Community Outbreak Preparedness Index (COPI)

Technical Report

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Executive Summary

Local-level organizations, including local public health agencies, hospitals, and other healthcare and social service providers, are on the frontline of communicable disease outbreak response efforts. Therefore, assessing outbreak preparedness capabilities at the local level is important to identify potential areas for improvement in preparing for and responding to future outbreaks and pandemics. We developed the Community Outbreak Preparedness Index (COPI) to assess county-level preparedness for future outbreaks. This 2023 index focuses on counties within California, where the county level government is an important player in public health, emergency management, and healthcare preparedness activities. Given that comprehensive outbreak preparedness requires capabilities and coordination across a diverse range of entities, the COPI sought to capture a broad view of capabilities that are important to preventing, detecting, and responding to outbreaks.

The COPI is comprised of four domains: (1) Healthcare System Preparedness, (2) Public Health System Preparedness, (3) Access to Health Insurance and Social Safety Net Services, and (4) Community Factors. These domains encompass activities within the most critical entities responding to outbreaks (e.g. within the healthcare and public health systems), and also explicitly recognizes the importance of social determinants of health and the safety net systems that may be called upon to help mitigate the social, health, and economic impacts of outbreaks. The index is calculated as a numerical score, on a 0-10 scale, including 63 indicators across the 4 domains and 16 subdomains.

Outbreak preparedness capabilities varied across the 58 California counties, and counties' scores varied across the four subdomains. COPI overall scores ranged from 5.2 to 7.8, with an average score of 6.7. Counties with higher overall COPI scores were more likely to be metropolitan counties, have larger proportions of Asian populations, larger percentages of college graduates and households with higher incomes. Scores varied widely across counties for Domains 1, 2, and 4, but were relatively similar across all counties for Domain 3, suggesting the importance of state-level policies driving access and quality of safety net services. These findings suggest there are areas for improvement within the public health and healthcare preparedness capabilities, such as improvements in hospital medical surge capacity and community preparedness efforts.

The COPI tool helps fill a critical gap in the assessment of local-level preparedness for future outbreaks. There are many challenges in building a local-level preparedness index, especially in identifying appropriate data to capture the level of detail needed to inform decision makers. Future research will help to identify more detailed or refined data on preparedness capabilities and potentially expand the tool to other states.

Chapter 1: Motivation for the Community Outbreak Preparedness Index (COPI) project

The need for tools to assess local-level outbreak preparedness in the United States

The ability to prevent, detect, respond, and recover from communicable disease outbreaks requires coordination and resources on a global, national, statewide, and local scale. While federal-level preparedness is an essential component of overall outbreak preparedness, state and local jurisdictions also play critical roles in outbreak preparedness and response in the United States. Local health departments are often at the frontline of outbreak response, such that effective preparedness and response at the local level may help prevent the further spread of disease. Given the many differences in roles and scope of activities among agencies and partner organizations at these different levels of government, an assessment of outbreak preparedness at the federal level is expected to evaluate different sets of factors compared to a local-level assessment.

There are several existing tools that evaluate pandemic preparedness on a global scale.(Moore et al., 2017; Welle & Birkmann, 2015) However, there are far fewer tools are available to assess preparedness at the local level. The majority of the local-level tools focus on assessing community vulnerability, often as it pertains to a specific disease, with many of these tools developed to assess vulnerability to COVID-19.(Cahill et al., 2021; Daras et al., 2021; Marvel et al., 2021; Mitrică et al., 2021) While vulnerability is important and may guide the ways in which we need to be prepared to meet the needs of the population in a local community, it is also important to assess the preparedness of the systems that are tasked with preventing, detecting, and responding to communicable disease outbreaks.

Therefore, we sought to develop the Community Outbreak Preparedness Index (COPI) as a tool to assess local-level preparedness that would be applicable to future communicable disease outbreaks in the United States. Such a tool would help to highlight areas of strength and identify gaps that can be addressed through targeted efforts. Given the multi-faceted nature of outbreak preparedness, we sought to include indicators the span the many systems that contribute to local-level preparedness, along with an assessment of community vulnerability, which increases the risk of negative outcomes of outbreaks and helps identify populations that may need additional support in outbreaks and pandemics. The COPI is not intended to predict where outbreaks will occur or what consequences may result, but rather, to assess various aspects of how a county's systems are prepared for preventing, detecting, and responding to future outbreaks.

Key events in outbreak and emergency preparedness in the United States

In the past several decades, the need for the nation's public health and healthcare systems to be prepared for handling emergency situations has seen several key inflection points. In 1999, following several high-profile terrorist bombings, the CDC began funding states and major metropolitan areas for preparedness and response activities, focused on bioterrorism prevention (Centers for Disease Control and Prevention, 2018b; Toner et al., 2009). After the terrorist attacks on September 11, 2001 and the Anthrax attacks that same year, the federal government prioritized further funding toward programs to detect, prevent, and address acts of bioterrorism. Specifically, Congress passed the Public Health Security and Bioterrorism Preparedness and Response Act of 2002, which provided funding for the Hospital Preparedness Program (HPP) administered by the Department of Health and Human Services Health Resources and Services Administration and the CDC-administered Cities Readiness Initiative (CRI)

and Public Health Emergency Preparedness (PHEP) programs (Center for Preparedness and Response, 2022; Medcalf et al., 2020). These programs funded a range of preparedness activities at hospitals and public health departments to prepare these institutions to detect and respond to bioterrorism attacks.

Emergency preparedness efforts soon evolved to preparedness for a broader list of emergencies. Hurricane Katrina in 2005 revealed how a natural disaster and insufficient national preparedness could have devastating impacts to many communities within a region. To address these gaps, the 2006 Pandemic and All Hazards Preparedness Act (PAHPA) created the Assistant Secretary of Preparedness and Response (ASPR), which became the agency responsible for the development of the National Health Security Strategy (NHSS), overseeing the HPP, and enhancing programs that stockpile medical countermeasures (U.S. Department of Health and Human Services, 2019). Additionally, the 2008 H5N1 avian influenza outbreaks in Asia and the 2009 H1N1 influenza pandemic spurred additional federal funding toward public health systems in detecting and tracking such outbreaks as well as increased focus not only on hospital preparedness, but also regional preparedness and the broader healthcare community's preparedness for major disasters (Niska & Shimizu, 2011; U.S. Department of Health and Human Services, 2011). In 2012, the ASPR HPP transitioned to a model where the funding supported the development of healthcare coalitions (HCCs), which included hospitals as well as public health agencies, emergency medical services (EMS), emergency management agencies, and other healthcare stakeholders, such as long-term care facilities, disaster volunteer organizations, and others (U.S. Department of Health and Human Services, 2011). These changes allowed the HPP to support both the formation of these coalitions as well as sustaining support for the coalitions' activities.

The HPP, PHEP, and CRI programs were formulated with an "all-hazards" approach to preparedness, recognizing that our nation's health systems needed to be prepared for a wide range of emergencies, including natural disasters, acts of terrorism, and communicable disease outbreaks. Indeed, in recent years, the likelihood of communicable disease outbreaks has increased the urgency for outbreak preparedness across healthcare, public health, and other sectors. In response to the 2009 H1N1 influenza pandemic, the 2009 Supplemental Appropriations Act for the Public Health and Social Services Emergency Fund provided funding for federal and state agencies to improve state and local preparedness for pandemic influenza (Centers for Disease Control and Prevention, 2020). In 2014, in response to the emerging Ebola outbreak in West Africa, Congress appropriated funding for Ebola treatment and prevention through the PHEP program (Center for Preparedness and Response, 2020) and funds to support healthcare facilities to identify, isolate, transport, and treat patients through the ASPR HPP Regional Treatment Network for Ebola and Other Special Pathogens (U.S. Department of Health and Human Services, 2018).

In response to the COVID-19 pandemic beginning late 2019 and early 2020, the federal government enacted several bills to fund response and relief efforts across the nation. Three major federal legislative packages were approved in March 2020, specifically the Coronavirus Preparedness and Response Supplemental Appropriations Act (Lowey (2020a), the Families First Coronavirus Response Act (Lowey, 2020b), and the Coronavirus Aid, Relief, and Economic Security Act (CARES Act)(Courtney, 2020). These acts provided emergency funding for agencies acting in response to the pandemic, including funding the development of diagnostics, therapeutics and vaccines, supporting testing and other biosurveillance activities, addressing medical supply shortages, and providing financial support for hospitals and medical providers. Additionally, in response to the resulting economic crisis, these legislative packages also included support for nutrition assistance programs and unemployment benefits, policy changes to

support employee sick leave and paid family and medical leave, tax relief to families, changes to the tax laws for employers. Subsequent federal funding acts provided additional support for the continued pandemic response and recovery efforts.(Cuellar, 2021; Yarmuth, 2021) While these federal actions pumped billions of dollars into these healthcare, public health, and economic recovery efforts, and helped to modernize electronic reporting systems that provide more timely public health data, there remained a continued need for investing in the infrastructure needed to prepare for and respond to future outbreaks and pandemics. Thus, the 2022 PREVENT Pandemics Act included provisions to invest in strengthening the public health and health professionals workforce, improve the nation's supply and stockpiles of medical supplies, improve research to develop novel biomedical technologies, and make structural changes within the federal government to improve policies supporting emergency response and preparedness, with particular requirements for the CDC and ASPR agencies (Murray, 2022).

The impacts of these most recent investments in public health and biomedical infrastructure are yet to be seen. Heading into the COVID-19 pandemic, the ASPR HPP and the CDC PHEP program remained the two primary sources of federal funding for healthcare and public health preparedness (Medcalf et al., 2020). These programs each have a set of defined capabilities that the grantees work to implement and demonstrate (Center for Preparedness and Response, 2021; Office of the Assistant Secretary for Preparedness Response, 2016). Since 2012, the HPP and PHEP capabilities were aligned to support the healthcare and public health communities in working toward complementary goals and reducing duplication of work (Centers for Disease Control and Prevention, 2012).

As the nation moves forward and prepares for the possibility of other new, emerging pathogens in the future, it is essential to ensure that our healthcare, public health, and other critical systems are prepared not only at a federal and state level, but also at the local level where much of the response takes place. In addition to healthcare and public health aspects of preparedness, the COVID-19 pandemic had a profound impact on local and global economies, which translated to the increased need for social safety net services, such as safety net programs for health insurance, unemployment benefits, housing, and food.(Abrams et al., 2022; Hetrick et al., 2020; Khorrami & Sommers, 2021; Leddy et al., 2020; Raifman et al., 2021; Saloner et al., 2020) Although the impact of most outbreaks are generally not as widespread, families may still be impacted on a household level, so access to these services remains an important component to our community-wide resilience to the effects of an outbreak. The ability of these services to effectively reach the populations they are intended to serve is important to assess as part of community-wide outbreak preparedness.

Additionally, COVID-19 and other communicable diseases have disparate impacts on vulnerable populations, including children, elderly persons, people with disabilities, communities with low household incomes, and communities of color (Beltran et al., 2022; Chandrasekhar et al., 2017; Green et al., 2021; Hutchins et al., 2009; Stokes et al., 2021). Such social determinants of health have an important impact on a broad spectrum of health outcomes (Lipshutz et al., 2022; Prata Menezes et al., 2021; Xu et al., 2021). Assessing the overall community vulnerability based on social determinants of health would help illustrate the need for higher degrees of outbreak preparedness in certain jurisdictions with high social and/or economic vulnerability.

Given the importance of healthcare systems, public health systems, social safety net programs, and social determinants of health on the population health impacts of outbreaks, these elements are essential to include in a tool that measures local-level outbreak preparedness.

Chapter 2: Review of existing outbreak preparedness indices

While there are several other previously-developed indices measuring outbreak preparedness, there are few indices that focus on bolstering local-level preparedness for communicable disease outbreaks (Rogers et al., 2023).(Rogers et al.) There are many indices focused on global outbreak preparedness, such as the Infectious Disease Vulnerability Index (Moore et al., 2017) or the Global Health Security Index (Abbey et al., 2020), which compare markers of preparedness, available resources, and vulnerability among countries across the world. Index tools to measure general community vulnerability for a wide range of diseases are also available, such as the CDC's Social Vulnerability Index and other indices that capture both environmental health and social factors contributing to public health outcomes (California Office of Environmental Health Hazard Assessment, 2021; Centers for Disease Control and Prevention and Agency for Toxic Substances Disease Registry, 2022; Flanagan et al., 2018). However, these community vulnerability tools do not measure preparedness of the systems intended to detect, respond to, and or mitigate communicable disease outbreaks. Among the local-level outbreak readiness indices available, many of these indices focus on COVID-19 community vulnerability (Marvel et al., 2021; Surgo Ventures, 2020), or community-level risk factors for other specific communicable diseases (e.g. HIV/HPV) (Yedinak et al., 2021). While these tools are useful when evaluating risk and vulnerability for specific diseases, they typically do not include measures of preparedness activities that are important in ensuring appropriate readiness for future outbreak events.

A handful of indices evaluate state or local level outbreak preparedness, which are the tools that will help identify areas for investment to prepare for future outbreaks, regardless of the specific pathogen involved. The National Health Security Preparedness Index (NHSPI) measures state-level preparedness for both communicable diseases as well as other health security concerns (e.g. bioterrorism, natural disasters) (Lumpkin et al., 2013). The Hospital Medical Surge Preparedness Index (HMSPI) measures hospital preparedness, but specifically focused on surge capacity (Marcozzi et al., 2020). The Neighborhood Pandemic Resilience Index measures local-level socioeconomic factors, neighborhood resources and infrastructure elements among neighborhoods in Tehran, Iran (Lak et al., 2021). Self-assessment tools also exist for jurisdictions to conduct a self assessment, such as the Rapid Urban Health Security Assessment (Boyce & Katz, 2020), but these tools do not easily allow for any comparisons or benchmarks against other similar jurisdictions.

To address this gap in indices that address local-level preparedness for future communicable disease outbreaks, we designed the COPI is designed as a tool that describes county-level preparedness, focusing on the major systems that are tasked with preparing for future outbreaks. Rather than focusing on any single pathogen, the COPI is designed to address preparedness for communicable disease outbreaks more broadly. Additionally, the COPI includes measures of community vulnerability, which impacts the degree to which an area may need to prepare for the special needs of vulnerable populations.

Chapter 3: Conceptual Framework and Domain Structure

The framework for the COPI is designed to reflect the intent to illustrate county-level preparedness within healthcare systems, public health systems, and key social safety net systems in the US. In addition, the framework also includes a component to reflect the importance of social determinants of

health on the impacts of outbreaks within communities. The overall framework of the COPI is shown graphically in Figure 1.

Domain 1: Healthcare System Preparedness

Domain 2: Public Health System Preparedness

Domain 3: Access to Social Safety Net Services

Domain 4: Community Factors

Figure 1. Overall framework for the Community Outbreak Preparedness Index (COPI)

Given the importance of the HPP and PHEP programs in funding preparedness activities in healthcare and public health, the structure of Domains 1 and 2 are based on these programs' respective capabilities. In this manner, agencies and organizations that do work primarily in one of those domains can look to that part of the index for guidance. Access to social safety net systems is reflected in a separate domain for a similar reason, such that organizations doing work in food insecurity, access to health insurance, unemployment benefits, or housing insecurity can look to these measures as areas where their work contributes to overall preparedness for the impacts of outbreaks. Domain 4 is intended to reflect the degree to which community vulnerabilities exist in the county.

In Chapter 4, we provide a summary of the evidence supporting the importance of healthcare coalition and public health capabilities pertaining to outbreak preparedness. We also present evidence for the use of specific measures of access to specific social safety net systems and community vulnerability, through the lens of outbreak preparedness.

Domain 1: Healthcare system preparedness

The framework for the healthcare system preparedness domain is based on the ASPR HPP program capabilities for regional healthcare coalitions. ASPR publishes their 5-year Health Care Preparedness and Response Capabilities to provide guidance to healthcare coalitions and member entities on the capabilities they need to develop and/or demonstrate to deliver timely and appropriate patient care during emergencies, reduce the negative health outcomes from emergencies, and promote healthcare system resilience after emergencies (Office of the Assistant Secretary for Preparedness Response, 2016). These capabilities have been updated periodically, with earlier editions being more focused on hospital readiness for mass care and medical surge, whereas the latest guidance focuses on a wider range of

capabilities to accommodate both larger and smaller healthcare facilities, and emphasizing the importance of collaborative activities. Four major capabilities are included in the 2017-2022 HPP guidance, specifically foundation for health care and medical readiness, health care and medical response coordination, continuity of health care service delivery, and medical surge. However, given that the performance measures for continuity of health care service delivery focus on facility evacuation, such as during natural disasters, this specific capability was not included in the COPI because it is less relevant for outbreak preparedness.

With the HPP funding coalitions all across the US, this framework provides the geographic coverage for a relevant regional coordinating unit for healthcare preparedness. Another strength of this approach is that the HPP capabilities are aligned with the PHEP capabilities, so that the domains are complementary (Harris et al., 2016).

