and evaluation consistently. Programmatic evaluation is key to capturing lessons learned and adopting quality improvement frameworks to ensure public health activities are being conducted as were intended and offer value to the community. Research and evaluation needs to be included in funding allocations and for providing skills training to staff in these areas.

Funding

- **Federal funding continues to pay for most epidemiology activities and personnel and limits adequate coverage of underserved program areas.** Federal funds constituted >80% of funding for all epidemiologic activities in state programs. Unlike previous ECAs, federal funding percentages also include COVID-19 funds provided by the federal government. States contributed an average of 12%; other sources accounted for

only a small percentage of the total in most states. Similar to epidemiology activities, federal funds constituted >80% of funding for personnel, including COVID-19 funds. States contributed an average of 15%, and other sources accounted for a small percentage of the total in most states. Federal funds constitute the vast majority of funds for virtually all program areas; only in the case of vital statistics and generalist program areas did state funding contribute >50% of funding. Current funding models are restrictive and prevent state health departments from being able to hire qualified, long-term personnel quickly and efficiently. Flexible, sustainable funding sources are needed that support and maintain the necessary public health infrastructure.

Recruitment and retention

- **The biggest assets for recruiting and retaining the epidemiology workforce include job interest and fulfillment, job benefits, and job security.** In qualitative responses, states also noted the need for standard position descriptions and career ladders that showcase clear opportunities for advancement. As the roles and responsibilities of the public health workforce evolve, it is necessary for institutions and departments to train emerging epidemiologists to have a diverse array of skills so they can remain competitive in the job market (Krasna et al., 2021). In addition, state health departments require a workforce with a variety of backgrounds and skills. However, only a quarter of states and DC have a strategy that addresses recruiting candidates with both diverse backgrounds and skills.
- **Lack of competitive salaries remains a barrier to recruitment and retention of the workforce.** Minimum and maximum salaries in the 50 states and DC increased with educational attainment, although physician pay was considerably higher than for PhDs and DVMs. Salaries also increased by career level, although the more managerial positions of Deputy and State Epidemiologist had substantially higher median salary ranges than those at senior level and below. Most salary increases in career-level categories did not surpass the 7.9% inflation rate from 2017 to 2021. Epidemiologists are starting at inadequate base salaries and often not receiving regular increases to cope with inflation and the increased cost of living. In an era of increasing education costs and student debt, the salaries offered by health departments are likely to be even less competitive than in the past. Epidemiologists working in scientific research and development (often in the pharmaceutical industry) are the highest paid in the field, with a median salary of $99K in 2020, notably higher than the median salary of $55K for mid-level epidemiologists working at the state level (Bureau of Labor Statistics, 2021).
- **States are allowing flexible schedules, encouraging paid leave, and promoting awareness of mental health to minimize burnout among the workforce.** Participating states cited allowing a flexible schedule, encouraging taking paid leave, and promoting awareness of mental health as major strategies for minimizing burnout. Although job fulfillment, security, and the opportunity to have a flexible schedule are notable assets for retaining the workforce, efforts should be made to increase recognition of epidemiologists, particularly given their vital role in the COVID-19 pandemic response. Public health leadership needs to both create policies and support a cultural shift in the workplace that promotes mental well-being and encourages the use of paid leave.

Epidemiology Leadership

- **A high proportion of epidemiologists are new to their positions; others are likely to retire in the upcoming years.** State Epidemiologists have been on the job for a median of 4 years, down from 5.8 years in 2017. One in 6 epidemiologists have been in their position for <1 year; only 41% have served in their current position for at least 5 years. High turnover and a lack of succession planning are detrimental as new epidemiologists must be prepared to tackle learning technical aspects of their job, navigating hiring and administrative practices, and obtaining funding to support epidemiologic activities. In addition, epidemiologists need to be able to skillfully navigate political challenges and manage large incoming funding, such as CDC Epidemiology and Laboratory Capacity for Prevention and Control of Emerging Infectious Diseases grants. Leadership training and mentoring might be important in states with new State Epidemiologists, and

succession planning might be important for states in which State Epidemiologists will be retiring soon. Retaining the workforce, particularly those in leadership positions, is important for maintaining continuity and conserving institutional knowledge.

- **The number of states with program area leads has increased for almost all areas, but most states still lack leads in areas such as oral health, mental health, and genomics.** The greatest increase in program area leads occurred in informatics, where the percentage of jurisdictions with a lead epidemiologist nearly doubled, a significant increase from 37% to 71%. Despite overall gains in the number of states with program area leads, more than half of states lacked a program lead in oral health, mental health, and genomics. Lack of a lead affects a state's capacity to monitor and investigate health problems in those program areas and to compete for funding in those areas. The absence of leads in genomics is particularly detrimental because it has the least amount of epidemiologists in the nation, despite being a priority need for many state health departments. Program area leads are critical for vying for funding and increasing the workforce in emerging program areas. Cross-training is also needed between program areas and positions that can work interoperably and connect program siloes, like data coordinators. Emerging issues, like COVID-19, have demonstrated the importance of having skilled personnel that can work efficiently across program areas when needed.

Case-based Surveillance and Outbreak Management Systems

- **Nearly all states implemented an additional contact-tracing system for the COVID-19 response; however, at the time the ECA was fielded, most states were unsure whether they would continue using the system after the pandemic.** Of the 50 states and DC, 78% reported also using an Outbreak Management System, defined as a system that "supports the initial characterization, investigation, response, and containment of outbreaks through the collection and analysis of data." This is a notable increase from the 69% of states reporting use in 2017. When asked about contact tracing systems, 94% of states implemented an additional contact tracing system for the COVID-19 response. States that were not going to continue use of the system cited issues of long-term sustainability and problems integrating the system into their surveillance plan. When asked to rate their case-based surveillance system's ability to adapt for COVID-19 on the basis of a scale of poor, fair, or good, nearly half of the states rated their system's adaptability as "fair." Because of the immediacy of the COVID-19 pandemic, surveillance systems were hastily implemented without strategic oversight and plans for sustainability. In addition, the political environment heavily influenced the collection and display of relevant data during the response, requiring immediate upskilling of the workforce. To achieve public health transformation and data modernization initiatives, strong leadership at the national level is needed to coordinate a strategy that accommodates state and local jurisdictional variation. Additional leadership to support the ongoing transition from case-based surveillance to greater sentinel and syndromic surveillance is essential to alleviate the burden on the public health workforce while still monitoring the health of communities.

The territorial situation

- **Territories face unique challenges related to geographic isolation, poor access to the literature, inability to host students, and the need for additional staff to achieve ideal capacity.** Maintaining continuity and capacity in these remote settings and fostering culturally appropriate interventions are particularly difficult. Many territories do not have nearby schools of public health or other universities from which to recruit emerging epidemiologists, limiting their workforce. In addition, territories struggle to retain epidemiologists, often lacking competitive salaries or clear paths for career advancement. Territories need basic infrastructure to be able to provide public health services and creative strategies for recruiting, retaining, and mentoring the applied epidemiology workforce. Further efforts, such as examining successful epidemiology programs in rural US states, are needed to learn what can be done to improve capacity.

Limitations

The 2021 ECA has several limitations. The response rate was 100% for the states and DC and only 4 of the US territories that received the assessment, and thus does not provide a comprehensive picture for all territories. Furthermore, the 2021 ECA was fielded during the COVID-19 pandemic, thus impacting the completeness of responses. Many State Epidemiologists were on the frontlines of the response efforts in their states and encountered time and capacity constraints for completing the 2021 ECA. Similarly, the data reflect the jurisdiction's needs at the time of fielding, which might be biased toward immediate priorities, such as responding to COVID-19, instead of routine public health activities and planned strategic priorities or the resources to support public health transformation.