While the medical surge capability includes the ability for healthcare coalition members to share critical resources during an emergency, it does not account for the general availability of healthcare personnel staffing in the region that might be a resource for surge staffing. While surge staffing resources can be brought in from other regions, a local resource would provide the timeliest response, especially if transportation challenges and cross-state licensure issues are at play. Therefore, measures of specific types of local healthcare staffing availability are included in this domain. Additionally, overall measures of healthcare quality may be important aspects to assess, as these are indicators of the quality of healthcare under normal circumstances; healthcare quality can be negatively impacted in emergency situations (Figure 2).

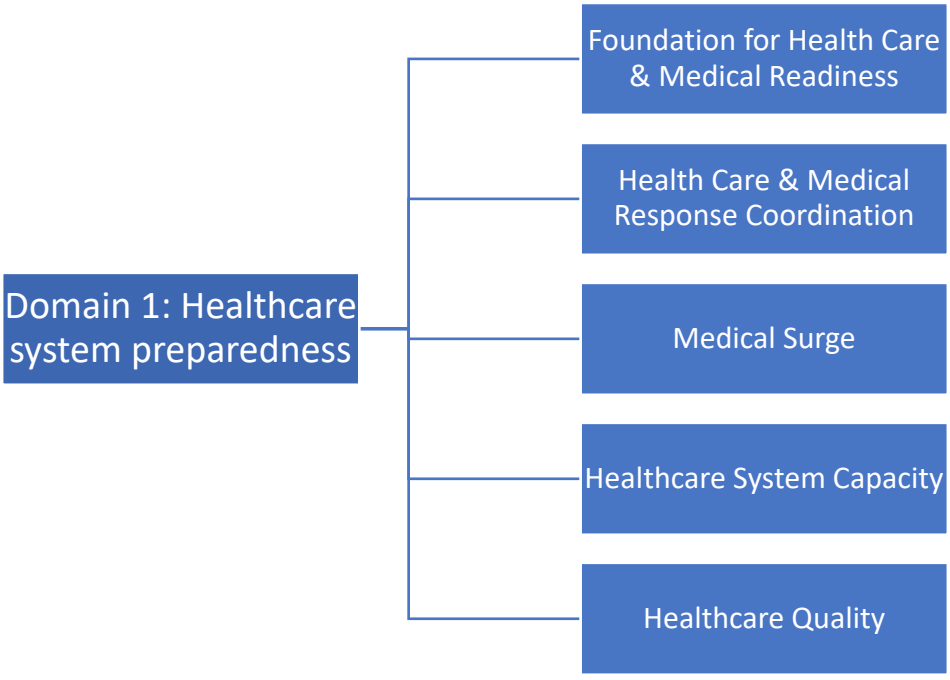

Figure 2. Domain 1 – Healthcare system preparedness is measured across 5 subdomains

Domain 2: Public health system preparedness

The framework for measuring public health system preparedness is based on the CDC PHEP program capabilities. The PHEP programs 15 capabilities are grouped into the following 6 categories (Figure 3):

(1) community resilience (community preparedness and community recovery), (2) incident management (emergency operations coordination), (3) information management (information sharing and emergency public information/warning), (4) surge management (fatality management, mass care, and surge management), (5) countermeasures and mitigation (medical countermeasures dispensing/administration, medical material management/distribution, nonpharmaceutical interventions, responder safety/health, and volunteer management), and (6) biosurveillance (public health laboratory testing and public health surveillance/epidemiological investigation).(Centers for Disease Control and Prevention, 2018b)

Core public health functions in outbreak preparedness typically include disease surveillance and the implementation of interventions and policies to reduce risk and mitigate negative outcomes. However, in the context of outbreak preparedness and response, public health also serves an important convening function, including sharing data and coordinating response with healthcare entities and other community entities such as schools, volunteer organizations, faith-based organizations, and businesses. The PHEP capabilities reflect all of these critical aspects of public health preparedness.

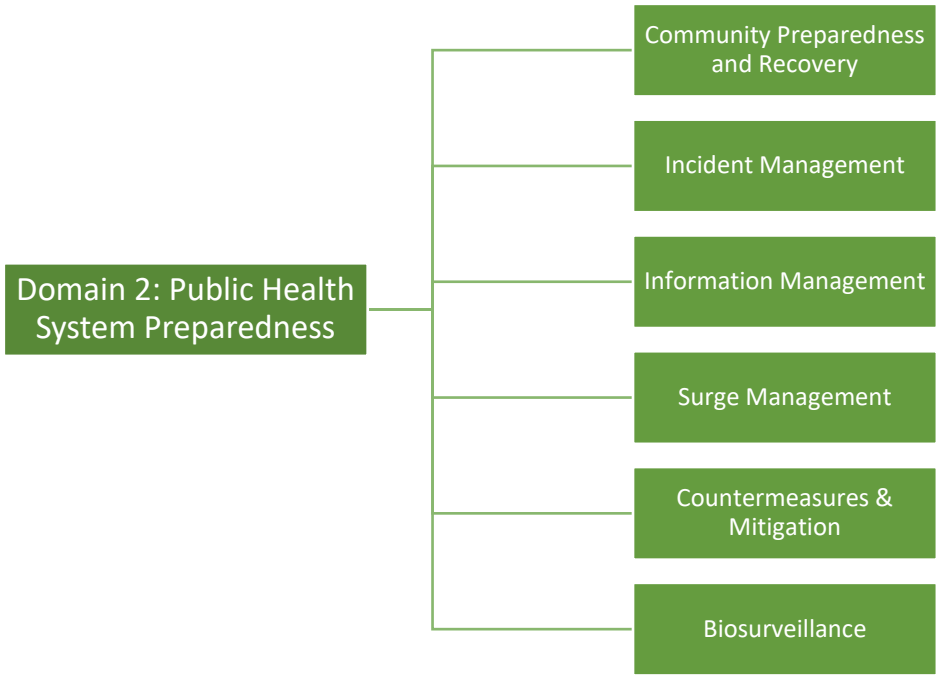

Figure 3. Public health system preparedness (Domain 2) is measured across 6 subdomains

Domain 3: Access to health insurance and social safety net services

Support systems for individuals and families to access their basic needs, such as food, medical care, and shelter, are important in mitigating negative health consequences and supporting recovery from outbreaks (Karpman et al., 2020). Additionally, access to financial support, such as from unemployment insurance benefits, helps to support access to these basic needs among populations with limited resources (Raifman et al., 2021). Safety net programs have been shown to prevent disease, which can help reduce the health burdens associated with communicable diseases (N Maqbool et al., 2015; Park & Kim, 2023; L. A. Taylor, 2018). Therefore, a robust social safety net system would represent better community-wide preparedness for outbreaks.

The COPI Domain 3 is structured to address each of these areas of basic need through measures reflecting the degree of access to these needs as well as the quality of the food, housing, and unemployment benefits available. While quality of medical care is also important, those measures are already captured in Domain 1, and therefore were not included in Domain 3 in order to reduce redundancy.

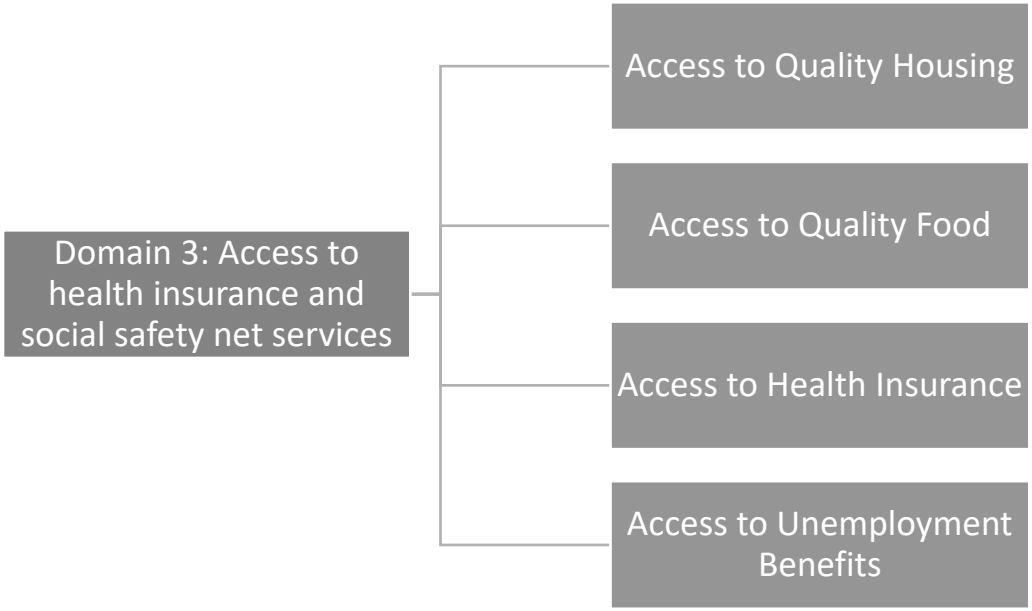

Figure 4. Access to health insurance and social safety net services (Domain 3) is measured across 4 subdomains

Domain 4: Community Factors

Social, economic, and environmental factors have clear health consequences, including links to worse outcomes for communicable diseases (Freese et al., 2021; Hughes et al., 2021; Teyton et al., 2023). Social vulnerability refers to the social factors that weaken the ability of a person or community to prevent or mitigate negative health outcomes (Flanagan et al., 2018), and may include factors such as poverty, race/ethnicity, and household characteristics. Because pre-existing chronic health conditions and environmental exposures also have impacts on communicable disease outcomes, the Environmental Justice Index includes measures of environmental burden, health vulnerability, and social vulnerability (Centers for Disease Control and Prevention and Agency for Toxic Substances Disease Registry, 2022). In the context of this tool, community factors are defined as the inverse of community vulnerability, with higher factor scores meaning lower levels of vulnerability. Domain 4 of the COPI is based on the EJI, but calculates a county-level metric based on these data (Figure 5).

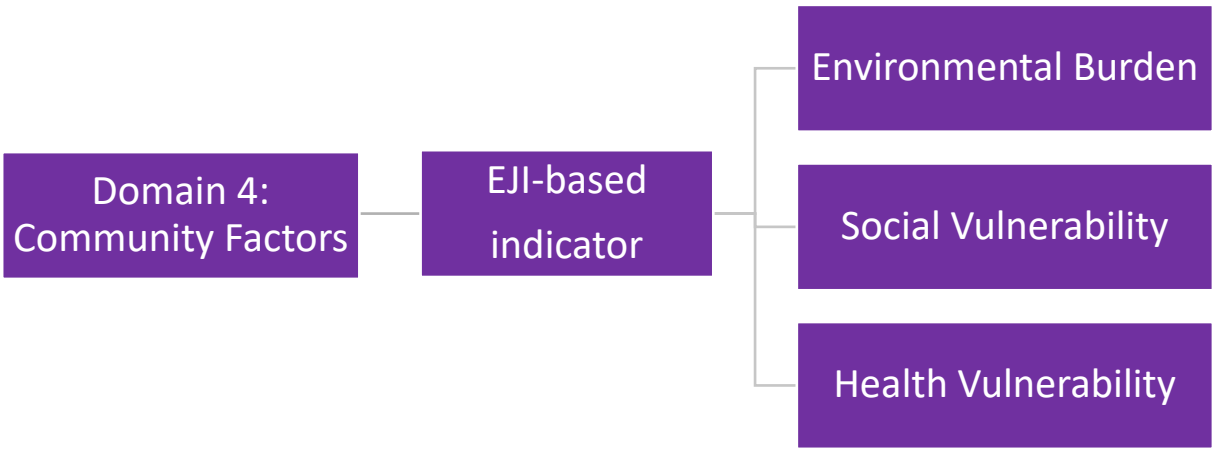

Figure 5. Community factors (Domain 4) is calculated based on the Environmental Justice Index, which has 3 subdomains

Chapter 4: Summary of the literature on domains important to preparedness and response to outbreaks

Healthcare system preparedness

Undoubtedly, healthcare systems are critical to outbreak response, starting with acute care facilities and emergency medical services, but also broadly including long-term care facilities, pharmacies, dialysis clinics, behavioral health providers, Medical Reserve Corps (MRCs), and agencies that also play a role in ensuring that patients get the healthcare services they need. Preparedness elements include having plans and systems in place for surge staffing, conducting drills and evaluations to test communications and surge capacities, ensuring continuity of patient transport services, and other planning elements that delineate the roles and responsibilities of coalition members in an emergency (Kim, 2016; Office of the Assistant Secretary for Preparedness and Response, 2020; Tobias et al., 2020). Outbreak (and all-hazards) preparedness can vary from facility to facility, but a local-level healthcare response relies on both individual facility preparedness as well as regional preparedness. Given the ASPR HPP program structure of funding coalitions, we examine the role of healthcare coalitions in outbreak and other emergency responses.

Healthcare coalition roles in outbreak response and preparedness

Hospitals and their healthcare coalition partners are frontline organizations in an outbreak response, including detecting and reporting cases, allocating and providing medical and other healthcare services, and expanding services during a surge in cases. In planning for these activities, healthcare coalitions have organized planning workgroups, test the plans through drills and exercises, and refine the plans by implementing recommendations from after-action reports. While the efficacy of HCCs overall is subject to debate, especially given the devastating gaps that the COVID-19 pandemic revealed (Barnett et al., 2020), we sought to identify examples in the peer-reviewed literature of healthcare coalitions that have demonstrated a coordinated response to an outbreak or other type of emergency requiring healthcare resources. Some of the limitations of HCCs are likely attributable to inadequate funding levels (Vick, 2021; Walsh et al., 2015), and the effectiveness of coalitions in the future is dependent on the ability to make appropriate resources available to sustain such collaborations within our diverse and fragmented healthcare and public health networks.

There are several published articles that describe the overall benefits, challenges, and best practices of HCCs in responding to emergencies (Barnett et al., 2020; Maldin et al., 2007; Walsh et al., 2015). Benefits identified are consistent with the overall goals of the HPP program in supporting coalitions, including relationship-building across healthcare entities, serving as a neutral entity to bring competitive organizations together, facilitating communication, coordination and information-sharing across sectors, understanding preparedness gaps from a regional perspective, and sharing staff and training resources for improved efficiency. Best practices and opportunities noted include working to establish more sustainable funding mechanisms, engaging a broad spectrum of healthcare entities in the coalition, ensuring alignment with the PHEP and other programs, and improving how stakeholders communicate the value of the coalition. Some challenges identified include difficulties working through administrative and geopolitical barriers, aligning organizational missions and capabilities, and ensuring that funding resources are available to support the work needed (which negatively impacts organizations' ability to

dedicate staff to work on preparedness activities, engage in coalition activities, and fulfill federal grant guidance). In particular, HCCs have tried to address the challenge of maintaining a high level of engagement across members and leadership, with some providing financial incentives for participation and others preferring Memoranda of Understanding (MOUs) rather than contracts, which inhibited collaboration (Maldin et al., 2007; Walsh et al., 2015). An example of incentivizing participation is the 2016 Centers for Medicare & Medicaid Emergency Preparedness Rule, which required providers to comply with emergency preparedness requirements, many of which are consistent with HCC activities (Centers for Medicare & Medicaid Services, 2021; Office of the Assistant Secretary for Preparedness and Response, 2017).

In December 2021, ASPR completed an evaluation of HCCs engaged in COVID-19 response and explored the roles that HCCs played in their regional response, strategies employed for information sharing, surge management, resource management, and implementing crisis standards of care (Office of the Assistant Secretary for Preparedness and Response, 2021). This evaluation found that HCCs benefitted from the strong relationships that were cultivated prior to the pandemic, and were thus able to facilitate information sharing that was critical in implementing medical surge strategies. HCCs took a leadership role in developing policies in their region (including crisis standards of care (CSC) guidelines, PPE usage), providing training to smaller HCC member entities, acquiring and distributing PPE that were in short supply, and convening stakeholders needed to deliver patient care. Some smaller healthcare entities, such as dental practices, were not previously engaged in the HCC, but turned to the HCC during this emergency to find support. MOCCs were a successful mechanism in many jurisdictions to coordinate patient transfers as part of load-balancing efforts, but HCCs had mixed reviews of how to implement the MOCC. In particular, rural areas did not always find that the MOCC was needed, but instead noted the main challenge being a lack of personnel or resources. Although CSCs were not implemented widely during the COVID-19 pandemic, many HCCs noted that they are conducting CSC planning activities and are looking for statewide guidance and frameworks, with an emphasis on decision making rather than merely scarce resource distribution. Additionally, the use of alternative care sites (ACS) is being revisited, as there is recognition of their value in medical surge in more typical emergencies where the entire nation or world is not simultaneously affected.

Healthcare system preparedness – key factors

In summary, the cross-sector planning, coordination, and resource sharing functions of healthcare coalitions are important contributors to healthcare system preparedness in the US (United States Government Accountability Office, 2022). Closely related elements include the overall capacity and baseline quality of the healthcare system in the region, which contributes to the ability of the region to respond to an outbreak or pandemic situation and recover from these emergencies. Medical surge capacity (including staffing and other types of critical resources) has been assessed at the hospital level, and also contributes to overall regional surge capacity within a coalition region (Marcozzi et al., 2021; Marcozzi et al., 2020).

Public health system preparedness

Public health systems play several important roles in outbreak preparedness and response at the local level. Core public health functions include disease investigation, epidemiological surveillance, community assessment and issuing public health guidance. Having a robust communicable disease program is central to a public health department's preparedness for outbreaks, providing disease

surveillance capabilities and expertise in prevention and response. Additionally, food and water safety are important aspects of outbreak preparedness; these functions are typically housed within environmental health programs. Lastly, public health agencies serve an important convening function, collaborating with other healthcare entities, public agencies, private entities, and community members to coordinate the response and ensure appropriate public communication (Centers for Disease Control and Prevention, 2018b).

States are the primary bodies with the responsibility to protect public health, and therefore have public health authority, although many states have delegated such authority to local (e.g. county or city) agencies (Institute of Medicine (US) Committee for the Study of the Future of Public Health, 1988). California is one such state where public health authority is delegated to the local entities. Each of California's 58 counties and 3 cities has a local health department; these health departments operate as agencies that are not part of the state government. This county-level organization is not unique to California, but there are many public health agency models across the country, including states that operate a state health department with local offices, states that have a mix of local (county/city) and state health departments, and states where a local town's board of health is the primary local public health authority (Centers for Disease Control and Prevention, 2022a). The local health department (LHD) is the central organization responsible for public health outbreak preparedness at the city or county level in states that have delegated their authority to local agencies.

Public health outbreak preparedness roles and programs

Preparedness roles of the public health department include conducting disease surveillance and investigations, providing public health guidance and/or requirements to stakeholders, implementing prevention and mitigation strategies (including non-pharmaceutical interventions and medical countermeasures), and providing timely communication to the public (Institute of Medicine; Board on Health Sciences Policy; Committee on Research Priorities in Emergency Preparedness and Response for Public Health Systems, 2008). Specific activities that enhance a LHD's ability to accomplish these roles include developing emergency operations plans, conducting workforce training and drills, building and maintaining effective surveillance systems, and developing effective communication strategies that reach the populations they serve. Ensuring that the public health workforce has adequate skills, training, and support to conduct these activities can help bolster local public health preparedness (Oza et al., 2023; Taylor et al., 2018). Recent studies have highlighted the challenges with maintaining a strong public health workforce, especially in the aftermath of the COVID-19 pandemic, which put a tremendous amount of stress on public health workers (Council of State and Territorial Epidemiologists, 2021; Leider et al., 2023). Ensuring adequate health department capacity and training this workforce to adapt their skills to the changing landscape of public health will be essential to building outbreak preparedness capabilities. Additionally, one of the unique roles of local and state public health agencies is the provision of legal authority to invoke Crisis Standards of Care (CSC) during public health emergencies where the limited healthcare resources across a region must be conserved to address the most critical patient needs with the goal of minimizing mortality and reducing morbidity (Hodge et al., 2022). Public health agencies are also the entity to lead the development of CSC guidelines for healthcare entities. Although the direct impact of CSCs is on the availability of healthcare resources, the invocation of these standards is a public health function intended to protect overall population health outcomes.

While public health agency capabilities account for the bulk of the preparedness work, such as having the capabilities to perform disease investigations, conduct public health surveillance, and assess

community needs, the capabilities of other partner entities are also critical. One such partner is the public health laboratory (PHL), which is critical for biosurveillance activities on the local or state level (Centers for Disease Control and Prevention, 2018a). Other key partnering entities include pharmacies, which would help dispense diagnostics, therapeutics, and medical countermeasures, as was seen during the COVID-19 pandemic (Luisi et al., 2023; Portman & Scolese, 2023; Smith & Oakley, 2023). Although hospitals and other healthcare providers have unique preparedness capabilities, some of the practices implemented in these healthcare settings contribute to the public health system's ability to conduct their outbreak preparedness activities, including streamlined surveillance through the use of electronic health records, electronic case reporting, health information exchanges, syndromic surveillance, and other health information technologies (Centers for Disease Control and Prevention, 2021; Morbey et al., 2023; Oetjens et al., 2020; Osborne et al., 2020). These technologies have the ability to increase efficiency and data quality (including providing more real-time data), but the implementation and adoption of these technologies within public health and healthcare systems come with many challenges (Sudat et al., 2021; Walker et al., 2021).

Other partner entities that are important to outbreak preparedness include schools, community organizations, and other entities that can partner with the public health authorities to enhance their capacity to reach the public. For example, schools were tasked with implementing several preventive measures during the COVID-19 pandemic, implementing health department guidelines and requirements (Pampati et al., 2023). Partnerships with universities, community-based organizations, faith-based organizations, and labor groups, have been useful in promoting resource-sharing and facilitating public engagement for disaster preparedness, outbreak response, and recovery activities (Acosta et al., 2018; Adams et al., 2018; Brewer et al., 2020; Dunlop et al., 2016).

A variety of programs exist to build capacity for emergency preparedness within their organizations and in their jurisdictions. The types of activities supported by these programs include training, emergency response planning, building partnerships and improving communications among stakeholders (Nelson et al., 2012; Savoia et al., 2017; Summers & Ferraro, 2017). The CDC's Cities Readiness Initiative (CRI) has provided funding to major metropolitan areas in developing emergency response plans, including a particular focus on building capacity to utilize medical countermeasures provided through the Strategic National Stockpile (SNS) (Nelson et al., 2012). The National Association of County and City Health Officials (NACCHO), in collaboration with CDC, established the Project Public Health Ready (PPHR) program in 2003 to provide training and recognition for local health departments to improve their all-hazards preparedness through planning, training, and quality improvement activities (Officials, 2023). Both these programs are examples of capacity building activities at local health departments that directly contribute to the PHEP capabilities, such as the health department's ability to utilize and deliver medical countermeasures or ensuring that the emergency plan includes building partnerships and conducting training to support community-wide preparedness. Previous case reports and studies have highlighted the impact of such health department capabilities in conducting public health investigations, providing public information, and delivering medical countermeasures in outbreak situations (Perry et al., 2018; Prevention, 2023).

The Public Health Accreditation Board (PHAB) was established in 2007 as the accreditation body for local and state health departments. PHAB accreditation standards are aligned with the PHEP capabilities, including a number of preparedness requirements that the health department must demonstrate in order to gain accreditation(CDC Office of Readiness and Response (ORR) and Center for State Tribal

Local and Territorial Support (CSTLTS), 2020) (CDC Office of Readiness and Response (ORR) and Center for State Tribal Local and Territorial Support (CSTLTS), 2020). Studies have found positive associations between accreditation and preparedness, including preparedness for communicable diseases (Public Health Accreditation Board, 2022) (Kennedy et al., 2021). These studies identified improved partnerships and accountability with external stakeholders as one of the key outcomes of accreditation.

A prior assessment of local health departments' emergency preparedness capacities highlighted how the PHEP program has helped to improve public health preparedness, particularly related to the implementation of countermeasures or other mitigation tools (Murthy et al., 2017). However, the same study also identified that coordination between the public health agency and healthcare systems needed further development, and cited common challenges including inadequate funding to support the workforce needed to build such preparedness capabilities.

Public health preparedness – key factors

Researchers have sought to identify factors that may contribute to improved public health preparedness. Qari et al. conducted a systematic review to summarize studies that identified criteria for assessing public health preparedness and response effectiveness (Qari et al., 2019). Regarding performance metrics for emergency response, the authors highlighted studies that identified the importance of the LHDs being engaged in community partnerships, information sharing, bio-surveillance, and implementation of medical countermeasures and non-pharmaceutical interventions (NPIs). Similarly, Bevc and colleagues found that having active relationships with community-based and faith-based organizations (Bevc et al., 2014) was associated with better LHD preparedness. Furthermore, in their systematic review of public health preparedness activities, Savoia et al. identified evidence suggesting the importance of incident and surge planning activities, such as health department capacity building through appropriate training drills and exercises, coordination across different types of organizations for training exercises, using a variety of information channels and methods to communicate to the public, sharing information with healthcare entities, emergency preparedness planning efforts, community assessments, and developing strategies reaching vulnerable populations (Savoia et al., 2017).

Social safety net access

Social safety net programs are important to help mitigate the impacts of communicable disease outbreaks and their socioeconomic consequences. Four important areas of outbreak preparedness and response, as evidenced by the recent COVID-19 pandemic, are access to quality housing, food, health insurance, and unemployment benefits. These also reflect four major areas of social assistance programs in the United States.

Access to quality housing

Housing conditions have been associated with many population health outcomes, and adequate housing is an important factor to consider in outbreak preparedness (Pollack et al., 2010; L. Taylor, 2018). Poor housing conditions have been associated with higher rates of infectious disease spread and with poorer outcomes following infection (Ahmad et al., 2020; World Health Organization, 2018). The U.S. Census Bureau's American Community Survey (ACS) provides recurring data on housing conditions in the United States, and the County Health Rankings and Roadmaps program utilizes the ACS data to calculate the following measures which are indicative of poor housing conditions: overcrowding, high housing cost,

incomplete kitchen facilities, or incomplete plumbing facilities (Remington et al., 2015; U.S. Census Bureau, 2005-2021). Household crowding is directly associated with infectious disease outbreaks through higher risk for exposure and disease spread (World Health Organization, 2018). Adequate kitchen and plumbing facilities are essential for nutrition and sanitation purposes, both highly related to preventing the spread of infectious diseases. High housing costs place individuals and families at increased risk for crowding and poor housing conditions, and further impact health outcomes by reducing resources available for food, health care expenditures, and other basic necessities (Nabihah Maqbool et al., 2015).

Multiple studies of housing conditions in relation to the COVID-19 pandemic found that poor housing conditions were associated with higher risks for COVID-19 incidence and mortality (Ahmad et al., 2020; Khanijahani et al., 2021). In a recent study of U.S counties, it was estimated that as many as 60% of households in some counties experienced at least one poor housing condition described above (Ahmad et al., 2020). This demonstrates the importance of continued assessment and improvement of housing conditions within the U.S. to support outbreak preparedness.

Access to quality food

Food access was greatly disrupted during the COVID-19 pandemic, due to alterations in food distribution chains, loss of employment, and hesitancy to leave the home due to risk of infection (Leone et al., 2020). The percentage of individuals and families experiencing food insecurity in the U.S. increased, largely due to loss of income (Adams et al., 2020; Lacko & Henchy, 2021). Food-insecure families experienced some of the greatest barriers to food access, due to less options for grocery stories nearby and online grocery ordering (Leone et al., 2020). In addition, food-insecure families with young children reported needing to sometimes ration food or use supplemental food sources to overcome challenges with obtaining food (Loth et al., 2023).

The recent COVID-19 pandemic, and its negative impacts on food access and food security, highlight the importance of social safety net programs. The Supplemental Nutrition Food Assistance Program (SNAP) is one of the main food assistance programs in the U.S. (U.S. Department of Agriculture Food and Nutrition Service, 2023b). In 2019, SNAP provided benefits to approximately 35 million people nationwide. However, only 82% of individuals who were eligible for the program were enrolled, showing clear room for improvement (U.S. Department of Agriculture, 2019). The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is another large, federally-funded program that provides benefits to purchase nutritious foods for low-income pregnant and postpartum women, infants, and children less than five years of age. In 2019, approximately 11 million women and children accessed WIC benefits (U.S. Department of Agriculture Food and Nutrition Service, 2023a). However, only 57% of eligible women and children participated in the program (U.S. Department of Agriculture, 2022).

Access to financial resources and proximity to grocery stores are also important measures of food access. The Food Environment Index is a scaled index based on proximity to a grocery store and food insecurity. Specifically, it is a scale from 1 (worst) to 10 (best) that equally weights the following two indicators of the food environment: 1) The percentage of the population that is low income (≤200 percent of the federal poverty threshold) and that does not live close to a grocery store; and 2) the percentage of the population that did not have access to a reliable source of food during the past year (County Health Rankings & Roadmaps, 2023). A low Food Environment Index score is associated with

greater reliance on fast food restaurants and other sources of unhealthy foods (Ashby, 2020). At the county level, greater access to grocery stores has been associated with better health outcomes including lower mortality rates (Ahern et al., 2011). Food insecurity is associated with poor diet (Hanson & Connor, 2014), which can lead to increased vulnerability to infection and adverse health outcomes (Iddir et al., 2020). Thus, the Food Environment Index represents an important measure related to food access and outbreak preparedness.

Health Insurance

Access to preventative health care and medical treatment is an essential component of outbreak preparedness. Health insurance is an important indicator of access to health care, as it connects individuals and families with networks of health care providers and protects them against the high costs associated with health care services. Individuals with health insurance are more likely to have a usual source of care (Kilbourne, 2005; Newacheck et al., 2000; Stevens et al., 2006), which is associated with better continuity of care, preventive care, and health outcomes (DeVoe et al., 2003; Kilbourne, 2005; Starfield & Shi, 2004). During COVID-19, lower rates of health insurance coverage were associated with higher infection rates (Hawkins, 2020), and communities with less access to health care providers experienced higher mortality rates due to COVID-19 (Ojinnaka et al., 2021).

In the United States, Medicare represents the primary source of health insurance coverage for elderly populations ages 65 and older. Among working adults and their family members, health insurance is primarily obtained as a benefit of employment (Spiegel & Fronstin, 2023). However, low-wage workers are often not offered health insurance benefits, or they are unable to afford health insurance premiums on low incomes (Clemans-Cope et al., 2006). Medicaid and the State Children's Health Insurance Program (SCHIP) are public programs that provide critical sources of coverage for these low-income, non-elderly populations. However, even with existing employer and public sources of coverage available, many Americans still remain without access to health insurance. In 2021, 8.3% of the population (27.2 million people) in the United States did not have health insurance, representing clear room for improvement (Keisler-Starkey & Bunch, 2022). Policies such as the Affordable Care Act's Medicaid expansion have increased access to health insurance, but adoption of this policy and increases in insurance coverage among populations has varied across states (Kaiser Family Foundation, 2022). Given the high percentage of adults ages 18-65 without health insurance, and its association with access to care and health outcomes, health insurance coverage represents an important factor relevant to outbreak preparedness.

Unemployment benefits

The unemployment insurance program remains an important social safety net program that helps mitigate economic instability, which helps to maintain health (Moffitt & Ziliak, 2020; Shahidi & Parnia, 2021). During the height of the COVID-19 pandemic, national unemployment rates more than tripled from 3.6 to 13.0 percent (Smith et al., 2021). Loss of employment had direct adverse effects by decreasing access to health insurance and income to pay for housing, food, and other household necessities required for daily living (Despard et al., 2020). Thus, factors that can protect individuals and households from unemployment and loss of income are critical components of outbreak preparedness.

Broadband internet access is an important factor associated with both employment opportunities as well as access to unemployment insurance benefits. Better access to broadband internet is associated

with lower unemployment rates, which has been observed particularly in rural areas where local employment opportunities may be limited (Marre, 2020). Further, during the COVID-19 pandemic, internet access enabled many workers to continue employment while working from home (Al-Habaibeh et al., 2021). Broadband internet access is also strongly associated with better access to unemployment benefits (Bell, Hedin, Mannino, et al., 2021; Bell, Hedin, SCHNORR, et al., 2021). This association was demonstrated in California during the COVID-19 pandemic, in which counties with more broadband access had substantially higher rates of unemployment benefit recipiency (Bell, Hedin, Mannino, et al., 2021). This points to the importance of addressing technological gaps to increase access to unemployment benefits.

Due to the risk of employment loss in connection with infectious disease outbreaks, the quality of unemployment benefits is a crucial factor in pandemic preparedness. Unemployment insurance provides unemployment benefits to eligible workers who have become unemployed through no fault of their own, usually provided in the form of weekly payments. The U.S. Department of Labor and individual states work jointly to administer unemployment insurance, and individual states develop their own system for delivering unemployment benefits (Stone & Chen, 2014). Amounts of benefits given vary by state, ranging from ~$200 for low states to ~$800 for high states for maximum amounts of benefits given on a weekly basis (World Population Review, 2022). States also differ in the length of time for which unemployment benefits are available, ranging from 12 to 26 weeks (Center on Budget and Policy Priorities, 2023; Stone & Chen, 2014).

The importance of unemployment benefits was demonstrated during the COVID-19 pandemic, during which the percentage of unemployed Americans collecting unemployment benefits rose to 60%, compared to 16% prior to the pandemic (Bell, Hedin, Mannino, et al., 2021). In March 2020, the U.S. Congress passed the Coronavirus Aid, Relief, and Economic Security Act (CARES), which extended the number of weeks in which eligible workers could collect uninsurance benefits (U.S. Congress, 2020). Under the CARES act, the federal government also enacted the Federal Pandemic Unemployment Compensation (FPUC), which increased unemployment benefits by $600 per week through July 2020. While FPUC was enacted, nearly three-fourths of workers eligible for compensation were eligible for benefits that exceeded their lost wages (Ganong et al., 2020). Enactment of FPUC was also found to have a positive effect by reducing competition for jobs at a time when jobs were unusually scarce (Marinescu et al., 2021). The quality of unemployment benefits is clearly an important indicator of outbreak preparedness to mitigate effects of unemployment loss as seen during the COVID-19 pandemic.