In addition, the ECA is cross-sectional, capturing only a specific point in time. Furthermore, although guidelines were provided in the questionnaire, the definition of what constitutes an epidemiologist does not necessarily align with job titles and has a subjective component to it, which might affect differences between states and in the same state over time, especially when the State or Territorial Epidemiologist completing the form has changed and a large influx of temporary epidemiology staff has occurred during the COVID-19 response. Although the ECA intentionally did not include contact tracers or case investigators in enumeration efforts, it is possible that some of these epidemiology support staff were unwittingly included in this year's overall count of epidemiologists.

The 2021 ECA included a new question asking State Epidemiologists to report the number of exit interviews conducted during March–December 2020. The number of exit interviews was intended to serve as a proxy for turnover rates during the COVID-19 response. However, epidemiologists might have left the department without an exit interview and therefore the number of exit interviews may not comprehensively measure the amount of turnover during the pandemic.

Yet another important issue was that a substantial proportion (39%) of the State Epidemiologists have been hired since the 2017 ECA, and thus respondents are not the same over time, which might have also influenced questions about topics such as perceived capacity, which have a large subjective element.

An additional potentially serious problem in making temporal comparisons rests with obtaining a comprehensive count of the number of epidemiologists in each state overall and by program area. In some states, environmental and mental health, for example, are part of separate agencies that were not included in the assessment. Perhaps more important numerically, in many states there are large city and county health departments that provide services for their local populations, and the state health agency data might not present a comprehensive picture. Although big city health departments are included in a separate ECA-like questionnaire that is now being conducted jointly with the Big Cities Health Coalition to gain a more comprehensive picture, data such as the number of epidemiologists per 100,000 population might underrepresent the reality in certain states.

RECOMMENDATIONS

Recommendations

The ECA data informs CSTE's recommendations on the topics of infrastructure, workforce, recruitment and hiring, retention, collaboration, and future assessments.

Infrastructure

Systems need to be in place to ensure connectivity and critical coordination between clinicians, laboratorians, and public health professionals for timely standardized data collection and analysis to accurately describe the health of communities and to prevent disease. Faxing case reports and duplicate data entry is antiquated and negatively impacts the validity of public health data. Shifting to electronic data collection and management is vital to support the infrastructure transformation resulting in timely and accurate data. Frequently epidemiologists use outdated computers with limited software licenses, which substantially slows the processing and analysis of data. The technology available to support epidemiology activities needs to be upgraded to ensure electronic data collection and timely data analysis and reporting.

Recommendations

- Create and maintain coordinated, interoperable data systems that provide timely, complete, useful, and accurate data from collection through dissemination.
- Adopt national standards for electronic data collection and reporting to ensure comparisons between providers and jurisdictions.
- Ensure public health providers have adequate equipment and software for field work and data analysis.

Workforce

Additional epidemiologists in state health departments are clearly needed, as evidenced by the substantial gap between current and ideal numbers to maintain current operations. The workforce requires personnel with the appropriate skills to bolster capacity across program areas and enable departments to continue sustained projects and address emerging issues.

Recommendations

- Create and fill designated positions in health departments to support robust epidemiology activities, including Deputy State Epidemiologist, Data Coordinators to oversee data modernization efforts spanning program areas, and leads for every program area.
- Create standardized career ladders for use across departments that demonstrate clear paths for advancement. Use these career ladders to support the classification of epidemiologists within human resource systems and set competitive salary ranges.
- Provide flexible spending allocations that enable health departments to prioritize their jurisdictional needs for personnel and technology.
- Enhance hiring to increase the number of epidemiologists across program areas, particularly areas with high need, such as genomics and mental health.
- Promote strategic recruitment and hiring of epidemiologists with specialized skills, such as genomics, data analytics, and research and evaluation.
- Incorporate epidemiology into middle and high school curricula, and expand postgraduate training experiences, including the Applied Epidemiology Fellowship, to attract professionals to work in public health and serve their communities instead of choosing careers in academia, clinical care, or corporate settings.
- Prioritize having a minimum of 1.26 epidemiologists per 100,000 population with an ideal goal of 5 epidemiologists per 100,000 for public health transformation.

Recruitment and Hiring

Faced with less competitive salaries and funding restrictions, many health departments struggle to recruit and hire a workforce with the appropriate skills. To attract and fill positions with qualified candidates, states need standard position descriptions and updated AECs that reflect the changing public health landscape. In addition, hiring teams need to incorporate strategies that focus on recruiting a workforce with diverse backgrounds and diverse skills.

Recommendations

- Update the AECs to incorporate emerging areas of practice and specialized skills.
- Create and update position descriptions using the AECs that describe the skills and responsibilities of epidemiology personnel by position type (entry, mid, senior manager, and senior scientist), and update pay scales to be competitive with other public health sectors.
- Foster collaboration between states and human resources departments to facilitate recruitment planning and hiring that focuses on obtaining a workforce with diverse backgrounds, subject-area expertise, and skills.

Retention

State health departments continue to struggle to retain epidemiologists, particularly mid-level and senior level epidemiologists. The inability to retain epidemiologists results in frequent turnover, loss of institutional knowledge, and lack of consistent program management. Training to improve job engagement and agency investment through upskilling of the current workforce is needed.

Recommendations

- Create opportunities for advancement within the state health department that enable epidemiologists to obtain career growth.
- Enable states to self-assess current salary ranges and increase salaries to be competitive with surrounding states and geographic areas and to other industries, including academia, clinical care, and the private sector.
- Provide on-the-job training that will upskill the existing workforce to meet emerging needs, including data analytics, software skills, and leadership development.
- Support cross-training between epidemiologists, preparedness personnel, and laboratory staff to update response plans and enhance future response efforts.
- Bolster succession planning to preserve institutional knowledge, including the creation and maintenance of mentorship programs.
- Provide resources to personnel that focus on managing and minimizing burnout, especially during public health emergencies

Collaboration

Collaboration is fundamental for achieving change and including all relevant stakeholders in decision making. Epidemiologists in state health departments are fundamental to public health and need to have a voice with federal partners. In addition, state health departments should form academic partnerships to increase access to literature, enhance learning opportunities for students, and ensure relevant training for emerging epidemiologists.

Recommendations

- Foster collaboration between CDC and state health departments that enables inclusion of State Epidemiologists in predecision meetings and provides important feedback and context to decision makers.
- Initiate collaboration with local providers for the smooth onboarding of Electronic Laboratory Reporting, Electronic Case Reporting, and syndromic surveillance systems.
- Partner with academic institutions for increased access to peer-reviewed literature, applied learning opportunities for students, surge capacity support by academic epidemiologists, and assurance that current public health curricula meet the emerging needs of the field.
- Particularly in larger state health departments, establish mechanisms to assure collaboration and communication among epidemiologists across program areas.

Future Assessments

Future assessments are critical for measuring the progress of the applied epidemiology workforce over time. Additional ECAs should be considered to evaluate the progress in data modernization efforts, assess changes in infrastructure, and monitor progress toward creating a more representative and diverse public health workforce and the field's response to structural racism. Future assessments should also incorporate metrics to evaluate surveillance systems and data completeness, accuracy, and timeliness.

Recommendations

- Conduct additional ECAs that assess ongoing data modernization efforts in state health departments and focus on changes in infrastructure.
- Field assessments that measure surveillance systems' ability to produce complete, accurate, and timely data.
- Assess and monitor public health's progress toward creating a more representative and diverse public health workforce and the field's ongoing response to structural racism as a public health issue.

REFERENCES

References

Brownson, R. C., Samet, J. M., Chavez, G. F., Davies, M. M., Galea, S., Hiatt, R. A., ... & Yarber, L. (2015). Charting a future for epidemiologic training. *Annals of epidemiology,* 25(6), 458-465.

Bureau of Labor Statistics, U.S Department of Labor, *Occupational Outlook Handbook,* Epidemiologists, at https://www.bls.gov/ooh/life-physical-and-social-science/epidemiologists.htm *(visited May 26, 2021*).