Community Factors

Community vulnerability or social determinants of health are strongly associated with increased communicable disease risk and morbidity from such health problems (Abrams et al., 2022; Keller, 2022). Community vulnerability is therefore an important factor that impacts the degree of preparedness needed for a given region.

The Environmental Justice Index (EJI), developed in 2022 by the Agency for Toxic Substances and Disease Registry (ATSDR), is a national tool to measure the cumulative impacts of social and environmental burdens on health, using data from the U.S. Census Bureau, the U.S. Environmental Protection Agency, the U.S. Mine Safety and Health Administration, and the U.S. Centers for Disease Control and Prevention (CDC) (Agency for Toxic Substances and Disease Registry, 2022). The EJI provides a composite score for

each census tract based on measures of social vulnerability, environmental burden, and health vulnerability. Public health officials, community-based organizations, and others can use these scores to identify and prioritize high-risk areas where special attention may be needed to improve health.

Within the social and health vulnerability areas of the EJI, multiple indicators of racial and ethnic minority status, socioeconomic status, household characteristics, housing type, and pre-existing health conditions are used to calculate the EJI score. These factors are important measures of community vulnerability to outbreaks, as they may increase the impacts of infectious disease, which was observed during the COVID-19 pandemic. People living in poverty were more likely to have a decrease in working hours and income and to experience psychosocial stressors, depressiveness, anxiety, and loneliness when compared to more affluent individuals during the COVID-19 pandemic (Petersen et al., 2022). Racial and ethnic minorities including non-Hispanic black and Hispanic populations had higher rates of COVID-19 infection, hospitalization, and mortality when compared to non-Hispanic white populations (Centers for Disease Control and Prevention, 2022b; Magesh et al., 2021; Vahidy et al., 2020). Crowded housing conditions were associated with high risk for COVID-19 exposure and infection due to limited ability to socially distance (Ahmad et al., 2020; Khanijahani et al., 2021; World Health Organization, 2018). Individuals with pre-existing chronic disease conditions were at especially high risk for COVID-19 morbidity and mortality (Centers for Disease Control and Prevention, 2023; Laires et al., 2021).

Measures of social and health vulnerability captured within the EJI are inter-related. For example, racial and ethnic minorities are more likely to have low socioeconomic status, crowded housing conditions, (Vahidy et al., 2020) and chronic disease (Oates et al., 2017). People living in poverty are at higher risk for chronic disease (Jayathilaka et al., 2020; Oates et al., 2017). These inter-relationships support the importance of each of the components, as well as the utility of the EJI as a single measure combining multiple related factors to indicate community vulnerability to outbreaks.

Chapter 5: Methods

External Advisors

We engaged external advisors to provide input on the development of the first version of the COPI tool. We sought advisors who had expertise in public health, healthcare, and community engagement. The advisors and their affiliations are listed in Appendix I.

Advisors provided advice and input on the structure of the index, the overall content, and the relevant units of comparison (e.g. county, state, country). Additionally, the advisors provided feedback on the validity of the indicators and the relative weighting of the 4 domains. The feedback was collected through individual meetings with each advisor.

Data Sources & Indicators

Domain	Sub-domain	Indicator	Data Sources & Years	Description & Calculations
1	1	Emergency Management Agencies Participation Rate in Healthcare Coalition	ASPR Healthcare Readiness Near You (2022)	Participation by emergency management agencies in the local healthcare coalition (HCC). The indicator is calculated as the proportion of emergency management agencies in the coalition area that participate in the HCC, multiplied by 10. The same participation rate applies to all counties that are within that HCC. Emergency management agencies plan for many types of emergencies (including outbreaks), operate emergency operations centers, and work closely with healthcare and public health organizations to respond to these emergencies.[1,2] Emergency management agencies are one of the core member types within healthcare coalitions, so their participation in these coalitions provides a foundation for outbreak preparedness work. Healthcare coalitions are the primary entities leading the emergency planning and coordination activities across a geographic region, allowing for better communication and resource sharing, which are essential in coordinating outbreak response.
1	1	Local Health Departments Participation Rate in Healthcare Coalition	ASPR Healthcare Readiness Near You (2022)	Participation by local health departments in the local healthcare coalition (HCC). The indicator is calculated as the proportion of local health departments in the coalition area that participate in the HCC, multiplied by 10. The same participation rate applies to all counties that are within that HCC. Local public health agencies play an important role in the healthcare aspects of outbreak response, providing credible information about disease risk and trends that may impact healthcare capacity, and developing guidance for

[1] Rose, D. A., Murthy, S., Brooks, J., & Bryant, J. (2017). The Evolution of Public Health Emergency Management as a Field of Practice. Am J Public Health, 107(S2), S126-s133. https://doi.org/10.2105/ajph.2017.303947

[2] Baxi, S., B-Lajoie, M., Craven, M., Mysore, M., & Wilson, M. (2021). The future of Emergency Operation Centers: Six shifts to consider from COVID-19. McKinsey & Company. Retrieved May 23 from https://www.mckinsey.com/industries/healthcare/our-insights/the-future-of-emergency-operation-centers-six-shifts-to-consider-from-covid-19#/

				diagnosing, managing, and treating patients and contacts.[3] Local public health agencies are one of the core member types within healthcare coalitions, so their participation in these coalitions provides a foundation for outbreak preparedness work. Healthcare coalitions are the primary entities leading the emergency planning and coordination activities across a geographic region, allowing for better communication and resource sharing, which are essential in coordinating outbreak response.
1	1	Acute Care Hospitals Participation Rate in Healthcare Coalition	CDPH Healthcare Coalition Member Data (FY2020-2021). CDPH County General Acute Care Hospitals dataset (2020)	Participation by acute care hospitals in the local healthcare coalition (HCC). The indicator is calculated as the number of acute care hospitals in the coalition area that participate in the local healthcare coalition (HCC), divided by the total number of acute care hospitals within that HCC region, then multiplied by 10. The same participation rate applies to all counties that are within that HCC. Acute care hospitals are central to outbreak response with roles including case identification and implementing infection prevention and control practices to protect healthcare workers and patients.[4] Acute care hospitals are one of the core member types within healthcare coalitions, so their participation in these coalitions provides a foundation for outbreak preparedness work. Healthcare coalitions are the primary entities leading the emergency planning and coordination activities across a geographic region, allowing for better communication and resource sharing, which are essential in coordinating outbreak response.
1	2	Hospital accreditation	Joint Commission (JC), Health Facilities Accreditation Program (HFAP), and National Accreditation for Healthcare Organizations	Accreditation among acute care or critical access hospitals through any one of the following programs: the Health Facilities Accreditation Program (HFAP), the National Accreditation for Healthcare Organizations (DNV), or the Joint Commission (JC). All 3 of these programs are approved accreditation programs from the Centers for Medicare and Medicaid Services (CMS) that have emergency preparedness standards.

[3] Center for Preparedness and Response. (2021). Public Health Emergency Preparedness and Response Capabilities: National Standards for State, Local, Tribal, and Territorial Public Health. Centers for Disease Control and Prevention, U.S. Department of Health and Human Services. https://www.cdc.gov/cpr/readiness/capabilities.htm

[4] Banach, D. B., Johnston, B. L., Al-Zubeidi, D., Bartlett, A. H., Bleasdale, S. C., Deloney, V. M., Enfield, K. B., Guzman-Cottrill, J. A., Lowe, C., Ostrosky-Zeichner, L., Popovich, K. J., Patel, P. K., Ravin, K., Rowe, T., Shenoy, E. S., Stienecker, R., Tosh, P. K., & Trivedi, K. K. (2017). Outbreak Response and Incident Management: SHEA Guidance and Resources for Healthcare Epidemiologists in United States Acute-Care Hospitals. Infect Control Hosp Epidemiol, 38(12), 1393-1419. https://doi.org/10.1017/ice.2017.212

			(DNV) websites (2022). CMS Hospital Compare (2022)	This indicator is calculated as the number of acute care and critical access hospitals that have one or more of these accreditations, divided by the total number of such hospitals in the CMS Hospital Compare database, multiplied by 10. The indicator does not include VA, federal, and other types of specialty care hospitals. Hospital accreditation requires having an emergency operations plan, hazard vulnerability analysis, and review of the emergency preparedness program; these activities require coordination across healthcare entities, which is the focus of this subdomain.[5,6]
1	3	Hospital medical surge capacity	American Hospital Association Annual Survey (2020 & 2021)	Hospital surge capacity within the healthcare coalition (HCC) region. This indicator is calculated by first calculating the Hospital Medical Surge Preparedness Index (HMSPI) among hospitals in the dataset, averaging scores from both years.[7] The HMSPI includes four subdomains based on the "Science of Surge" construct: staff, supplies, space, and system. The surge index is normalized across hospitals within the state. Next, the HMSPI scores were averaged across hospitals within each healthcare coalition (HCC). All counties within the HCC receive the same score. Outbreaks can create surging demand for critical care resources, particularly hospital resources, such as intensive care beds, personal protective equipment (PPE), and healthcare personnel. Measuring hospital-based medical surge capacity is of critical importance in assessing healthcare preparedness for outbreaks.[8]
1	4	Critical Care Nursing and Physician Capacity	National Plan and Provider Enumeration System (NPPES) National Provider Identifier (NPI) Registry (2022), American	Staffing capacity for critical care nurses and physicians. To calculate this indicator, the first step is to calculate the number of critical care nurses per 100,000 population and number of intensivist physicians (i.e. trained in critical care medicine) per 100,000 population in the county. Next, these two measures are averaged and min-max scaled from 0-10 based on data from counties across the state.

[5] The Joint Commission. (2021). New and Revised Standards in Emergency Management (R3 Report: Requirement, Rationale, Reference, Issue. https://www.jointcommission.org/-/media/tjc/documents/standards/r3-reports/final-r3-report-emergency-management.pdf

[6] 42 CFR § 482.15

[7] Marcozzi, D. E., Pietrobon, R., Lawler, J. V., French, M. T., Mecher, C., Peffer, J., Baehr, N. E., & Browne, B. J. (2020). Development of a Hospital Medical Surge Preparedness Index using a national hospital survey. Health Serv Outcomes Res Methodol, 20(1), 60-83. https://doi.org/10.1007/s10742-020-00208-6

[8] Hick, J. L., Einav, S., Hanfling, D., Kissoon, N., Dichter, J. R., Devereaux, A. V., & Christian, M. D. (2014). Surge capacity principles: care of the critically ill and injured during pandemics and disasters: CHEST consensus statement. Chest, 146(4 Suppl), e1S-e16S. https://doi.org/10.1378/chest.14-0733

			Community Survey 5-year population (2020)	The nursing taxonomy codes included are: 163WC0200X - Registered Nurse (Critical Care Medicine) 364SC0200X - Clinical Nurse Specialist (Critical Care Medicine) 363LC0200X - Nurse Practitioner (Critical Care Medicine) 367500000X - Nurse Anesthetist, Certified Registered The physician taxonomy codes included are: 207LC0200X - Physician/Anesthesiologist (Critical Care Medicine) 207RC0200X - Internal Medicine (Critical Care Medicine) 207VC0200X - Obstetrician & Gynecologist (Critical Care Medicine) 2084A2900X - Psychiatry & Neurology (Neurocritical Care) 2086S0102X - Surgery (Surgical Critical Care) The presence of critical care nurses and physicians in the region is an indicator of potential resource availability in the immediate geographic area to provide local capacity for handling routine healthcare needs. Areas that have lower baseline capacity may be more prone to strain during outbreak incidents.
1	4	Nursing home staffing COVID-19 vaccination	CMS Nursing Home COVID 19 Vaccination Data (2022)	Extent of COVID-19 vaccination among nursing home staff. This indicator is calculated as the proportion of nursing home staff in the county who were up-to-date with their COVID-19 vaccinations. The vaccination rates were weighted based on the number of certified beds at the facility and averaged across facilities in the county. This weighted average was multiplied by 10 to create the indicator on a 0-10 scale. Nursing home staff represent an important category of healthcare workers that serve a population of older adults, who are at higher risk of morbidity and mortality from a wide variety of communicable diseases. Vaccination is an important measure to prevent transmission of diseases between staff and residents, as well as a measure to help preserve available workforce during outbreaks. A high vaccination rate for COVID-19 among nursing home staff is indicative of the ability and willingness of these institutions and communities to be vaccinated for a novel pathogen, which could be applied to other vaccine-preventable diseases.
1	4	Dental healthcare capacity	Health Professional Shortage Area, from HRSA (2022)	Dental healthcare capacity in the county. To calculate this indicator, the first step is to calculate the percent of the county population that the does not have a geographic designation from the Health Resources and Services Administration (HRSA) as a Health Professional Shortage Area (HPSA) for

				Dental Health providers shortages. This percent is multiplied by 10 to create the indicator on a 0-10 scale. Dental healthcare is an important component of general healthcare and is included in this subdomain, which assesses baseline healthcare capacity. Lower levels of baseline healthcare capacity are associated with poorer general population health, in part due to delayed or deferred necessary care, which may lead to more complex healthcare needs during outbreaks.
1	4	Mental healthcare capacity	Health Professional Shortage Area, from HRSA (2022)	Mental healthcare capacity in the county. To calculate this indicator, the first step is to calculate the percent of the county population that the does not have a geographic designation from the Health Resources and Services Administration (HRSA) as a Health Professional Shortage Area (HPSA) for Mental Health providers shortages. This percent is multiplied by 10 to create the indicator on a 0-10 scale. Mental healthcare is an important component of general healthcare and is included in this subdomain, which assesses baseline healthcare capacity. Lower levels of baseline healthcare capacity are associated with poorer general population health, in part due to delayed or deferred necessary care, which may lead to more complex healthcare needs during outbreaks.
	4	Primary care capacity	Health Professional Shortage Area, from HRSA (2022)	Primary care capacity in the county. To calculate this indicator, the first step is to calculate the percent of the county population that the does not have a geographic designation from the Health Resources and Services Administration (HRSA) as a Health Professional Shortage Area (HPSA) for Primary Care providers shortages. This percent is multiplied by 10 to create the indicator on a 0-10 scale. Primary care is an important component of general healthcare and is included in this subdomain, which assesses baseline healthcare capacity. Lower levels of baseline healthcare capacity are associated with poorer general population health, in part due to delayed or deferred necessary care, which may lead to more complex healthcare needs during outbreaks.
1	4	EMT staffing capacity	Bureau of Labor Statistics (BLS), Occupational Employment Statistics (OES) (2020), American Community Survey 5-year population (2020)	Staffing capacity for emergency medical technicians (EMTs) and paramedics. This indicator is calculated as the number of EMTs and paramedics in the county, divided by the county population, then min-max scaled based on data from counties across the state, and scaled to a 0-10 scale.

1	5	Acute Care Hospital Healthcare Worker influenza vaccination rate	California Department of Public Health, Health Care Personnel Influenza Vaccination (2018-2019, 2020-2021, 2021-2022 flu seasons)	Influenza vaccination among healthcare workers at acute care hospitals. This indicator is calculated as the percent of healthcare workers at acute care hospitals in each county who are vaccinated for influenza in each of the 3 seasons included. The average vaccination rate for each county is calculated by averaging the percent vaccinated across the 3 influenza seasons. This percent is multiplied by 10 to create the indicator on a 0-10 scale. The Healthy People 2020 goal is to have 90% of healthcare workers vaccinated for influenza by the 2020-2021 season. Vaccination is an important measure to prevent transmission of diseases between staff and patients, as well as a measure to help preserve available healthcare workforce during outbreaks. A high healthcare worker vaccination rate for influenza is indicative of the presence of a robust immunization program, which could be applied to many vaccine-preventable diseases.[9]
1	5	Hospital utilization reporting completeness for COVID-19	HHS Hospital Data Coverage Reporting (2022), CMS Hospital Compare (2022)	Hospital reporting completeness of hospital utilization data to the Health and Human Services Agency (HHS) during COVID-19 pandemic. To calculate this indicator, the first step is to calculate the number of community hospitals in the county that had complete reporting to HHS at the first time point (October 17, 2022), divided by the total number of hospitals in the county based on CMS data. Next, we calculate the same fraction for a second time point (December 12, 2022). The average reporting completeness for each county was calculated by averaging across these two time points. The indicator is then multiplied by 10 to create the indicator on a 0-10 scale. This specific reporting requirement was implemented during the COVID-19 pandemic to provide nation-wide surveillance on critical hospital resource utilization.[10] This type of reporting serves as a potential model for other forms of timely reporting mechanisms that may be implemented in the future.
1	5	Preventable Hospitalizations	County Health Rankings (2021, based on Centers for Medicare & Medicaid	The preventable hospitalizations indicator is a measure of healthcare quality, and is calculated from the County Health Rankings Preventable Hospital Stays measure, which reports the age-standardized rate of hospitalizations for

[9] Healthcare-Associated Infections Program. (2021). Protecting Patient Health for All Californians: Influenza Vaccination Coverage among Health Care Personnel in California Hospitals: 2020-21 Annual Report. https://www.cdph.ca.gov/Programs/CHCQ/HAI/CDPH%20Document%20Library/CDPH_HAIProgram_HCPfluVaxReport_2020-2021_FINAL_041822.pdf

[10] US Department of Health and Human Services. (2022). COVID-19 Guidance for Hospital Reporting and FAQs For Hospitals, Hospital Laboratory, and Acute Care Facility Data Reporting. https://www.hhs.gov/sites/default/files/covid-19-faqs-hospitals-hospital-laboratory-acute-care-facility-data-reporting.pdf

			Services Office of Minority Health's Mapping Medicare Disparities Tool)	ambulatory-care sensitive conditions per 100,000 Medicare enrollees. To calculate the indicator, we applied min-max scaling from 0-10 to the CHR Preventable Hospital Stays measure based on data from counties within the state, and reversed the polarity such that a higher score on this indicator means there were fewer preventable hospitalizations. Reducing preventable hospital stays in the county helps reduce the strain on healthcare resources during outbreak situations.
1	5	Nursing Home Quality	CMS Skilled Nursing Facility Quality Reporting Program, 2022 release	This indicator of nursing home quality is based on the percent of nursing home residents at facilities within the county that did not have an infection control citation in the past 3 years, among facilities that had an inspection. This percent was multiplied by 10 to create the indicator on a 0-10 scale. Nursing homes are congregate living facilities for older adults, who are a vulnerable population for a wide variety of communicable diseases. Infection control practices at these facilities help to minimize disease transmission in these settings.[11]
1	5	Nursing Home Staffing	CMS Skilled Nursing Facility Quality Reporting Program, 2022 release	Adequacy of nursing home staffing. The indicator is calculated as the percent of Nursing Homes in the county that meet CMS recommended staffing ratios for RN, LPN and CNA, multiplied by 10 to create an indicator on a 0-10 scale. The recommended staffing ratios are: >=0.75 RN hours per resident per day, >=0.55 LPN/LVN hours per resident per day, and >=2.8 CNA hours per resident per day. Nursing homes are congregate living facilities for older adults, who are a vulnerable population for a wide variety of communicable diseases. Studies have linked adequate staffing ratios to improved nursing home quality.[12]
1	5	Hospital Quality	CMS Hospital Compare, 2022 release	The Hospital Quality indicator is calculated as the average CMS Overall Star Rating across acute care and critical access hospitals, among counties with at least 50% complete data. Since the CMS Overall Star Rating is provided on a 5-point scale, the average rating is multiplied by 2 to create this indicator on a 10-point scale.

[11] Cohen, C. C., Engberg, J., Herzig, C. T., Dick, A. W., & Stone, P. W. (2015). Nursing Homes in States with Infection Control Training or Infection Reporting Have Reduced Infection Control Deficiency Citations. Infect Control Hosp Epidemiol, 36(12), 1475-1476. https://doi.org/10.1017/ice.2015.214

[12] Harrington, C., Schnelle, J. F., McGregor, M., & Simmons, S. F. (2016). The Need for Higher Minimum Staffing Standards in U.S. Nursing Homes. Health Serv Insights, 9, 13-19. https://doi.org/10.4137/hsi.S38994

				The Overall Star Rating is a summary of several quality measures, including mortality, safety of care, readmission, patient experience, and timely and effective care.[13] Better hospital quality is important in helping to ensure better patient outcomes.
1	5	Pediatric Care Quality	Agency for Healthcare Research and Quality (AHRQ) Pediatric Quality Indicators (2017-2019)	The Pediatric Care Quality indicator is created using the AHRQ Pediatric Quality Indicators (PDIs), Pediatric Overall Quality Composite measure. The county-level PDIs are measures of potentially avoidable hospitalizations for Ambulatory Care Sensitive Conditions (ACSCs). The composite measure includes admission rates for pediatric asthma, pediatric gastroenteritis, diabetes short-term complications, and UTI's. To calculate the indicator, we applied min-max scaling among counties across the state, reversed the polarity such that a higher score means there were fewer potentially avoidable hospitalizations, and scaled the indicator from 0-10. Children have developing immune systems and are therefore a vulnerable population for having complications from communicable diseases, such as influenza, measles, and respiratory syncytial virus.[14,15,16] Preventing hospitalizations for the conditions captured in the PDIs would help alleviate the burden on pediatric hospital resources during outbreak conditions.
2	1	Community Health Assessment	NACCHO Profile of Local Health Departments (2016), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	The Community Health Assessment indicator was calculated as the proportion of the county population served by an LHD which has completed a community health assessment in the last several years. LHDs with CHAs completed within last 3 years received 3 points. CHA's performed more than 3 years ago received fewer points (2 points for completing a CHA 3-5 years ago, 1 point for completing a CHA more than 5 years ago). The number of points was multiplied by the proportion of the county population served by the local health department, which was calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). Scores for local health departments within the same county were summed for a final county score, and divided by 3 to

[13] CMS. Overall star rating for hospitals. CMS. Retrieved May 24 from https://www.medicare.gov/care-compare/resources/hospital/overall-star-rating

[14] Thompson, W. W., Shay, D. K., Weintraub, E., Brammer, L., Cox, N., Anderson, L. J., & Fukuda, K. (2003). Mortality associated with influenza and respiratory syncytial virus in the United States. Jama, 289(2), 179-186. https://doi.org/10.1001/jama.289.2.179

[15] Centers for Disease Control and Prevention. (2019). Measles. CDC. Retrieved May 26 from https://www.cdc.gov/globalhealth/newsroom/topics/measles/index.html

[16] Hansen, C. L., Chaves, S. S., Demont, C., & Viboud, C. (2022). Mortality Associated With Influenza and Respiratory Syncytial Virus in the US, 1999-2018. JAMA Netw Open, 5(2), e220527. https://doi.org/10.1001/jamanetworkopen.2022.0527

				account for the maximum possible number of points. County scores were then multiplied by 10 to create indicator scores ranging from 0-10. Understanding the characteristics, health needs, and vulnerabilities of a community are important aspects of an LHD's emergency preparedness, and instrumental to an LHD's ability to support them in recovering from an outbreak and other emergencies.
2	1	Social Capital Index	Penn State University Social Capital Index (2014)	Social Capital is a measure of the degree of social engagement among people within a community. The PSU-SC Index (2014) is a composite score of civic engagement comprised of the number of membership organizations (i.e., religious organizations, civic and social associations, business associations, political organizations, professional organizations, labor organization, bowling center, fitness and recreational sports centers, golf courses and country clubs, and sports teams and clubs) per 1,000 population, voting rate in presidential elections, the response rate to the Census Bureau's decennial census, and the number of non-profit organizations per 10,000 population. The indicator was min-max scaled from 0-10. Social capital is associated with stronger community networks, which can facilitate preparedness awareness and planning, ease communications, and are instrumental in supporting responses to emergency, outbreak, and disaster events.[17]
2	1	Public Health Accreditation	Public Health Accreditation Board (PHAB) (2021)	The Public Health Accreditation indicator is calculated as the proportion of the population of the county served by an LHD which has been accredited by PHAB, multiplied by 10 to create an indicator on a 0-10 scale. The proportion is calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). The PHAB accreditation requirements are aligned with many of the CDC PHEP program requirements, including developing emergency operations plans and

[17] Saville, C. W. N., & Thomas, D. R. (2022). Social capital and geographical variation in the incidence of COVID-19: an ecological study. *J Epidemiol Community Health*, *76*(6), 544-549. https://doi.org/10.1136/jech-2021-217360

				risk communication plans, as well as engagement and partnerships with the communities they serve.[18]
2	1	Public Health Emergency Planning	NACCHO PPHR (2023), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	The Public Health Emergency Planning indicator is calculated as the proportion of the county population served by an LHD which has been recognized through NACCHO's Project Public Health Ready (PPHR) program. PPHR recognition prior to 2020 were given less weight (1 point) than those recognized in 2020 or more recently (2 points). The points were multiplied by the proportion of the county population served by the local health department, which was calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). Scores for local health departments within the same county were summed to create a county-wide score. County scores were divided by 2 to account for the maximum point value, then multiplied by 10 to create indicator scores ranging from 0-10. PPHR participation helps build LHD capacity in preparedness and serves as an indicator that the LHD has developed an emergency preparedness plan.[19]
2	2	Emergency Preparedness Coordinator	NACCHO Profile of Local Health Departments (2016), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	The Emergency Preparedness Coordinator indicator is calculated as the proportion of the population of the county served by an LHD with a designated Emergency Preparedness coordinator, scaled from 0-10. The proportion is calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). The coordinator is considered an important resource for local health departments to oversee emergency preparedness exercises, resources, and activities, which may often involve multiple programs and departments within the organization.
2	2	Emergency Preparedness Full-scale Exercises	NACCHO Profile of Local Health Departments (2016), ACS 5yr 2020, US Census	The Emergency Preparedness Full-scale Exercises indicator is calculated as the proportion of the population of the county served by an LHD that participated in full-scale emergency preparedness exercises in the past year, scaled to a 0-

[18] CDC Office of Readiness and Response (ORR) and Center for State Tribal Local and Territorial Support (CSTLTS). (2020). Crosswalk between Public Health Accreditation Board's Standards and Measures and CDC's Public Health Emergency Preparedness and Response Capabilities. https://www.cdc.gov/orr/readiness/capabilities/accreditation.htm

[19] Summers, S. K., & Ferraro, M. J. (2017). Project Public Health Ready: History and Evolution of a Best Practice for Public Health Preparedness Planning. Am J Public Health, 107(S2), S138-S141. https://doi.org/10.2105/AJPH.2017.303949

			City and Town Population Totals: 2020-2021	10 point scale. The proportion is calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). Full-scale exercises are lengthy exercises that imitate an emergency situation (such as a disease outbreak) on location using the equipment and personnel which would be required in case of an actual emergency. These exercises allow LHDs to evaluate their emergency plans and resources and identify deficiencies.[20]
2	2	Emergency Preparedness Functional Exercises	NACCHO Profile of Local Health Departments (2016), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	The Emergency Preparedness Functional Exercises indicator is calculated as the proportion of the population of the county served by an LHD that participated in functional exercises in the past year, scaled to a 0-10 point scale. The proportion is calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). Functional exercises are scenario-driven and require personnel to perform their duties in a simulated operational emergency environment (such as a disease outbreak). These exercises allow LHDs to evaluate their emergency plans and resources and identify deficiencies. [21]
2	2	Administrative Preparedness	NACCHO Profile of Local Health Departments (2016), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	Administrative Preparedness refers to the local health department having administrative processes in place for use during emergencies. Typically, a county or city administrative branch develops these policies, which apply to the many departments contained within their jurisdiction, including public health. The local health department needs to ensure coordination and linkage to the administrative branch of their agency to utilize these expedited processes. The indicator is calculated the proportion of the county population served by the LHD that had these processes in place during the past year; these expedited administrative processes include government funding, procurement, contracting, and hiring. The proportion is calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). County scores were multiplied by 10 to create indicator scores ranging from 0-10.

[20] U.S. Department of Homeland Security (2021). Exercises. Retrieved May 31, 2023. Ready.gov/exercises.
[21] U.S. Department of Homeland Security (2021). Exercises. Retrieved May 31, 2023. Ready.gov/exercises.

				Administrative processes for emergencies can avoid delays by removing barriers (for example, in hiring personnel or acquiring goods), supporting a timely response in an emergency situation such as a disease outbreak.[22]
2	2	Relationships with Community Entities	NACCHO Profile of Local Health Departments (2016), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	Relationships between the local health department and community organizations, including faith communities, K12 schools, libraries, media, parks and recreation, colleges and universities, businesses, CBOs, co-ops, and emergency responders. Having shared personnel or resources, written agreements, regularly scheduled meetings, or information exchange were counted toward a point total for each type of organization with whom the LHD had relationships. The points for each LHD were aggregated for each county, weighted by the population served by each LHD. The county score was then divided by the highest point total among counties, and then scaled from 0-10 points. Existing relationships with community organizations can facilitate the way in which LHDs engage, coordinate, and communicate with the public in the event of a disease outbreak.
2	3	Electronic Disease Reporting Systems	CDPH (2023), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	Use of Electronic Disease Reporting Systems by local health departments in the county. The indicator is calculated as the proportion of the population of the county served by an LHD that utilized an Electronic Disease Reporting System, scaled from 0-10 points. Electronic disease reporting systems allow for the timely reporting of diseases between healthcare providers, local health departments, and state and federal agencies, which allows the monitoring of disease trends and acts as a warning system for impending outbreaks.[23]
2	3	Electronic Lab Reporting	CDPH (2023), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	Use of Electronic Lab Reporting by local health departments in the county. The indicator is calculated as the proportion of the population of the county served by an LHD that utilized Electronic Lab Reporting, scaled from 0-10 points. Electronic lab reporting refers to the digital transmission of laboratory reports, which improves the speed and accuracy of data transmissions

[22] National Association of County and City Health Officials. Guide for incorporating administrative preparedness into exercise. Retrieved May 31, 2023. https://www.naccho.org/programs/public-health-preparedness/systems-preparedness/administrative-preparedness-exercise-guide.

[23] Centers for Disease Control and Prevention. Integrated Surveillance Information Systems/NEDSS. Retrieved May 31, 2023. https://www.cdc.gov/nndss/about/nedss.html

				between healthcare providers, local health departments, state and local public health laboratories, and state and federal agencies. This allows for the rapid identification and response to potential disease outbreaks.[24]
2	3	Health Information Exchanges	NACCHO Profile of Local Health Departments (2016), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	Use of a Health Information Exchange by local health departments in the county. The indicator is calculated as the proportion of the population of the county served by an LHD that utilized Health Information Exchanges, scaled from 0-10 points. The proportion is calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). Health information exchanges allows for the electronic sharing of medical records between healthcare providers, patients, and local health departments. These exchanges allow healthcare professionals and potentially first responders to have rapid access to patient medical records, removing barriers to patient care in emergency situations (such as disease outbreaks).
2	3	IPAWS	FEMA IPAWS (2022)	County or state uses FEMA's Integrated Public Alert & Warning System (IPAWS). The indicator denotes whether the county uses IPAWS notifications, multiplied by 10 to create a score from 0-10 points. IPAWS is FEMA's national system for transmitting local alerts and emergency information to the public through mobile phones, radio, and television.[25]
2	3	Electronic Prescribing Adoption	healthit.gov (2014)	Use of the Surescripts Network by physicians using an electronic health record to create electronic prescriptions. This indicator measures the proportion of physicians in a county e-prescribing using Surescripts, multiplied by 10 to create indicator scores ranging from 0-10. Use of electronic prescription systems helps to streamline prescribing, which reduces medical errors and costs.[26] Use of these systems also helps make prescription data more accessible to public health authorities for surveillance and assessment purposes.

[24] Association of Public Health Laboratories (2020). ELR (Electronic Laboratory Reporting). Retrieved May 31, 2023. https://www.cdc.gov/nndss/about/nedss.html

[25] Federal Emergency Management Agency (2023). Integrated Public Alert & Warning System. Retrieved May 31, 2023. https://www.fema.gov/emergency-managers/practitioners/integrated-public-alert-warning-system

[26] Esmaeil Zadeh, P., & Tremblay, M. C. (2016). A review of the literature and proposed classification on e-prescribing: Functions, assimilation stages, benefits, concerns, and risks. Res Social Adm Pharm, 12(1), 1-19. https://doi.org/10.1016/j.sapharm.2015.03.001

2	3	Electronic Health Record Technology - Hospitals	healthit.gov (2016)	Extent of adoption of electronic health records by short-term general and Critical Access Hospitals. This includes the demonstration of meaningful use of certified electronic health record technology (CEHRT) through either the Medicare or Medicaid EHR Incentive Programs. Critical Access Hospitals are facilities with no more than 25 beds and located in a rural area further than 35 miles from the nearest hospital. This is a state-level indicator, calculated as the proportion of these hospitals that have demonstrated meaningful use of CEHRT, multiplied by 10 to create indicators ranging from 0-10. Meaningful use of CEHRT improves data transfer quality and accuracy, facilitates electronic surveillance, and minimizes manual components of data transmissions.
2	3	Electronic Health Record Technology - Providers	healthit.gov (2016)	Extent of adoption of electronic health records by office-based healthcare providers. This indicator utilizes data on whether the following types of providers have demonstrated meaningful use of certified electronic health record technology (CEHRT): office-based medical doctors, doctors of osteopathy, nurse practitioners, and physician assistants. This includes the demonstration of meaningful use through either the Medicare or Medicaid EHR Incentive Programs. This is a state-level indicator, calculated as the proportion of these providers that have demonstrated meaningful use of CEHRT, multiplied by 10 to create indicators ranging from 0-10. Meaningful use of CEHRT improves data transfer quality and accuracy, facilitates electronic surveillance, and minimizes manual components of data transmissions.
2	3	Electronic Health Record Technology - Rural Areas	healthit.gov (2016)	Extent of adoption of electronic health records by rural hospitals, which includes Critical Access and small rural short-term general hospitals. This indicator includes the demonstration of meaningful use of certified electronic health record technology (CEHRT) through either the Medicare or Medicaid EHR Incentive Programs. Critical Access Hospitals are facilities with no more than 25 beds and located in a rural area further than 35 miles from the nearest hospital and/or in a mountainous region. Small hospitals are defined as having fewer than 100 inpatient beds. Rural hospitals are defined as hospitals located in non-metropolitan areas. This is a state-level indicator, calculated as the proportion of these hospitals that have demonstrated meaningful use of CEHRT, multiplied by 10 for a score ranging from 0-10.