Centers for Disease Control and Prevention. (2003). Assessment of the epidemiologic capacity in state and territorial health departments--United States, 2001. MMWR Morb Mortal Wkly Rep, 52(43), 1049-1051. and territorial health departments--United States, 2004. *MMWR: Morbidity and mortality weekly report,* 54(18), 457-459.

Centers for Disease Control and Prevention. (September 8, 2020). *Original Essential Public Health Services Framework,* Center for State, Tribal, Local and Territorial Support, Centers for Disease Control and Prevention. https://www.cdc.gov/publichealthgateway/publichealthservices/originalessentialhealthservices.html

Centers for Disease Control and Prevention. (March 18, 2021). 10 *Essential Public Health Services,* Center for State, Tribal, Local and Territorial Support, Centers for Disease Control and Prevention. https://www.cdc.gov/publichealthgateway/publichealthservices/essentialhealthservices.html

Coghlan, A. T., Preskill, H., & Tzavaras Catsambas, T. (2003). An overview of appreciative inquiry in evaluation. *New directions for evaluation,* 2003(100), 5-22.

Council of State and Territorial Epidemiologists. (2006). 2006 *National assessment of epidemiologic capacity: findings and recommendations.* http://www.cste2.org/webpdfs/2006CSTEECAFINALFullDocument.pdf

Council of State and Territorial Epidemiologists. (2009). *2009 National assessment of epidemiology capacity: findings and recommendations*. http://www.cste2.org/webpdfs/2009EpidemiologyCapacityAssessmentReport.pdf

Council of State and Territorial Epidemiologists. (2013). *2013 National assessment of epidemiology capacity: findings and recommendations*. http://www.cste2.org/2013eca/CSTEEpidemiologyCapacityAssessment2014-final2.pdf

Council of State and Territorial Epidemiologists. (2017). *2017 Epidemiology capacity assessment report*. https://cdn.ymaws.com/www.cste.org/resource/resmgr/eca/2017_ECA_Report_Web_final.pdf

Czeisler, M. É., Lane, R. I., Petrosky, E., Wiley, J. F., Christensen, A., Njai, R., ... & Rajaratnam, S. M. (2020). Mental health, substance use, and suicidal ideation during the COVID-19 pandemic—United States, June 24–30, 2020. *Morbidity and Mortality Weekly Report, 69*(32), 1049.

Daly, E. R. (2020). *Exploring the Role and Readiness of State Health Department Epidemiologists in the United States to Work in Emerging Areas of Public Health Practice* (Doctoral dissertation, The University of North Carolina at Chapel Hill).

de Beaumont Foundation and Association of State and Territorial Health Officials (ASTHO). (2017). *Public Health Workforce Interests and Needs Survey: 2017 Findings*. phwins.org/most-recent-findings/.

Drehobl, P. A., Roush, S. W., Stover, B. H., & Koo, D. (2012). Public health surveillance workforce of the future. *MMWR Surveill Summ,* 61(3), 25-29.

Frieden, T. R. (2015). The future of public health. *New England Journal of Medicine,* 373(18), 1748-1754.

Groseclose, S. L., & Buckeridge, D. L. (2017). Public health surveillance systems: recent advances in their use and evaluation. *Annual review of public health,* 38, 57-79.

Hadler, J. L., Lampkins, R., Lemmings, J., Lichtenstein, M., Huang, M., & Engel, J. (2015). Assessment of epidemiology capacity in state health departments—United States, 2013. *MMWR. Morbidity and mortality weekly report, 64*(14), 394.

Inflation Tool. (2021). Value of 2017 US Dollars Today. Retrieved from https://www.inflationtool.com/us-dollar/2017-to-present-value#:~:text=The%20inflation%20rate%20in%20the,in%202017%20equals%20%24107.92%20today.

Kaufman, N. J., Castrucci, B. C., Pearsol, J., Leider, J. P., Sellers, K., Kaufman, I. R., ... & Sprague, J. B. (2014). Thinking beyond the silos: emerging priorities in workforce development for state and local government public health agencies. *Journal of Public Health Management and Practice, 20*(6), 557.

Krasna, H., Czabanowska, K., Beck, A., Cushman, L. F., & Leider, J. P. (2021). Labour market competition for public health graduates in the United States: A comparison of workforce taxonomies with job postings before and during the COVID-19 pandemic. *The International journal of health planning and management, 36*(S1), 151-167.

Last, J. M. (Ed.) (2001). *A Dictionary of Epidemiology* (4 ed.). New York, NY: Oxford University Press, Inc.

National Consortium for Public Health Workforce Development. (2017). *Building Skills for a More Strategic Public Health Workforce: A Call to Action,* de Beaumont Foundation. http://www.debeaumont.org/wordpress/wp-content/uploads/Building-Skills-for-a-More-Strategic-Public-Health-Workforce.pdf

Trust for America's Health. (2013). A Healthier America 2013, Define *"foundational" capabilities of public health departments.* http://kresge.org/sites/default/files/Trust-for-Americas-Health.pdf

US Census Bureau. (2015). *Recent Population Trends for the U.S. Island Areas: 2000 to 2010.* https://www.census.gov/library/publications/2015/demo/P23-213.html

US Census Bureau. (2019). *Table 1. Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2019.* https://www.census.gov/data/tables/time-series/demo/popest/2010s-national-total.html

APPENDIX A

Assessment Instructions

2021 Epidemiology Capacity Assessment

The Council of State and Territorial Epidemiologists (CSTE) appreciates your support in completing the 2021 Epidemiology Capacity Assessment (ECA). The ECA aims to assess the overall state health department epidemiology capacity from the perspective of the State Epidemiologists. Your responses will be kept confidential and shared only in de-identified, aggregate form.

CSTE has periodically assessed epidemiology capacity in state and territorial health departments since 2001. CSTE's 2021 ECA will provide important information about the current capacity of epidemiology programs in state health departments. The 2021 ECA will also serve to measure the effects of the COVID-19 pandemic on epidemiological capacity and staffing within state health departments. For more information about previous ECAs, visit the CSTE website: http://www.cste.org/group/ECA.

Why complete the ECA? The ECA provides important data to both states and the CSTE National Office. This information aids in our efforts to educate legislators on the needs of state health agencies and helps inform future public health funding decisions.

Please use the following as guidelines when completing this assessment:

We strongly recommend reviewing and completing the PDF version of the assessment before proceeding with this online form. It may be helpful to consult state health department staff, organizational charts, or other documents to complete portions of the ECA.

Assessment Functionality: The link received by the State Epidemiologist may be forwarded to other health department staff to complete. The assessment cannot be completed by two

individuals simultaneously.

Using the Online Tool

The assessment is designed so that it can be completed in multiple sittings and/or by several people. Please keep the following in mind as you navigate through the assessment: It is possible to move back and forth throughout the assessment. A limited number of questions will "request a response" before allowing you to move forward. Messages will appear if question(s) within a section have not been completed, and the unanswered question(s) will be highlighted in pale blue. It is still possible to move forward to the next section. For questions that require responses in multiple columns and rows, the TAB key can be used to navigate quickly from cell to cell.

Because no questions require a response to move forward, it is essential that the State Epidemiologist go through the entire assessment a final time before submission to confirm that all questions and all parts within questions have been answered.

To aid in completing the ECA, please reference the following supporting documents:

- Frequently Asked Questions FAQs
- Human Resources Worksheet
- Program Area Leads Worksheet
- Applied Epidemiology Competencies (AECs)

For questions, contact Sarah Auer at ECA@cste.org.

The following is an outline of the ten assessment sections:

Section	Guidance
Section 1: Epidemiology leadership within the state health department	**Question 4** (training needs) has been included in the Program Area Leads Worksheet.
Section 2: COVID-19 surveillance within the state health department	All questions within this section should be completed by the State Epidemiologist or a senior level health official within your agency.