				Meaningful use of CEHRT improves data transfer quality and accuracy, facilitates electronic surveillance, and minimizes manual component of data transmissions.
2	4	Environmental Health Program	Local public health department websites (2023), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	Local health department provides environmental health services. The indicator measures the proportion of the county population served by the local health department, which was calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). County scores were multiplied by 10 to create indicator scores ranging from 0-10. Local health departments with environmental health programs have the capacity and resources to detect and respond to emergency situations involving environmental exposures (such as waterborne or foodborne diseases) and provide environmental health support for incidents to reduce the risks of communicable diseases in mass care shelters and other communal living settings.
2	4	Partnerships with Volunteer Entities	NACCHO Profile of Local Health Departments (2016), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	Engagement of the local health department with volunteer entities (including community emergency response teams (CERT), Medical Reserve Corps, American Red Cross, other organized groups, and individuals recruited independently by the LHD). One point was granted for each volunteer entity with whom the LHD had a relationship. The point totals were multiplied by the proportion of the county population served by the LHD, which was calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). Scores for LHDs within the same county were summed for a final county score, and divided by 5 to account for the maximum possible points. County scores were multiplied by 10 to create indicator scores ranging from 0-10. Pre-existing relationships with volunteer organizations can allow local health departments to leverage these relationships during public health emergencies (such as a disease outbreak) necessitating the rapid engagement and deployment of volunteers.
2	4	Crisis Standards of Care	Manchada et al.; Network for Public Health Law (2022)	State invocation of crisis standards of care (including providing guidance) during the COVID-19 pandemic. This is a state-level indicator, multiplied by 10 for scores ranging from 0-10. Crisis standards of care invocations can provide legal protections for healthcare providers and facilities operating in public health emergencies,

				which can allow for rapid determinations in allocating resources and providing care within the constraints of a crisis, such as a disease outbreak. Whether these standards were invoked during the COVID-19 pandemic indicates that that state had the ability and willingness to do so in this emergency, and may be willing to do so in other emergencies.
2	4	Community Emergency Response Teams (CERT)	FEMA CERT (2015), ACS 5yr 2020	Number of CERT programs in a county per capita. The indicator was standardized using the min-max technique to scale scores from 0-10 based on data from counties across the state. CERT programs can provide staffing in emergency situations associated with surges in demand for disaster response services, such as during disease outbreaks.
2	4	Registered Environmental Health Specialists (REHS)	CDPH Registered Environmental Health Specialist Program (2022)	Registered environmental health specialists per capita. The indicator was standardized using the min-max technique to scale scores from 0-10 based on data from counties across the state. Environmental health professionals perform important tasks in outbreak and emergency situations which require use of shelters or other mass care sites (e.g., water supply testing, food safety inspections, shelter assessment, sanitation evaluations, safety determinations).
2	5	Communicable Disease Services	CDPH (2023), Local health department websites (2023), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	Local health department provides communicable disease services. The indicator measures the proportion of the county population served by a LHD providing communicable/infectious disease services, which was calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). County scores were multiplied by 10 to create indicator scores ranging from 0-10. Communicable disease programs allow health departments to assess disease prevalence and incidence, and to track individuals who may be infected or exposed to an illness. Additionally, these programs provide guidelines and recommendations for actions to help reduce infections, morbidity and mortality, such as through recommended treatment regimens, medical countermeasures, and non-pharmaceutical interventions.
2	5	Epidemiology Workforce	NACCHO Profile of Local Health Departments (2016), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	The Epidemiology Workforce indicator is a measure of whether the local health department meets NACCHO's Local Public Health Workforce

				Benchmarks for epidemiologists (0.39 FTE per 100,000 population).[27] The indicator is calculated as the proportion of the population served by local health departments in the county which meet the benchmark, which was calculated as the total individuals served by the health department (per NACCHO survey estimates) over the total county population (per ACS). County scores were multiplied by 10 to create indicator scores ranging from 0-10. An appropriate epidemiology workforce allows local health department to provide disease surveillance, investigate disease trends, and identify patterns and outbreaks.
2	5	Local Public Health Laboratory	Association of Public Health Laboratories Member website (2022)	County has an Association of Public Health Laboratories (APHL) member laboratory within its geography. The indicator was multiplied by 10 to scale the indicator from 0-10. Counties with local APHL laboratories may have faster access to testing services, which are important during disease outbreaks. Additionally, these laboratories support the mission of local health departments, which may be different from state priorities and mandates.[28]
2	5	Biological Monitoring Laboratory Testing	NHSPI (2020)	Biological Monitoring & Laboratory Testing score from the National Health Security Preparedness Index (NHSPI). This is a state-level indicator which assesses a state's capacity to monitor biological agents through effective laboratory testing. The indicator is already scaled from 0-10, so no further scaling was performed. This indicator includes an assessment of functions such as active and passive biosurveillance, specimen testing, report investigation supports, and situational awareness, all of which are important components to an emergency response, such as during a disease outbreak.[29]

[27] NACCHO. (2021). Local Public Health Workforce Benchmarks. https://www.naccho.org/uploads/downloadable-resources/local-public-health-workforce-staffing-benchmarks.pdf

[28] Wilson, M. L., Gradus, S., & Zimmerman, S. J. (2010). The role of local public health laboratories. Public Health Rep, 125 Suppl 2(Suppl 2), 118-122. https://doi.org/10.1177/00333549101250s215

[29] National Health Security Preparedness Index. Health Security Surveillance Sub-Domains. Retrieved May 31, 2023. https://nhspi.org/indicator/hss-health-security-surveillance/

2	5	Veterinary Public Health	NACCHO Profile of Local Health Departments (2016), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	The Veterinary Public Health indicator measures local health department relationships with veterinarians. More points were granted for each type of relationship the LHD had with veterinarians (shared personnel or resources; written agreements; regularly scheduled meetings; exchanged information). The point totals were multiplied by the proportion of the county population served by the LHD, which was calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). Scores for LHDs within the same county were summed for a final county score, and divided by the maximum point total across counties. County scores were multiplied by 10 to create indicator scores ranging from 0-10. Local health departments' collaborations with veterinarians help to build capabilities for detecting and addressing zoonotic diseases.
2	5	Wastewater Surveillance	CalSuWers Dashboard (2022), ACS 5yr 2020	Population coverage for wastewater surveillance testing. This indicator was calculated as the proportion of the county population that resides within a sewer shed participating in wastewater surveillance testing, multiplied by 10 to create indicator scores ranging from 0-10. Wastewater surveillance can be an important piece of a county's monitoring of population-level disease trends. Counties served by sewer sheds with the infrastructure to participate in wastewater surveillance may be better prepared to identify and track disease outbreaks.
2	5	Syndromic Surveillance	CDPH Health Information Exchange Gateway (2023), ACS 5yr 2020, US Census City and Town Population Totals: 2020-2021	Syndromic surveillance adoption by the local health department. This indicator is calculated as the proportion of the population served by an LHD providing syndromic surveillance services, calculated as the total individuals served by the health department (per NACCHO survey estimates) divided by the total county population (per ACS). County scores were multiplied by 10 to create indicator scores ranging from 0-10. Syndromic surveillance systems help to monitor disease trends to detect case clusters rapidly, allowing for a more timely response to disease outbreaks.
2	6	Pharmacist Workforce	NPPES (2022), ACS 5yr 2020	Pharmacist workforce in the county, per capita. The indicator was standardized using the min-max technique to scale scores from 0-10 based on data from counties across the state. The pharmacy taxonomy codes included are: - Pharmacist: 183500000X

				○ Ambulatory Care: 1835P2201X ○ Critical Care: 1835C0205X ○ Geriatric: 1835G0303X ○ Nuclear: 1835N0905X ○ Nutrition Support: 1835N1003X ○ Oncology: 1835X0200X ○ Pediatrics: 1835P0200X ○ Pharmacist Clinician/Clinical Pharmacy Specialist: 1835P0018X ○ Pharmacotherapy: 1835P1200X ○ Psychiatric: 1835P1300X - Pharmacy technician: 183700000X Pharmacists dispense medications (including vaccines) and, as such, are a crucial workforce component for distributing medical countermeasures in response to a disease outbreak.
2	6	COVID-19 vaccination	CalHHS COVID-19 Vaccine Progress Dashboard Data (2022)	COVID-19 population-wide vaccination rates. This indicator is calculated as the proportion of the county's population who have completed the primary series of the COVID-19 vaccine, multiplied by 10 to create indicator scores ranging from 0-10. This indicator reflects the capacity of a county to execute a mass vaccination campaign, as well as the ability and willingness of the county's population to comply with public health guidelines regarding a new vaccine.
2	6	Cities Readiness Initiative	CDC Cities Readiness Initiative website (2022)	Participation in Cities Readiness Initiative (CRI) program. CRI is a federally funded program that helps prepare major population centers to implement medical countermeasures in response to public health emergencies. Only Metropolitan Statistical Areas (MSAs) are eligible to participate in CRI . For all counties with an MSA, the indicator denotes participation in CRI, multiplied by 10 to create indicator scores ranging from 0-10. Counties without an MSA are marked as having no data for this indicator. The purpose of CRI is to enhance the emergency preparedness capabilities of metropolitan centers, helping them develop and test emergency response plans. These plans can streamline the procurement of medicines, medical

				supplies, and other medical countermeasures from the Strategic National Stockpile.[30]
2	6	Pediatric Vaccination	CDPH Immunization Branch Reporting Data for Kindergarten (2020-2022)	Completeness of vaccination requirements among school-age children. This indicator is calculated as the proportion of the county's children who have received all required immunization for school enrollment, averaged over 3 school years (2019-2020, 2020-2021, and 2021-2022), and multiplied by 10 to create indicator scores ranging from 0-10. Compliance with school enrollment guidelines regarding pediatric vaccination reflects the county's capacity to administer pediatric immunizations, as well as parental willingness to comply with these guidelines. Such acceptance of public health guidance is crucial during outbreaks where existing immunity can help slow down disease transmission, or outbreaks that may require the rapid immunization of pediatric populations.
2	6	Influenza vaccination provider accessibility	vaccines.gov (2022), ACS 5yr 2020	Population distance to influenza vaccination providers. This indicator is calculated as the proportion of the population residing within specific distance buffers of an influenza vaccination provider, with the distances varying by urbanicity. The distances were based on the CMS travel distance standards for healthcare plan network adequacy for primary care services, based on county type: 5 miles for large metropolitan counties; 10 miles for metropolitan counties; 20 miles for micropolitan counties; 30 miles for rural counties; and 60 miles for counties with extreme access considerations.[31] Access to vaccination sites is an important consideration in a county's response to a disease outbreak.
2	6	Influenza Vaccination	NIS Flu (2020), ACS 5yr 2020	Influenza vaccination rate in the county. This indicator is calculated as the proportion of persons vaccinated against influenza in the county, multiplied by 10 to create indicator scores ranging 0-10. Influenza vaccination uptake assesses a county's infrastructure to administer immunizations, as well as its populations' overall receptivity to obtaining recommended vaccines.

[30] Centers for Disease Control and Prevention (2022). CDC's Cities Readiness Initiative (CRI). Retrieved May 31, 2023. https://www.cdc.gov/orr/readiness/phep/cri.htm

[31] Centers for Medicare & Medicaid Services. 2023 Draft Letter to Issuers in the Federally-facilitated Exchanges. Retrieved May 31, 2023. https://www.cms.gov/files/document/2023-draft-letter-issuers-508.pdf

3	1	Housing Affordability	County Health Rankings 2021 (based on American Community Survey 5-year 2019).	Housing Affordability is a measure of access to affordable housing. This indicator is calculated as the percent of households that spend less than 50% of their household income on housing, scaled on a 0-10 scale. Housing is a basic need that affects many aspects of health and healthcare. Safety net programs exist to help individuals and families pay for housing, such as Section 8 and other housing support programs. Improving access to such programs and/or increasing availability of lower-cost housing options would help alleviate problems with housing affordability.
3	1	Housing Quality	County Health Rankings 2021 (based on HUD Comprehensive Housing Affordability Strategy (CHAS) data)	Housing Quality is a measure of the quality of available housing in the county. This indicator is calculated as the percent of households that do not have any of the following four housing problems – overcrowding, high housing costs, lack of kitchen facilities, or lack of plumbing facilities. The indicator is scaled on a 0-10 scale. Housing is a basic need that affects many aspects of health and healthcare. Poor housing quality may increase the risk of communicable disease transmission within a household (e.g. due to overcrowding or lack of plumbing) or impede the recovery from such diseases.[32]
3	2	Food Environment Index	County Health Rankings 2021 (based on USDA Food Environment Atlas, Map the Meal Gap from Feeding America)	The Food Environment Index measures access to healthy foods by considering the distance an individual lives from a grocery store or supermarket, locations for healthy food purchases in communities, and cost barriers in accessing healthy foods. Specifically, it is expressed as a scale from 0 (worst) to 10 (best) that equally weights the following two indicators of the food environment: 1) The percentage of the population that is low income (≤200 percent of the federal poverty threshold) and that does not live close to a grocery store; and 2) the percentage of the population that did not have access to a reliable source of food during the past year.[33] Lower access to healthy foods is associated with greater reliance on sources of unhealthy foods.[34] Better access to grocery stores is associated with better

[32] Ahmad, K., Erqou, S., Shah, N., Nazir, U., Morrison, A. R., Choudhary, G., & Wu, W.-C. (2020). Association of poor housing conditions with COVID-19 incidence and mortality across US counties. PloS one, 15(11), e0241327.

[33] County Health Rankings & Roadmaps. (2023). Food Environment Index. Retrieved March 7, 2023 from https://www.countyhealthrankings.org/explore-health-rankings/county-health-rankings-model/health-factors/health-behaviors/diet-and-exercise/food-environment-index?year=2022

[34] Ashby, N. J. (2020). Impact of the COVID-19 pandemic on unhealthy eating in populations with obesity. Obesity, 28(10), 1802-1805.

				health outcomes including lower mortality rates.[35] Better access to healthy foods is an important social determinant of health that contributes to outbreak-related health outcomes.
3	2	Supplemental Nutrition Assistance Program (SNAP) Access	CalFresh Program Reach Index (2015-2019)	The SNAP Access indicator measures how well this food assistance program is reaching people who may benefit from this food assistance program. SNAP is a federal program that provides financial assistance to low-income families to purchase food, and CalFresh is California's implementation of this federal program. The indicator is represented by the CalFresh Program Reach Index, which aims to estimate the percent of the population enrolled in CalFresh among those who are eligible.[36] The Program Reach Index is expressed as a proportion, which was multiplied by 10 to scale this indicator from 0-10. This program aims to reduce food insecurity among low-income families by reducing some cost barriers to purchase healthy foods. Food insecurity may lead to a poor diet, which increases vulnerability to infection and adverse health outcomes.[37]
3	2	Women, Infants & Children Program (WIC) Access	USDA National and State Level Estimates of WIC Eligibility and Program Reach 2019	The WIC Access indicator measures how well this food assistance program is reaching people who may benefit from this food assistance program. WIC is a federal program that provides food assistance to low-income pregnant women, recent mothers, infants and children under age 5. This indicator is calculated as the proportion of the population that are enrolled in WIC among those who are eligible, scaled from 0-10. This is a state-level indicator. This program aims to reduce food insecurity during a critical life stage for healthy eating among low-income families by reducing some cost barriers to purchase healthy foods. Food insecurity may lead to a poor diet, which increases vulnerability to infection and adverse health outcomes.[38]

[35] Ahern, M., Brown, C., & Dukas, S. (2011). A national study of the association between food environments and county-level health outcomes. The Journal of Rural Health, 27(4), 367-379.

[36] California Department of Social Services. (2023). CalFresh Data Dashboard. California Department of Social Services. Retrieved May 26 from https://www.cdss.ca.gov/inforesources/data-portal/research-and-data/calfresh-data-dashboard

[37] Hanson, K. L., & Connor, L. M. (2014). Food insecurity and dietary quality in US adults and children: a systematic review. The American journal of clinical nutrition, 100(2), 684-692.

[38] Hanson, K. L., & Connor, L. M. (2014). Food insecurity and dietary quality in US adults and children: a systematic review. The American journal of clinical nutrition, 100(2), 684-692.

3	3	Health Insurance – Adults	US Census Bureau, Small Area Health Insurance Estimates (2018)	The Health Insurance – Adults indicator is a measure of the prevalence of health insurance among people ages 18-64 years old. The indicator is calculated as the number of people within this age group that have any type of health insurance divided by the total population in this age group; this proportion is multiplied by 10 to create an indicator with a maximum range of 0-10. Health insurance represents an important factor to access to healthcare both on a routine basis as well as during outbreak conditions. Having health insurance is associated with better continuity of care, preventive care, and health outcomes including mortality from communicable diseases.[39,40,41,42] Because adults over 65 years old in the US are eligible for Medicare health insurance, this indicator focuses on adults ages 18-64, who are more reliant on employer-based health insurance.
3	3	Health Insurance – Minors	US Census Bureau, Small Area Health Insurance Estimates (2018)	The Health Insurance – Minors indicator is a measure of the prevalence of health insurance among people <19 years old. The indicator is calculated as the number of people within this age group that have any type of health insurance divided by the total population in this age group; this proportion is multiplied by 10 to create an indicator with a maximum range of 0-10. Medicaid and the State Children's Health Insurance Program (SCHIP) are public programs that provide critical sources of coverage for low-income non-elderly populations, and better access and expanded eligibility to programs such as these can increase health insurance rates.[43] Lack of health insurance can cause delayed or deferred care, which may lead to higher risk of infections and poorer clinical outcomes in children.[44,45]

[39] DeVoe, J. E., Fryer, G. E., Phillips, R., & Green, L. (2003). Receipt of preventive care among adults: insurance status and usual source of care. American Journal of Public Health, 93(5), 786-791.
[40] Kilbourne, A. M. (2005). Care without coverage: too little, too late. Journal of the National Medical Association, 97(11), 1578.
[41] Starfield, B., & Shi, L. (2004). The medical home, access to care, and insurance: a review of evidence. Pediatrics, 113(Supplement_4), 1493-1498.
[42] Ojinnaka, C. O., Adepoju, O. E., Burgess, A. V., & Woodard, L. (2021). Factors associated with COVID-related mortality: the case of Texas. Journal of Racial and Ethnic Health Disparities, 8, 1505-1510.
[43] Medicaid and the State Children's Health Insurance Program (SCHIP) are public programs that provide critical sources of coverage for these low-income
[44] Smith, P. J., Marcuse, E. K., Seward, J. F., Zhao, Z., & Orenstein, W. A. (2015). Children and Adolescents Unvaccinated Against Measles: Geographic Clustering, Parents' Beliefs, and Missed Opportunities. Public Health Rep, 130(5), 485-504. https://doi.org/10.1177/003335491513000512
[45] Gushue, C., Miller, R., Sheikh, S., Allen, E. D., Tobias, J. D., Hayes, D., Jr., & Tumin, D. (2019). Gaps in health insurance coverage and emergency department use among children with asthma. J Asthma, 56(10), 1070-1078. https://doi.org/10.1080/02770903.2018.1523929

3	4	Quality of Unemployment Benefits	worldpopulationreview.com Unemployment Benefits by State (2022), ACS Supplemental Poverty Measures (2019)	The Quality of Unemployment Benefits indicator is a measure of the extent to which the unemployment benefits may help keep a family out of poverty. This indicator is calculated as the ratio of the state maximum total weekly unemployment benefits, divided by the county's average Supplemental Poverty Measure (SPM) poverty threshold (based on weekly income) for a family with 2 parents and 2 kids. The SPM accounts for differences in local cost of living, such that the poverty threshold in a high cost of living area is higher than the threshold in a low cost of living area. Unemployment insurance is an important social safety net program that helps buffer financial instability, which may occur as a result of illness. Loss of employment can result in loss of health insurance and income to pay for housing, food, and other household necessities required for daily living.[46]
3	4	Broadband Access	County Health Rankings 2021 (based on American Community Survey 5 year 2019).	Broadband Access is an important factor affecting access to a range of services, including safety net services. Studies have shown that broadband connection is a predictor of better access to unemployment benefits.[47] Broadband access is also associated with lower unemployment rates, especially in rural areas.[48] This indicator is calculated as the percentage of households with any type of broadband internet connection (cable, DSL, fiber-optic, cell phone, or satellite). Improved access to social safety net services, including unemployment benefits, helps to mitigate the health impacts of unemployment.
4	-	Community Factors	ATSDR Environmental Justice Index (2022)	Community Factors are population and environmental characteristics that result in some areas having higher risks of adverse health outcomes. This indicator (which constitutes the entire domain) is calculated as the proportion of the county's population that has an Environmental Justice Index score in the lower 75th percentile in the US. EJI assesses the Environmental Burden, Health Vulnerability, and Social Vulnerability of communities, multiplied by 10 to scale the indicator from 0-10. A higher score indicates lower levels of vulnerability in the county.

[46] Despard, M., Grinstein-Weiss, M., Chun, Y., & Roll, S. (2020). COVID-19 job and income loss leading to more hunger and financial hardship. Brookings Institution: Washington, DC, USA.

[47] Bell, A., Hedin, T. J., Mannino, P., Moghadam, R., Schnorr, G., & Von Wachter, T. (2021). Disparities in Access to Unemployment Insurance During the COVID-19 Pandemic: Lessons from US and California Claims Data. eScholarship, University of California.

[48] Marre, A. (2020). Bringing Broadband to Rural America. Community Scope, 8(1). https://www.richmondfed.org/publications/community_development/community_scope/2020/comm_scope_vol8_no1

				Community factors or social determinants of health are strongly associated with increased communicable disease risk and morbidity from such health problems.[49,50] Therefore, this domain contributes to the overall COPI score by accounting for some social determinants that may require additional consideration when preparing for future outbreaks.

[49] Abrams, E. M., Greenhawt, M., Shaker, M., Pinto, A. D., Sinha, I., & Singer, A. (2022). The COVID-19 pandemic: Adverse effects on the social determinants of health in children and families. Ann Allergy Asthma Immunol, 128(1), 19-25. https://doi.org/10.1016/j.anai.2021.10.022

[50] Keller, J. (2022). INFECTIOUS DISEASE, SOCIAL DETERMINANTS AND THE NEED FOR INTERSECTORAL ACTION. Legfin Multidisciplinary Research Journal, 12(2).

Missing Data Imputation Methods

Given that healthcare preparedness (Domain 1) and public health system preparedness (Domain 2) in some counties does not necessarily translate to similar levels of preparedness in nearby counties , we considered that imputation based on regional means was not an appropriate estimator for missing data for Domains 1 and 2. Therefore, our scores for those two domains were calculated without imputing values for missing indicators; instead, missing data was excluded from the average calculations for subdomains and domains.

However, we believe that regional levels of access to healthcare and social safety net services (Domain 3) can be used as informed estimates of nearby access to those services, especially since many safety net policies are established at the state level. Therefore, we performed state-level mean imputation for missing observations in Domain 3.

As we used the Environmental Justice Index to assess community resilience (Domain 4) at the county level, no missing data imputation was needed or performed for Domain 4.

Scaling of Measures

All measures were scaled so that the maximum possible range for each indicator is between 0 and 10. For example, a measure that is based on a percentage or proportion with a value of 76% or 0.76 would be scaled to a value of 7.6 for the indicator. Some variables have a natural maximum equivalent to 100% (or a perfect “10” for the indicator). Examples of such variables include the percentage of a population that has health insurance, the percentage of healthcare workers that have received a specific immunization, or the proportion of the population served by a health department that has a certain preparedness function. Although in some cases achieving 100% on these indicators is very challenging, that is the natural maximum that could be achieved in ideal circumstances.

However, for variables which did not have a natural maximum equivalent to 100%, we used the min/max standardization technique to obtain values from 0-10 using the minimum and maximum county-level values within the state. This includes indicators such as those measuring workforce counts per capita (e.g., pharmacists, critical care workforce, etc), which did not have a natural maximum of 100%.

No normalization techniques were used that impacted the underlying distribution of the variables.

Combining Subdomains and Domains

The county-level COPI scores are calculated using a sequential averaging approach. First, each subdomain value is calculated as an unweighted average of the indicators within that subdomain. Next, the domain value is calculated as an unweighted average of the subdomains. Finally, the overall COPI score is calculated as a weighted average of the four domains, with the weighting determined using the input from the expert panel. Based on the feedback from the expert panel, the domain weights were assigned as follows: Domain 1 weight=0.30; Domain 2 weight=0.33; Domain 3 weight=0.22; Domain 4 weight=0.15. The domain weighting is intended to reflect the overall importance of that measure on the county’s ability to prevent, detect, and respond to communicable disease outbreaks while factoring in the degree of community vulnerability, which impacts how prepared a community needs to be.

Using such a sequential approach in calculating the subdomains and domain values ensures greater balance across measures and subdomains, so that subdomains that have many associated measures do not outweigh other subdomains that have a smaller number of measures. However, the weighting of the domain scores in calculating the overall index score allows for the ability to account for some domains having greater importance in the spectrum of outbreak preparedness. The weighting methodology can be further refined in future iterations of the COPI.

In general, the COPI should be used examine indicators at the county level. However, there may be interest in characterizing the degree of overall outbreak preparedness across counties within a state. Therefore, state-level averages are calculated as an unweighted average of the county-level COPI values within that state. This unweighted approach puts equal weight on each county within the state, signifying the importance of each county achieving a high level of outbreak preparedness.

Sensitivity Analysis

We conducted sensitivity analyses to ensure that the overall index value is not driven by any single measure and that the index performs similarly under different weighting scenarios. To test the degree of influence of each indicator on the overall index score, we calculated the index score while leaving out each measure individually. We looked at the maximum absolute value percent change across all counties within the state using each of these scenarios to identify whether leaving out any single measure caused substantial changes in the domain score or the overall index score. This sensitivity analysis also helps identify which measures have more influence on the overall index.

Because the weighting across domains is subjective and based on an assessment of the relative importance of these factors, we conducted sensitivity analyses to assess the influence of the choice of domain weights on the overall index score by comparing the advisor-informed weighting scenario to an equal-weight scenario, where all domains were weighed equally (0.25 for Domains 1-4). We calculated the percent change in their overall COPI score based on the two weighting scenarios, and identified any changes in overall ranking among California counties when using the alternative weighting scenario.

We were unable to perform more robust statistical analyses to test the reliability and validity of our index given the nature of the indicators in our dataset. Psychometric testing techniques, including exploratory factor analysis and the calculation of Cronbach's Alpha, assume linear data with no missing values. Instead, our index included non-linear variables (both binary and categorical) and had at least one missing value for each county in the dataset. In addition, the small number of California counties (N=58) further limited our ability to perform these analyses, as did the fact that we collected data from numerous data sources collected from different respondents. In summary, we did not feel that the assumption violations and data transformations required would have led to valid results that could have allowed us to make accurate conclusions regarding the psychometric properties of our instrument.

Describing High Scoring Counties

We used descriptive statistics to explore the distribution of COPI scores among California counties, and used maps to visually represent county scores by quartiles for the overall COPI as well as for each of the 4 COPI domains. To explore the characteristics of counties with COPI scores in the top 25th percentile, we ranked all counties into quartiles and divided them in two groups: those scoring in the top 25th percentile ("higher scoring", n=14 counties) and those with COPI scores among the lower 75th percentile ("lower scoring", n=44 counties). Independent sample T-tests, chi-square, and Fishers Exact

Tests were performed to compare the characteristics of high vs. low scoring counties (α =0.05). In particular, we explored differences in rurality, age, race/ethnicity, sex, education, and income.

Chapter 6: Findings

COPI Scores in California Counties

Overall COPI scores in California county averaged 6.7 points, ranging between 5.2 to 7.8 (Figure 6). Preparedness scores tended to be higher along the coast and other urban centers (e.g., Sacramento, Lake Tahoe, etc.), and lower among the more traditionally agricultural and rural counties (Figure 7).

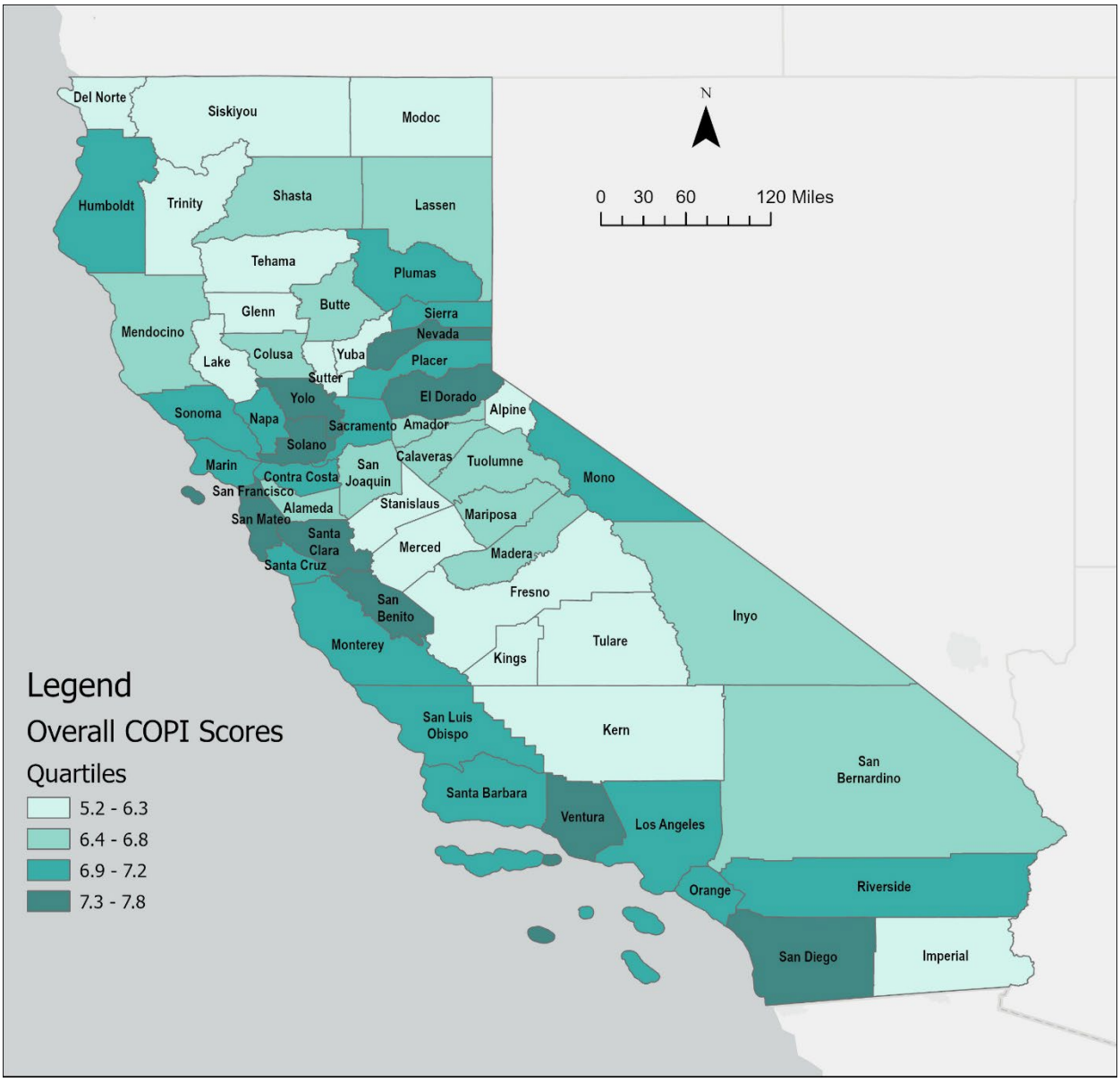

Figure 6. Overall COPI Scores in California Counties

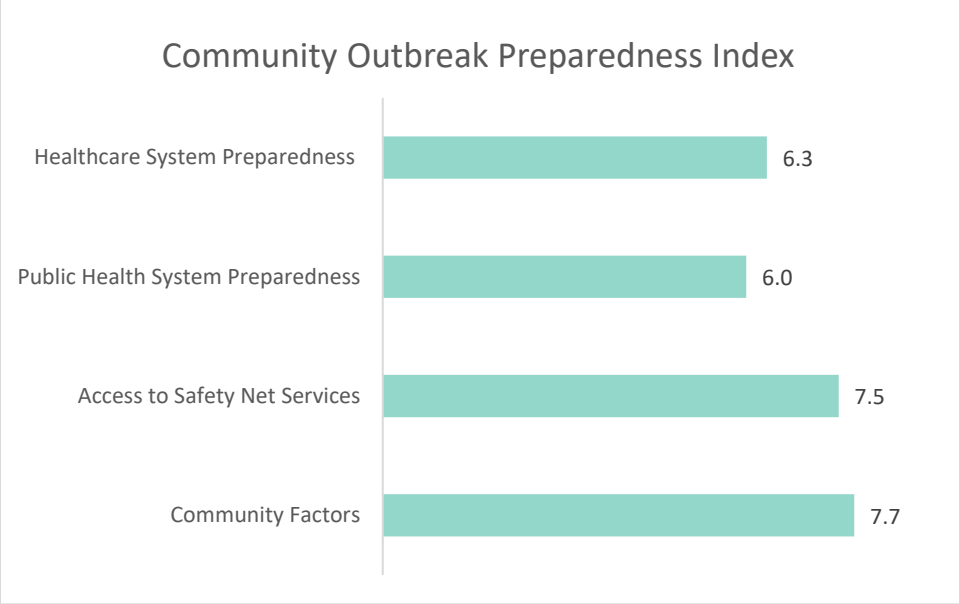

Figure 7. Average COPI Domain Scores.