Section	Guidance
Section 3: Epidemiology and surveillance capacity within the state health department	**Question 12** (perceived capacity) has been included as an option in the Program Area Leads Worksheet.
Section 4: Epidemiology funding sources and staffing within the state health department	**Question 15** (number of epidemiologists and source of funding by program area) and **Question 16** (ideal number of epidemiologists by program area) have been included in the Program Area Leads worksheet. **Question 15** is also included in the Human Resources Worksheet.
Section 5: Civil service annual salary ranges for epidemiologists in your state health department	*Please consult with your Human Resources or other hiring director when completing this section.* **Questions 17 and 18** have been included in the Human Resources Worksheet.
Section 6: Recruiting the epidemiology workforce	All questions within this section should be completed by the State Epidemiologist or a senior level health official within your agency. *It may be helpful to consult with a Human Resources or other hiring director.* **Question 19** (assets for recruiting epidemiologists) has been included in the Program Area Leads Worksheet.

Section	Guidance
Section 7: Vacancies and retention of the state epidemiology workforce	All questions within this section should be completed by the State Epidemiologist or a senior level health official within your agency. *It may be helpful to consult with a Human Resources or other hiring director.* **Question 24** (number of vacancies) and **Question 25** (number of exit interviews) have been included in the Human Resources Worksheet. **Question 27** (tactics for retaining epidemiologists) has been included in the Program Area Leads Worksheet.
Section 8: Leadership feedback	All questions within this section should be completed by the State Epidemiologist or a senior level health official within your agency.
Section 9: Review of the assessment	All questions within this section should be completed by the State Epidemiologist or a senior level health official within your agency.

The assessment must be completed in its entirety before it can be submitted. A confirmation that all parts of the assessment have been completed is required.

Please complete the entire assessment by 11:59 pm EST on February 26, 2021.

Section 1: Epidemiology Leadership

Section 1: Epidemiology leadership within the state health department (Questions 1-4)

This section can be completed by the State Epidemiologist without additional input.

Q1. How long has the State Epidemiologist been in his/her current position?

Please indicate half years in increments of 0.5

Years in current position:

Q2. Is there a formal lead epidemiologist for each program area below?

If the "Other" category is not relevant to your situation, please select "No."

Who should be counted as an epidemiologist? Some questions will require an enumeration of the current epidemiology workforce within the state health department. Please count each epidemiologist only once.

State level epidemiologists include:

- All those employed by the state
- All those working at the state level who are either federal assignees (e.g. EISO, CEFO, PHAP), contract employees (e.g. CDC Foundation assignee, contracted from school of public health to work at or for the state health department) or fellows (e.g. CSTE trainee)
- State employees assigned to work at a local or regional level (e.g. to conduct investigations for a region of the state).

As part of the pandemic response, your department may have added additional staff including case investigators, contact tracers and epidemiologists. **For the purpose of this assessment, please only count COVID-19 response staff serving as an epidemiologist or performing functions consistent with an epidemiologist (see below).**

When considering who should be counted, please focus on the functions performed by the individual rather than the job title. Reference the Applied Epidemiology Competencies (AECs) for examples of epidemiology job functions if you need assistance in determining the status of an employee.

Please note that this is the same definition that was used in 2017. You may wish to review your state's individual report from the previous assessment as a point of reference. Your state's individual report will be to sent to you in a separate email. Further instructions on who should be counted as an epidemiologist can be found here.

	Yes	No
Chronic Disease	○	○
COVID-19 Response	○	○
Environmental Health	○	○
Generalist	○	○
Genomics	○	○
Infectious Disease	○	○
Informatics	○	○
Injury	○	○
Maternal and Child Health	○	○
Mental Health	○	○
Occupational Health	○	○
Oral Health	○	○
Preparedness	○	○
Substance Use	○	○
Vital Statistics	○	○
Other (please specify)	○	○

Q3. Do epidemiologists at the state health department have easy access to peer-reviewed literature that is not open access? *Open access is defined as available online to the reader without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself.*

Select option from the dropdown scale.

- ○ Yes, within 2 hours
- ○ Yes, the same day (2-23 hours)
- ○ Yes, within 24-72 hours
- ○ Yes, but >72 hours

- ◯ No access

Q4. From your perspective, what are the most pressing training needs among your epidemiology staff?

For more information on who should be counted as an epidemiologist, please click here.

Please select the top two most pressing training needs.

- ☐ Assessments and evaluations (development and distribution)
- ☐ Continuing education (basic epi refreshers, novel methodologies, updates to the field/literature, etc.)
- ☐ Cultural competency (diversity and inclusion, improving knowledge and attitudes to promote culturally responsive work, community collaboration, etc.)
- ☐ Data analytics (informatics, translating and applying public health data, etc.)
- ☐ Fiscal management (planning, budgeting, and/or monitoring resources)
- ☐ Leadership development (identifying future leaders, coaching/mentoring programs, retention of current leaders)
- ☐ Persuasive communication (articulating a message to the public, communicating public health research and data, policy engagement, etc.)
- ☐ Systems thinking (systems development, change management, strategic planning, and/or flexibility)
- ☐ Software skills (Epi Info, SAS, SPSS, R, etc.)
- ☐ Team-building (improving interpersonal relations and collaboration among staff)
- ☐ Emergency preparedness (Incident Command System, etc.)
- ☐ _____ Other (please specify)

Section 2: COVID-19 Surveillance

Section 2: COVID-19 Surveillance within the state health department (Questions 5-10)

These questions should be completed by the State Epidemiologist or a senior level health official within your agency.

Q5. Do you utilize an Outbreak Management System?

An outbreak management system supports the initial characterization, investigation, response, and containment of outbreaks through the collection and analysis of data.

- ○ Yes, the Outbreak Management System is integrated into our case-based surveillance system
- ○ Yes, the Outbreak Management System is a standalone system
- ○ No, we do not utilize an Outbreak Management System

Q6. How would you rate your case-based surveillance system's ability to adapt for the COVID-19 response?

- ○ Good
- ○ Fair
- ○ Poor

Q7. Please share the name of the surveillance system used below.

Q8. Did the state implement an additional contact tracing system for the COVID-19 response?

- ○ Yes
- ○ No

Q9. Does the state have plans to continue using the contact tracing system after COVID-19?

- ○ Yes
- ○ No
- ○ Unknown at this time

If you responded YES to Q9, you do not need to complete Q10.

Q10. If your state does not have plans to continue using the contact tracing system after the COVID-19 response, why? *Select all that apply.*

- [ ] Financial concerns
- [ ] No longer need the system
- [ ] Issues of long-term sustainability
- [ ] Problems integrating the system into our surveillance plan
- [ ] Not satisfied with the performance of the system
- [ ] Unsure at this time
- [ ] Other (please specify)

Section 3: Epidemiology and Surveillance Capacity

Section 3: Epidemiology and surveillance capacity within the state health department (Questions 11-12)

This section focuses on the three key Essential Public Health Services (EPHS) that have been identified as significant for epidemiologists:

EPHS 1: Assess and monitor population health status, factors that influence health, and community needs and assets
EPHS 2: Investigate, diagnose, and address health problems and hazards affecting the population
EPHS 9: Improve and innovate public health functions through ongoing evaluation, research, and continuous quality improvement

For further details on the EPHS, please click here. The 2021 ECA utilizes the updated Essential Public Health Services released on September 9, 2020. Previous ECAs utilized Essential Public Health Services 1, 2, 9 and 10. The updated Essential Public Health Services combine research and evaluation into EPHS 9. Therefore, to ensure continuity and the ability to measure trends, the 2021 ECA measures EPHS 1, 2 and 9.

If necessary, please seek the guidance of other state health department staff within program specific areas when completing this section.

Question 12 (perceived capacity) has been included as an option in the Program Area Leads Worksheet.

Q11. Does your state health department have adequate epidemiological capacity to provide the following three Essential Public Health Services (EPHS), such that the department is able to lead activities, provide subject matter expertise, and apply for, receive, and manage resources to conduct key activities? **Please answer this question based on your department's CURRENT capacity.**

See below for a definition of scales used in this question.

None: 0% adequate epidemiological capacity to provide this EPHS.

Minimal: 1-24% adequate epidemiological capacity to provide this EPHS.

Partial: 25-49% adequate epidemiological capacity to provide this EPHS.

Substantial: 50-74% adequate epidemiological capacity to provide this EPHS.

Almost full: 75-99% adequate epidemiological capacity to provide this EPHS.

Full: 100% adequate epidemiological capacity to provide this EPHS.

Select capacity option from the dropdown scale.

	None (0%)	Minimal (1-24%)	Partial (25-49%)	Substantial (50-74%)	Almost full (75-99%)	Full (100%)
EPHS #1 Assess and monitor population health status, factors that influence health, and community needs and assets	☐	☐	☐	☐	☐	☐
EPHS #2 Investigate, diagnose, and address health problems and hazards affecting the population	☐	☐	☐	☐	☐	☐
EPHS #9 Improve and innovate public health functions through ongoing evaluation, research, and continuous quality improvement	☐	☐	☐	☐	☐	☐

Q12. What best describes the overall current epidemiological capacity to provide the three Essential Public Health Services (EPHS) in the each of the following program areas in your

state health department, such that the department is able to lead activities, provide subject matter expertise, and apply for, receive, and manage resources to conduct key activities? **Please answer this question based on your department's CURRENT capacity.**

See below for a definition of scales used in this question.

None: 0% epidemiological and surveillance capacity to provide the three EPHS.

Minimal: 1-24% epidemiological and surveillance capacity to provide the three EPHS.

Partial: 25-49% epidemiological and surveillance capacity to provide the three EPHS.

Substantial: 50-74% epidemiological and surveillance capacity to provide the three EPHS.

Almost full: 75-99% epidemiological and surveillance capacity to provide the three EPHS.

Full: 100% epidemiological and surveillance capacity to provide the three EPHS.

We do not have this program area.

Select capacity option from the dropdown scale.

If the "Other" category is not relevant to your situation, please select "We do not have this program area."

	None (0%)	Minimal (1-24%)	Partial (25-49%)	Substantial (50-74%)	Almost full (75-99%)	Full (100%)	We do not have this program area
Chronic Disease	☐	☐	☐	☐	☐	☐	☐
COVID-19 Response	☐	☐	☐	☐	☐	☐	☐
Environmental Health	☐	☐	☐	☐	☐	☐	☐
Generalist	☐	☐	☐	☐	☐	☐	☐
Genomics	☐	☐	☐	☐	☐	☐	☐
Infectious Disease	☐	☐	☐	☐	☐	☐	☐
Informatics	☐	☐	☐	☐	☐	☐	☐
Injury	☐	☐	☐	☐	☐	☐	☐
Maternal and Child Health	☐	☐	☐	☐	☐	☐	☐
Mental Health	☐	☐	☐	☐	☐	☐	☐
Occupational Health	☐	☐	☐	☐	☐	☐	☐
Oral Health	☐	☐	☐	☐	☐	☐	☐
Preparedness	☐	☐	☐	☐	☐	☐	☐
Substance Use	☐	☐	☐	☐	☐	☐	☐

	None (0%)	Minimal (1-24%)	Partial (25-49%)	Substantial (50-74%)	Almost full (75-99%)	Full (100%)	We do not have this program area
Vital Statistics	☐	☐	☐	☐	☐	☐	☐
Other (please specify)	☐	☐	☐	☐	☐	☐	☐

Section 4: Epidemiology Funding Sources and Staffing

Section 4: Epidemiology funding sources and staffing within the state health department (Questions 13-16)

Question 15 (number of epidemiologists and source of funding by program area) and Question 16 (ideal number of epidemiologists by program area) have been included as options in the Program Area Leads Worksheet.

Question 15 is also included as an option in the Human Resources Worksheet.

Q13. What are the funding sources for all epidemiology activities within the state health department? *Activities may include but are not limited to assessing and monitoring population health, ongoing research and evaluation and use of surveillance systems.*

***Note:* This question will not automatically validate total percent. Total must equal 100%. Please do not leave any box blank- if necessary, indicate 0%.**

Please answer this question based on your department's CURRENT funding during the COVID-19 response.

Federal Funds %	
COVID-19 Supplemental Federal Funds %	
State Funds %	
Other %	

Total

Q14. What are the funding sources for all epidemiology personnel within the state health department?

For more information on who should be counted as an epidemiologist, please click here.

***Note:* This question will not automatically validate total percent. Total must equal 100%. Please do not leave any box blank- if necessary, indicate 0%.**

Please answer this question based on your department's CURRENT funding during the COVID-19 response.

Federal Funds %

COVID-19 Supplemental Federal Funds %

State Funds %

Other %

Total

Q15. Please indicate the total number of epidemiologists (FTEs) currently working for your state health department by program area and funding source. If an epidemiologist has responsibilities divided over more than one program area, please attribute the fraction of the time the epidemiologist works in any given program area to the nearest 0.1 FTE (e.g. 0.2 ID, 0.4 PR, 0.4 EH).

For enumeration purposes state-level epidemiologists include all those employed by the state, all those working at the state level who are either federal assignees (e.g. EISO, CEFO, PHAP), contract employees (e.g. contracted from school of public health to work at or for the state health department), fellows (e.g. CSTE trainee) and state employees assigned to work at local or regional level (e.g. to conduct investigations for a region of the state).

When considering who should be counted, please focus on the functions performed by the individuals rather than the job title. ***Please answer this question based on your department's CURRENT capacity during the COVID-19 response.***

You may wish to consult the 2017 responses from your state in completing this form.

***Note:* Only numbers are accepted. Please round to one decimal place.**

To navigate across rows, use the TAB key. All cells should be completed even if you do not have a program in this area.

If the "Other" category is not relevant to your situation, please also indicate "0" for each value in that row.

The "Total" column can be used to validate responses by program area rows.

	Number supported with federal funds from CDC	Number directly funded by CDC (e.g., CEFO, EIS, PHAP, etc.)	Number supported with federal funds from other agencies	Number supported with state funds	Number supported with funds from other sources (e.g., foundations)	#Conjoint, Total#
Chronic Disease						
COVID-19 Response						
Environmental Health						
Generalist						
Genomics						
Infectious Disease						
Informatics						
Injury						
Maternal and Child Health						
Mental Health						
Occupational Health						
Oral Health						
Preparedness						
Substance Use						
Vital Statistics						
Other (please specify)						

Q16. Please estimate the ideal number of additional epidemiologists needed to reach full capacity for your state health department by program area (the number of epidemiologists in addition to the current number regardless of resources - it may be helpful to reference Question 15). Please attribute the fraction of capacity in each program area to the nearest 0.1 FTE if less than one FTE is needed. **Please answer this question based on your department's CURRENT capacity needs during the COVID-19 response.**

***Note*: Only numbers are accepted. Please round to one decimal place.**

To navigate down the column, use the TAB key. All cells should be completed even if you do not have a program in this area.

If the "Other" category is not relevant to your situation, please indicate "0" for that row.

	Estimate of ideal number of additional epidemiologists needed to reach full capacity
Chronic Disease	
COVID-19 Response	
Environmental Health	
Generalist	
Genomics	
Infectious Disease	
Informatics	
Injury	
Maternal and Child Health	
Mental Health	
Occupational Health	
Oral Health	
Preparedness	
Substance Use	
Vital Statistics	
Other (please specify)	

Section 5: Civil Service Annual Salary Ranges

Section 5: Civil service annual salary ranges for epidemiologists in your state health department (Questions 17-18)

It may be helpful to consult with your Human Resources or other hiring director for Questions 17 and 18.

Questions 17 and 18 have been included as options in the Human Resources Worksheet.

Please include only civil service employees. Further instructions for who should be counted as an epidemiologist can be found here.

Q17. Describe the civil service annual salary range for epidemiologists working in your state health department by degree (state employees only). If you have more than one position for a given degree below, please use the low end of the lowest position in that level to the high end of the highest position in that level. *Example: If an entry level epidemiologist with an MD makes $75,000 to $100,000 and a senior level epidemiologist with an MD makes $125,000 to $150,000 the salary scale is: $75,000-$150,000.*

Please include only civil service employees.

***Note:* Commas are not permitted in response boxes. Only numbers are accepted. Please round to the nearest whole number.**

	Salary Range (Minimum)	Salary Range (Maximum)
MD, DO		
DDS		
DVM		
PhD, DrPH, other doctoral		
MPH, MSPH, other Master		
BA, BS, BSN, other Bachelor		

	Salary Range (Minimum)	Salary Range (Maximum)
Associate or no post high school degree		

Q18. Describe the official Human Resources civil service annual salary range for epidemiologists working in your state health department by career level according to the Applied Epidemiology Competencies (AECs). If you have more than one position in a given career level below, please use the low end of the lowest position in that level to the high end of the highest position in that level.

Please include only civil service employees.

***Note:* Commas are not permitted in response boxes. Only numbers are accepted. Please round to the nearest whole number.**

	Salary Range (Minimum)	Salary Range (Maximum)
State Epidemiologist		
Deputy State Epidemiologist		
Senior Level Epidemiologist		
Mid Level Epidemiologist		
Entry Level Epidemiologist		

Section 6: Recruiting the Epidemiology Workforce

Section 6: Recruiting the Epidemiology Workforce (Questions 19-22)

Please consult other state health department epidemiologists for questions pertaining to domains not under your area of responsibility.

Question 19 (assets for recruiting epidemiologists) has been included in the Program Area Leads Worksheet.

Q19. CSTE aims to gather best practices and understand what attracts epidemiologists to your agency. What are your department's 3 best assets for recruiting epidemiologists?

- [ ] Competitive salary
- [ ] Personnel policies and procedures
- [ ] Job benefits
- [ ] Job security
- [ ] Job location
- [ ] Opportunity for promotion
- [ ] Opportunity for travel
- [ ] Job interests/fulfillment
- [ ] Opportunity for skills training
- [ ] Flexible schedule
- [ ] Opportunity for continued education
- [ ] Other factor (please specify)

Q20. As part of the COVID-19 response, how has your agency procured surge staffing to support epidemiology work? *This refers to anyone who assisted with epidemiology activities and is not limited to epidemiologists. Select all that apply.*

- [ ] Utilized contractors
- [ ] Repurposed existing state employees
- [ ] Engaged academic partners
- [ ] Engaged local public health departments
- [ ] Requested staffing assistance through CDC
- [ ] Requested staffing assistance through CDC Foundation
- [ ] Utilized existing or new fellows or trainees (e.g. EIS officers, Applied Epidemiology Fellows, PHAPS, etc.)
- [ ] Other (please specify)

Q21. What are your departments' strategies for recruiting a diverse workforce? Select all that apply.

- [ ] We have a recruitment strategy that addresses race, ethnicity and gender
- [ ] We have a recruitment strategy that addresses diverse skillsets and subject matter expertise
- [ ] We do not have a recruitment strategy that addresses diversity, but it is a priority
- [ ] None of the above
- [ ] Other (please specify)

Q22. Please share any additional context and details about your recruitment strategies. *This may include innovative approaches, such as creating a strong workforce pipeline by hosting student interns from academic institutions or serving as an academic health department.*

Section 7: Retention of the Workforce

Section 7: Vacancies and retention of the state epidemiology workforce (Questions 23-28)

All questions within this section should be completed by the State Epidemiologist or a designated senior level health official within your agency. It may be helpful to consult with a Human Resources director or other state health department staff by specific program areas.

Question 24 (vacancies by program area) has been included as an option in the Human Resources Worksheet.

Question 27 (assets for retention) has been included as an option in the Program Area Leads Worksheet.

Q23. Does your state health department utilize contractors to fill vacancies for epidemiology/surveillance positions?

A vacancy is defined as a position to be filled at the state health department that meets the following conditions: (1) there is work available for the position and (2) the job could start within 30 days.

- ◯ Yes
- ◯ No

Q24. For epidemiology/surveillance positions, please estimate the number of vacancies by program area in civil service positions (columns A and B) and contract employees (columns C and D). Please attribute the fraction of time for vacancy by program area to the nearest 0.1 FTE if there is vacancy for a position over multiple program areas.

A vacancy is defined as a position to be filled at the state health department that meets the following conditions: (1) there is work available for the position and (2) the job could start within 30 days. Do not include positions that are required to be left vacant due to hiring freezes or other requirements.

To navigate across rows, use the TAB key.

Please do not leave any box blank, indicate "0" instead.

For columns C and D, if you do not use contractors, indicate "0."

	A. What is the number of vacant epidemiology positions at the health department for civil service employees?	B. How many civil service positions do you intend to fill (actively working with HR)?	C. What is the number of vacant epidemiology positions at the health department for contract employees?	D. How many contract positions do you intend to fill (actively working with HR)?
Chronic Disease				
COVID-19 Response				
Environmental Health				

	A. What is the number of vacant epidemiology positions at the health department for civil service employees?	B. How many civil service positions do you intend to fill (actively working with HR)?	C. What is the number of vacant epidemiology positions at the health department for contract employees?	D. How many contract positions do you intend to fill (actively working with HR)?
Generalist				
Genomics				
Infectious Disease				
Informatics				
Injury				
Maternal and Child Health				
Mental Health				
Occupational Health				
Oral Health				
Preparedness				
Substance Use				
Vital Statistics				
Other (please specify)				

Q25. We want to understand turnover of epidemiologists in your agency since the onset of the COVID-19 pandemic. How many exit interviews were conducted for epidemiologists that left the agency between March 2020 and December 2020? **Please do not count exit interviews for internal transitions.**

Q26. How does this number of exit interviews during the COVID-19 response compare to non-pandemic conditions?

- Higher than non-pandemic conditions
- Similar to non-pandemic conditions

- ◯ Less than non-pandemic conditions

Q27. What are your state's 3 most successful tactics for retaining epidemiologists?

Please include only civil service employees.

- ☐ Competitive salary
- ☐ Personnel policies and procedures
- ☐ Job benefits
- ☐ Job security
- ☐ Opportunity for promotion
- ☐ Opportunity for travel
- ☐ Job interests/fulfillment
- ☐ Opportunities for skills training
- ☐ Flexible schedule
- ☐ Opportunities for continued education
- ☐ Accurate job description during interview process
- ☐ _____ Other factor (please specify)

Q28. How are you currently working to minimize burnout among staff?

Please choose your top 3 strategies.

- ☐ Allowing a flexible schedule
- ☐ Providing task autonomy (e.g. ability to control deadlines, methodology, etc.)
- ☐ Providing time-limited detail assignments
- ☐ Promoting meaningful relationships at work
- ☐ Promoting awareness of mental health and burnout
- ☐ Encourage taking paid leave as needed
- ☐ None of the above
- ☐ _____ Other (please specify)

Section 9: Leadership Feedback

Section 9: Leadership feedback (Questions 29-31)

All questions within this section should be completed by the State Epidemiologist or a designated senior level health official within your agency.

Q29. As the State Epidemiologist, what are the most critical issues you face?

Q30. What does your agency need to support data modernization activities?

Q31. What other thoughts, comments, concerns or questions would you like to share with CSTE with regard to the epidemiology workforce and training?

Section 10: Review Assessment

Section 10: Review of assessment (Questions 32-33)

All questions within this section should be completed by the State Epidemiologist or a designated senior level health official within your agency.

Please review the previous 9 sections of the assessment prior to completing this section to confirm all questions have been answered accurately.

Q32. As the State Epidemiologist, I confirm that all questions within this assessment have been answered.

Click here to confirm

Q33. As the State Epidemiologist, I confirm that all parts of this assessment have been completed accurately, to the best of my knowledge. I have consulted with other state health department staff as needed.

Click here to confirm

Submit Assessment

After you have completed a review of the responses to the 2021 Epidemiology Capacity Assessment and confirm that the assessment has been completed accurately to the best of your knowledge, please click the forward arrow below to submit your responses. Your responses cannot be reviewed after submission.

Click the next arrow to submit your responses.

If you have any additional questions or comments, please email Sarah Auer at ECA@cste.org.

APPENDIX B

State Epidemiologist Instructions:

1. To facilitate feedback from your human resources group, we have created this worksheet, which allows you to gather information on specific questions of your choosing. These include **(1) question 15**, which examines the numbers of FTEs in each program area by funding source; **(2) questions 17 and 18**, which include salary ranges by highest degree and by job category; **(3) question 24**, which explores the number of vacancies by program area; and **(4) question 25,** the number of exit interviews during the COVID-19 response.

2. If you prefer not to obtain input from human resources on some of these topics, you may simply delete the individual worksheets. Question 15 might be filled out by the program area leads or by human resources. For large health departments with multiple epidemologists, the question 15 worksheet allows the development of a line listing for each epidemiologist including their program area and their funding, and provides an automatically generated table and sums the total FTEs by program area for inclusion on the actual assessment form.

3. Click the tabs at the bottom of the spreadsheet to navigate between questions. Note that some of the tabs include content outside the view from 100% zoom, so it is necessary to scroll down.

4. Please remove this tab before sending out. **Do not remove the tab marked "DO NOT DELETE"** since it contains the code to facilitate automatic entry of the program lead information.

5. If you wish to print this spreadsheet, please scale to one page to preserve formatting.

Human Resources Worksheet, Epidemiology Capacity Assessment
Identify HR Lead

HR Lead Name:	
HR Lead Email:	

HR Lead Name	0
HR Lead Email:	0

Section 4, Question 15

Please indicate the total number of epidemiologists (FTEs) currently working in your program area by funding source. Please round to the nearest 0.1 FTE. **Please answer this question based on your departments' CURRENT capacity during the COVID-19 response.**

For enumeration purposes State level epidemiologists include all those employed by the state, all those working at the state level who are either federal assignees (e.g. EISO, CEFO, PHAP) or contract employees (e.g. CSTE trainee, contracted from school of public health to work at or for the state health department), and state employees assigned to work at local or regional level (e.g. to conduct investigations for a region of the state). When considering who should be counted, please focus on the functions performed by individuals rather than the job title.

Instructions for Completion:

1. For each epidemiologist, complete the following table. Values will automatically populate the summary table found at A164 at the bottom of the worksheet.
2. If an epidemiologist's time is split between two program areas, do separate listings. For example, if Person X has a full FTE but works 0.2 time in chronic disease and 0.8 time in environmental health, list their name twice. In the first of the two rows, choose "chronic disease" from the popdown screen under program area and distribute the 0.2 FTE according to the appropriate funding source(s). On the second row, choose "environmental health" and distribute the 0.8 FTE according to funding source(s).
3. If there is a program area not listed specifically among the pop-down choices, please use the "other-1" category. There are additional "other" categories (other-2 and other-3) if you have more than one area that falls outside the options provided. Please make note below the summary table of what each of the "other" categories consist of.
4. The summary table headings and rows correspond to those in the Assessment form. Unfortunately, it is not possible to copy and paste the findings, but we suggest you print and transcribe the information on the Assessment form.

Row Labels	Sum of Fraction of FTE supported with federal funds from CDC	Sum of Fraction of FTE directly funded by CDC (e.g., CEFO, EIS, PHAP, etc.)	Sum of Fraction of FTE supported with federal funds from other agencies	Sum of Fraction of FTE supported with state funds	Sum of Fraction of FTE supported with funds from other sources (e.g., foundations)	Sum of Total FTE
(blank)						0.0
Grand Total						**0.0**

HR Lead Name:	0
HR Lead Email:	0

Section 5, Question 17

Describe the civil service annual salary range for epidemiologists working in your state health department by degree (State employees only). If you have more than one position for a given degree below, please use the low end of the lowest position in that level to the high end of the highest position in that level. *Example: If an entry level epidemiologist with an MD makes $75,000 to $100,000 and a senior level epidemiologist with an MD makes $125,000 to $150,000 the salary scale is: $75,000-$150,000. Please include only civil service employees.*

Instructions for Completion:

1. Click each cell to enter the minimum or maximum value of the range. Values will automatically appear as currency.
2. Only numbers are accepted. Please round to the nearest whole number.
3. Please do not leave any cell blank.

Degree	Salary Range (Minimum)	Salary Range (Maximum)
MD, DO	$ -	$ -
DDS	$ -	$ -
DVM	$ -	$ -
PhD, DrPH, other doctoral	$ -	$ -
MPH, MSPH, other Master	$ -	$ -
BA, BS, BSN, other Bachelor	$ -	$ -
Associate or no post high school degree	$ -	$ -

Section 5, Question 18

Describe the official Human Resources civil service annual salary range for epidemiologists working in your state health department by career level according to the Applied Epidemiology Competencies (AECs). If you have more than one position in a given career level below, please use the low end of the lowest position in that level to the high end of the highest position in that level. *Please include only civil service employees.*

Instructions for Completion:

1. Click each cell to enter the minimum or maximum value of the range. Values will automatically appear as currency.
2. Only numbers are accepted. Please round to the nearest whole number.
3. Please do not leave any cell blank.

Title	Salary Range (Minimum)	Salary Range (Maximum)
State Epidemiologist	$ -	$ -
Deputy State Epidemiologist	$ -	$ -
Senior Level Epidemiologist	$ -	$ -
Mid Level Epidemiologist	$ -	$ -
Entry Level Epidemiologist	$ -	$ -

HR Lead Name:	0
HR Lead Email:	0

Section 7, Question 24

For epidemiology/surveillance positions, please estimate the number of vacancies by program area in civil service positions (columns A and B) and contract employees (columns C and D).

A vacancy is defined as a position to be filled at the State Health Department that meets the following conditions: (1) there is work available for the position and (2) the job could start within 30 days. Do not include positions that are required to be left vacant due to hiring freezes or other requirements.

Instructions for Completion:

1. Cells within the table are restricted to numbers only.
2. Please attribute the fraction of time for vacancy by program area to the nearest 0.1 FTE if there is vacancy for a position over multiple program areas.
3. Please do not leave any cell blank, indicate "0" instead.
4. For columns C and D, if you do not use contractors, indicate "0."

Program Area	A. What is the number of vacant epidemiology positions at the health department for civil service employees?	B. How many civil service positions do you intend to fill (actively working with HR?)	C. What is the number of vacant epidemiology positions at the health department for contract employees?	D. How many contract positions do you intend to fill (actively working with HR?)
Chronic Disease				
COVID-19 Response				
Environmental Health				
Generalist				
Genomics				
Infectious Disease				
Informatics				
Injury				
Maternal and Child Health				
Mental Health				
Occupational Health				
Oral Health				
Preparedness				
Substance Use				
Vital Statistics				
Other:				

HR Lead Name:	0
HR Lead Email:	0

Section 7, Question 25

We want to understand turnover of epidemiologists in your agency since the onset of the COVID-19 pandemic. How many exit interviews have you conducted for epidemiologists leaving the agency between March 2020 and December 2020? *Please do not count exit interviews for internal transitions.*

Number of exit interviews:	

APPENDIX C

State Epidemiologist Instructions:

1. To facilitate feedback from your program area leads, we have created this worksheet, which allows you to gather information on specific questions of your choosing. These include **(1) question 4**, which examines the departments' most pressing training needs; **(2) question 12**, which concerns the capacity of each program area to achieve the four Essential Public Health Services most closely linked to epidemiology; **(3) question 15**, which examines the numbers of FTEs in each program area by funding source; **(4) question 16**, which concerns the ideal number of epidemiologists in the program area; **(5) question 19**, which enquires about best assets for recruiting epidemiologists; and **(6) question 27**, which asks about tactics for successfully retaining epidemiologists.

2. If you prefer not to obtain input from the program leads on some of these topics, you may simply delete the individual worksheets. For large health departments or program areas with multiple epidemologists, the question 15 worksheet allows the program area leads to develop a line listing for each epidemiologist in their group and sums the total FTEs for inclusion on the actual assessment form.

3. Click the tabs at the bottom of the spreadsheet to navigate between questions. Note that some of the tabs include content outside the view from 100% zoom, so it is necessary to scroll down.

4. Please remove this tab before sending out. **Do not remove the tab marked "DO NOT DELETE"** since it contains the code to facilitate automatic entry of the program lead information, as well as code for dropdown lists.

5. If you wish to print this spreadsheet, please scale to one page to preserve formatting.

Program Area Lead Worksheet, Epidemiology Capacity Assessment
Identify Program Area Lead

Your name:	
Your email:	
Program Area (click cell to view list):	

Your name:	0
Your email:	0
Program Area (click cell to view list):	

Section 1, Question 4:
What are the most pressing training needs among your epidemiology staff?

Instructions for Completion:
1. This question is included so that program leads can provide input to the State Epidemiologist. The State Epidemiologist will answer in the Assessment from their perspective.
2. Please select the top two most pressing training needs from the list.
3. Select by replacing "m" with "X". Please leave the placeholder values in the options you do not wish to select.

What are the top **two** most pressing training needs?	
m	Assessments and evaluations (development and distribution)
m	Continuing education (basic epi refreshers, novel methodologies, updates to the field/literature, etc.)
m	Cultural competency (diversity and inclusion, improving knowledge and attitudes to promote culturally responsive work, community collaboration, etc.)
m	Data analytics (informatics, translating and applying public health data, etc.)
m	Fiscal management (planning, budgeting, and/or monitoring resources)
m	Leadership development (identifying future leaders, coaching/mentoring programs, retention of current leaders)
m	Persuasive communication (articulating a message to the
m	Systems thinking (systems development, change
m	Software skills (Epi Info, SAS, SPSS, R, etc.)
m	Team-building (improving interpersonal relations and
	Emergency preparedness (Incident Command System)
m	Other (please specify)

Your name:	0
Your email:	0
Program Area (click cell to view list):	

Section 3, Question 12:

What best describes the current epidemiological capacity to provide the three Essential Public Health Services (EPHS), such that the department is able to lead activities, provide subject matter expertise, and apply for, receive, and manage resources to conduct key activities in the each of the following program areas in your State Health Department? **Please answer this question based on your departments' CURRENT capacity.**

Instructions for Completion:
1. Please answer only for your program area.
2. The three EPHS and the capacity scale response options are listed in the two tables immediately below.
3. Select capacity option from the dropdown scale of the third table below. Click on the cell to see the dropdown list.

Essential Public Health Services:
EPHS #1 Assess and monitor population health status, factors that influence health, and community needs and assets (1)
EPHS #2 Investigate, diagnose, and address health problems and hazards affecting the population (2)
EPHS #9 Improve and innovate public health functions through ongoing evaluation, research, and continuous quality improvement (3)

Capacity scale response options:
None: 0% epidemiological and surveillance capacity to provide the three EPHS.
Minimal: 1-24% epidemiological and surveillance capacity to provide the three EPHS.
Partial: 25-49% epidemiological and surveillance capacity to provide the three EPHS.
Substantial: 50-74% epidemiological and surveillance capacity to provide the three EPHS.
Almost full: 75-99% epidemiological and surveillance capacity to provide the three EPHS.
Full: 100% epidemiological and surveillance capacity to provide the three EPHS.

Select capacity option for your program area:	None (0%)

Your name:	0
Your email:	0
Program Area (click cell to view list):	

Section 4, Question 15:

Please indicate the total number of epidemiologists (FTEs) currently working in your program area by funding source. Please round to the nearest 0.1 FTE.
For enumeration purposes State level epidemiologists include all those employed by the state, all those working at the state level who are either federal assignees (e.g. EISO, CEFO, PHAP) or contract employees (e.g. CSTE trainee, contracted from school of public health to work at or for the state health department), and state employees assigned to work at local or regional level (e.g. to conduct investigations for a region of the state). When considering who should be counted, please focus on the functions performed by individuals rather than the job title. **Please answer this question based on your departments' CURRENT capacity during the COVID-19 response.**

Instructions for Completion:
1. Table A below should reflect the total number of epidemiologists in the program area (last column) broken down by funding source (column categories).
2. Table B below should reflect individual staff members and their amount of FTE support in each funding source category. See specific Table B instructions in the box directly above it.
3. Please make sure that the first row from Table B (TOTALS) matches that of Table A (TOTAL EPIS IN PROGRAM AREA) exactly.

TABLE A	Number supported with federal funds from CDC	Number directly funded by CDC (e.g., CEFO, EIS, PHAP, etc.)	Number supported with federal funds from other agencies	Number supported with state funds	Number supported with funds from other sources (e.g., foundations)	Total
TOTAL EPIS IN PROGRAM AREA						0

If there are multiple epidemiologists in your program area, you may wish to develop a line list with the individual names of your staff members and the amount of FTE support in each category. The sums will appear automatically in line 13 above. If there are more than 10 epidemiologists in the group, please adjust the AutoSum formula to include all.

TABLE B	Fraction of FTE supported with federal funds from CDC	Fraction of FTE directly funded by CDC (e.g., CEFO, EIS, PHAP, etc.)	Fraction of FTE supported with federal funds from other agencies	Fraction of FTE supported with state funds	Fraction of FTE supported with funds from other sources (e.g., foundations)	Total FTE
TOTALS	0	0	0	0	0	0
Name 1						0
Name 2						0
Name 3						0
Name 4						0
Name 5						0
Name 6						0
Name 7						0
Name 8						0
Name 9						0
Name 10						0

Your name:	0
Your email:	0
Program Area (click cell to view list):	

Section 4, Question 16:

Please estimate of ideal number of additional epidemiologists needed to reach full capacity in your program area (the number of epidemiologists in addition to the current number regardless of resources. Please attribute the fraction of capacity ito the nearest 0.1 FTE if less than one FTE is needed. **Please answer this question based on your departments' CURRENT capacity needs during the COVID-19 response.**

Instructions for Completion:
1. Insert estimated number into the blue cell.
2. Only numbers are accepted. Please round to one decimal place.

Estimate ideal number of additional epidemiologists needed to reach full capacity	

Your name:	0
Your email:	0
to view list):	

Section 6, Question 19:
What are your state's 3 best assets for recruiting epidemiologists?

Instructions for Completion:
1. Please answer only for your program area.
2. Select by replacing "m" with "X". Please leave the placeholder values in the options you do not wish to select.

What are your state's 3 best assets for recruiting epidemiologists? Please only include civil service employees.	
m	Competitive salary
m	Personnel policies and procedures
m	Job benefits
m	Job security
m	Job location
m	Opportunity for promotion
m	Opportunity for travel
m	Job interests/fulfillment
m	Opportunity for skills training
m	Flexible schedule
m	Opportunity for continued education
m	Other (please specify)

Your name:	0
Your email:	0
Program Area (click cell to view list):	

Section 7, Question 27:

What are your state's 3 most successful tactics for retaining epidemiologists? Please include only civil service employees.

Instructions for Completion:

1. Please answer only for your program area.
2. Select by replacing "m" with "X". Please leave the placeholder values in the options you do not wish to select.

What are your state's 3 most successful tactics for retaining epidemiologists? Please only include civil service employees.	
m	Competitive salary
m	Personnel policies and procedures
m	Job benefits
m	Job security
m	Opportunity for promotion
m	Opportunity for travel
m	Job interests/fulfillment
m	Opportunities for skills training
m	Flexible schedule
m	Opportunities for continued education
m	Accurate job description during interview process
m	Other (please specify)