Domain 1 – Healthcare System Preparedness

Healthcare system preparedness scores averaged 6.3 across California counties and ranged between 3.9 and 7.6 (Figure 8). We observe a trend of higher healthcare system preparedness scores in urban areas compared to rural areas, which is consistent with our understanding of healthcare access in rural vs.

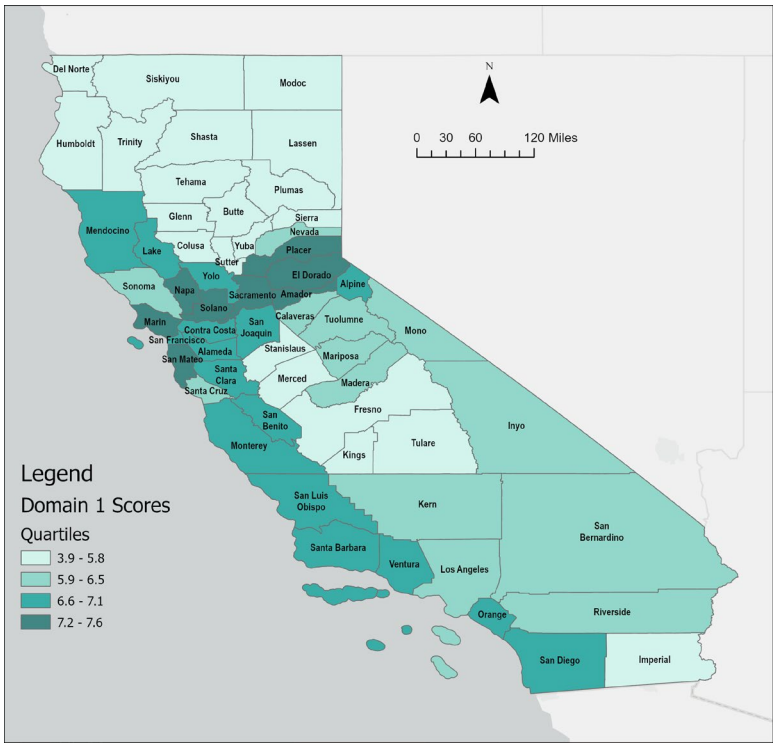

Figure 8. Domain 1 Scores in California counties.

urban areas. A histogram of Domain 1 scores reflects a left-skew, highlighting how Modoc County's relatively lower score is an outlier among California counties (Figure 9).

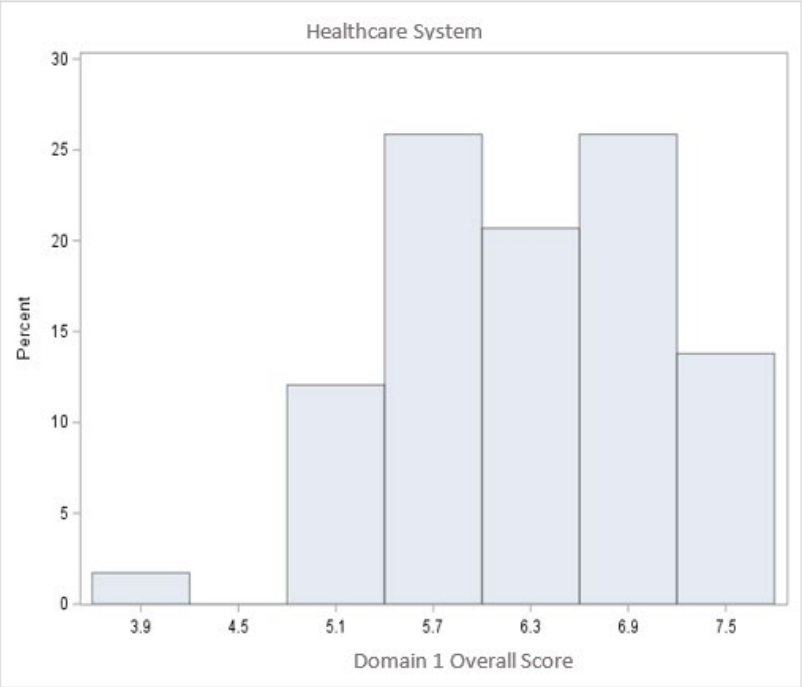

Figure 9. Histogram of Domain 1 Scores.

California counties scored particularly low in terms of their medical surge capabilities, which is based on an indicator that calculates the surge capacity of each hospital in the dataset, scaled to the maximum score among hospitals in the United States (Figure 10). California hospitals scored relatively low on this scale compared to the maximum score, so the medical surge subdomain score was low across all counties. On the other hand, scores for the Foundation for Health Care and Medical Readiness Subdomain were high (average of 9.7), ranging from 8.8 to 10, with 37 counties scoring 10, the highest possible score. The indicators within this subdomain are the healthcare coalition participation rates of three out of the four core member types (acute care hospitals, local health departments, and emergency management agencies); these member types typically have very high participation rates, which contributes to the overall high score in this subdomain. However, the fourth healthcare coalition core member type is Emergency Medical Services, where participation rates are often lower (Assistant Secretary for Preparedness and Response, 2021), but we were unable to find reliable data to assess participation rates from these types of members.

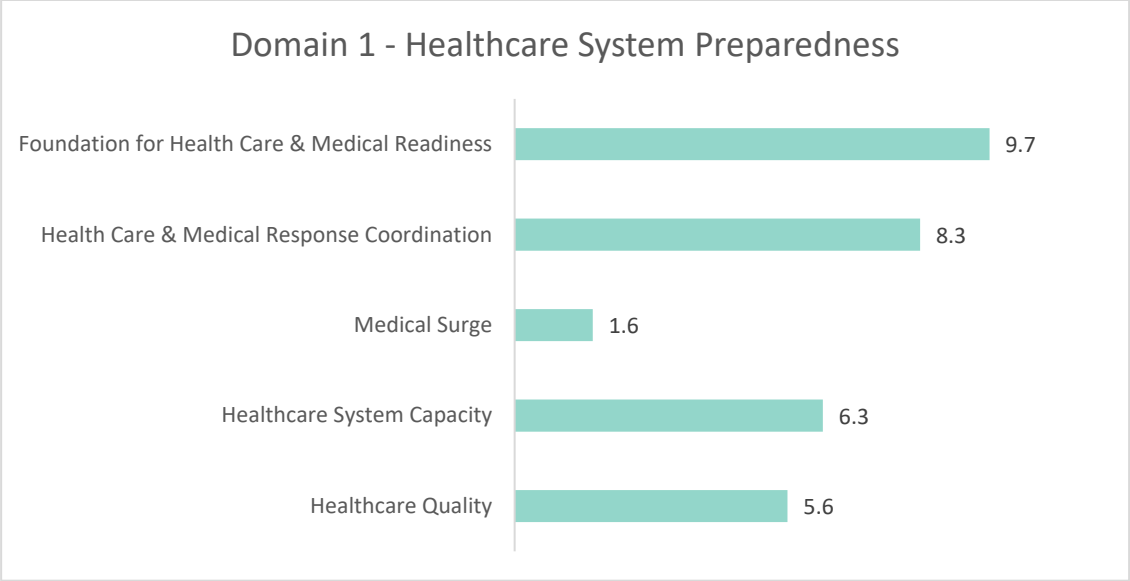

Figure 10. Domain 1 Subdomain Scores.

Domain 2 – Public Health System Preparedness

The average score for Public Health System Preparedness in California counties was 6.0, ranging from 4.2 to 7.7 with no obvious geographic pattern (Figure 11). Domain 2 scores were normally distributed among California counties (Figure 12).

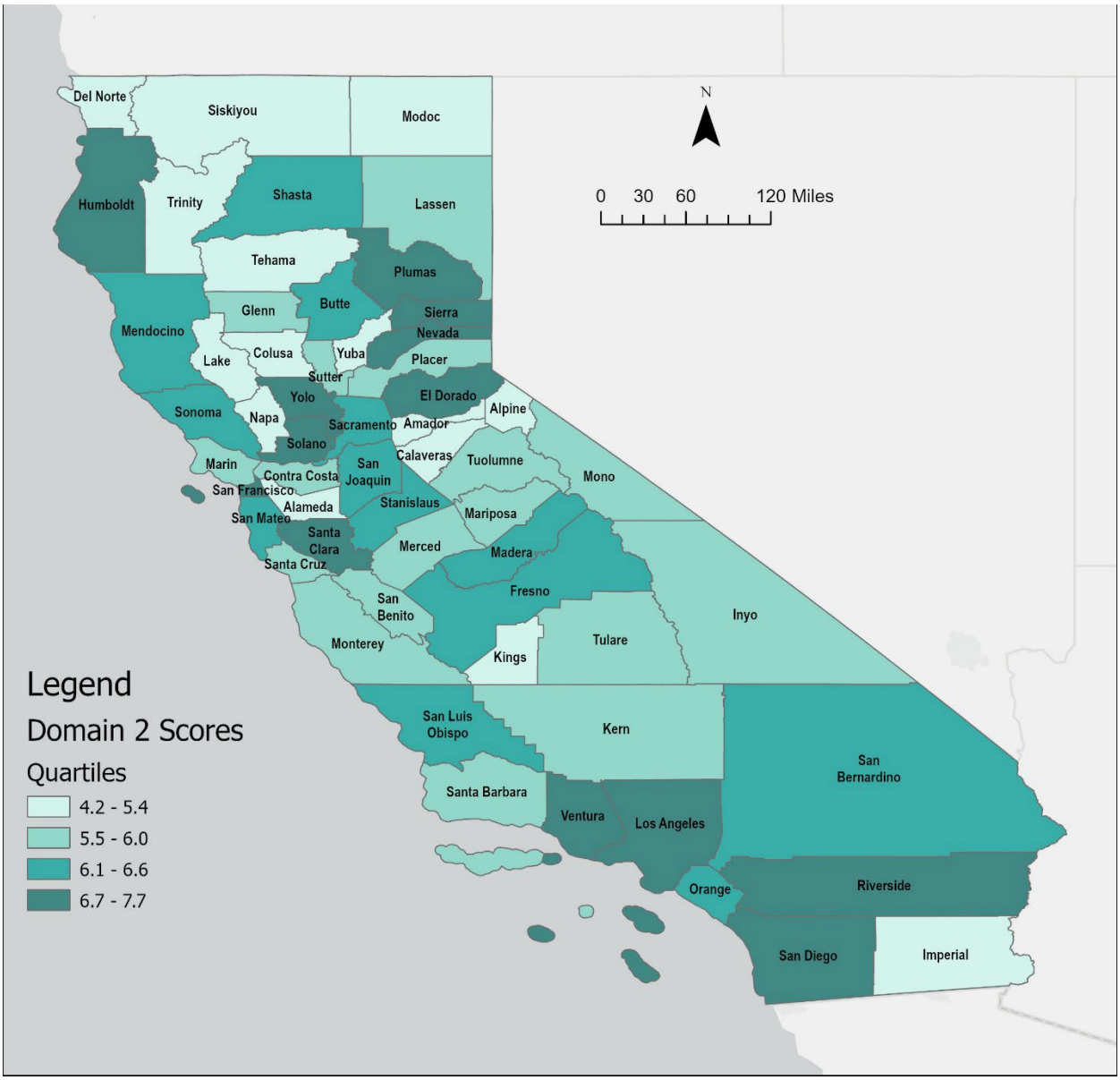

Figure 11. Domain 2 Scores in California Counties.

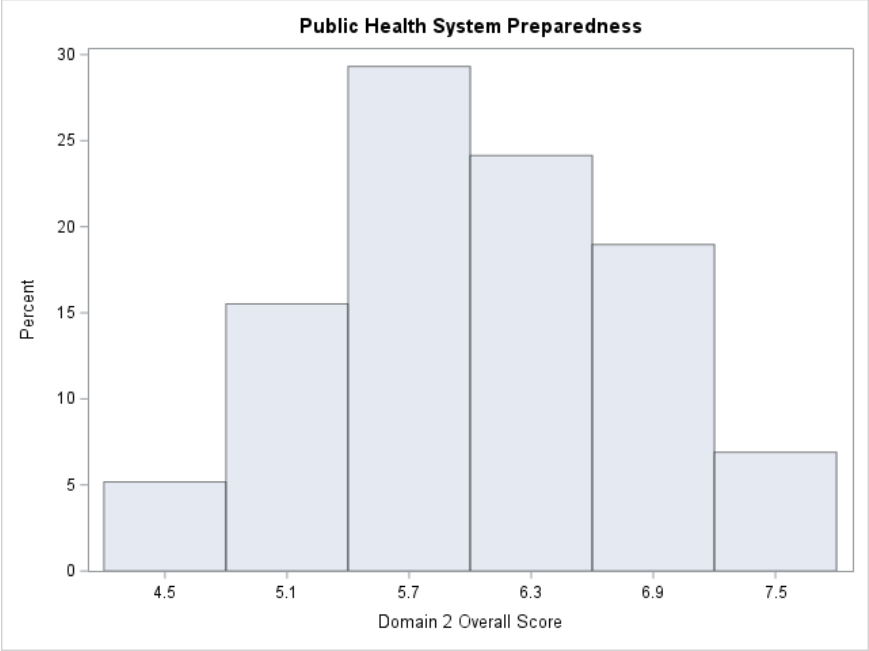

Figure 12. Histogram of Domain 2 Scores.

While the lowest average score within Domain 2 subdomains was Community Preparedness and Recovery (3.3) (Figure 13). There was a wide Community Preparedness and Recovery score range across California counties, from 0.1 (Kings) to 8.3 (Santa Clara). Scores for both Incident Management and Information Management subdomains were generally high, though it is important to note that some federal preparedness grants are contingent upon adoption of the National Incident Management System (NIMS) (Federal Emergency Management Agency, 2023), which provides a financial incentive for the state to ensure support for these programs within its counties.

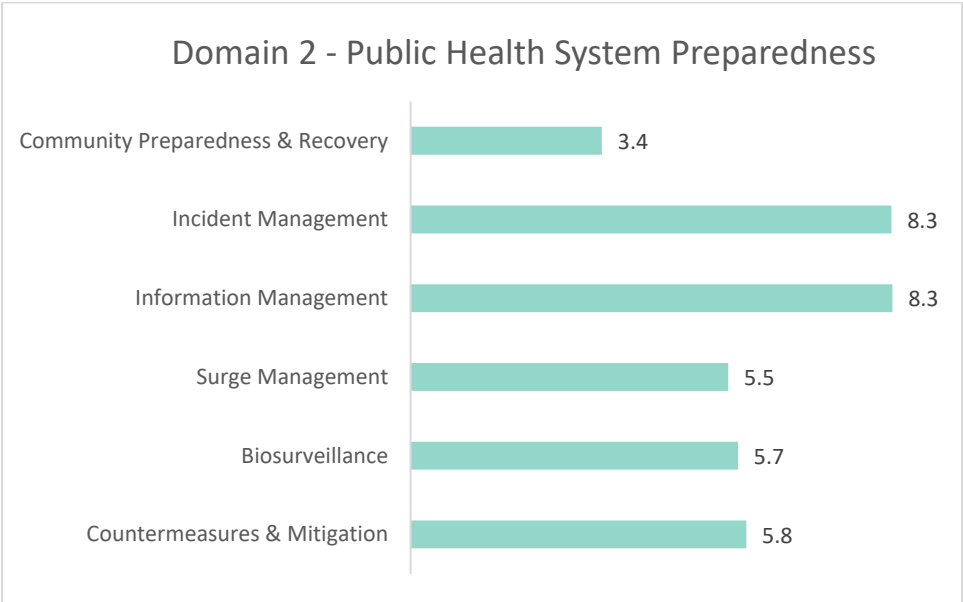

Figure 13. Domain 2 Subdomain Scores.

Domain 3 – Access to Health Insurance and Social Safety Net Services

The average score for Domain 3 was 7.5 among California counties, with a relatively narrow range from 7.2 to 7.9 (Figure 14). A histogram of Domain 3 scores shows a slight right-skewed distribution of county scores, within this narrow range of scores (Figure 15).

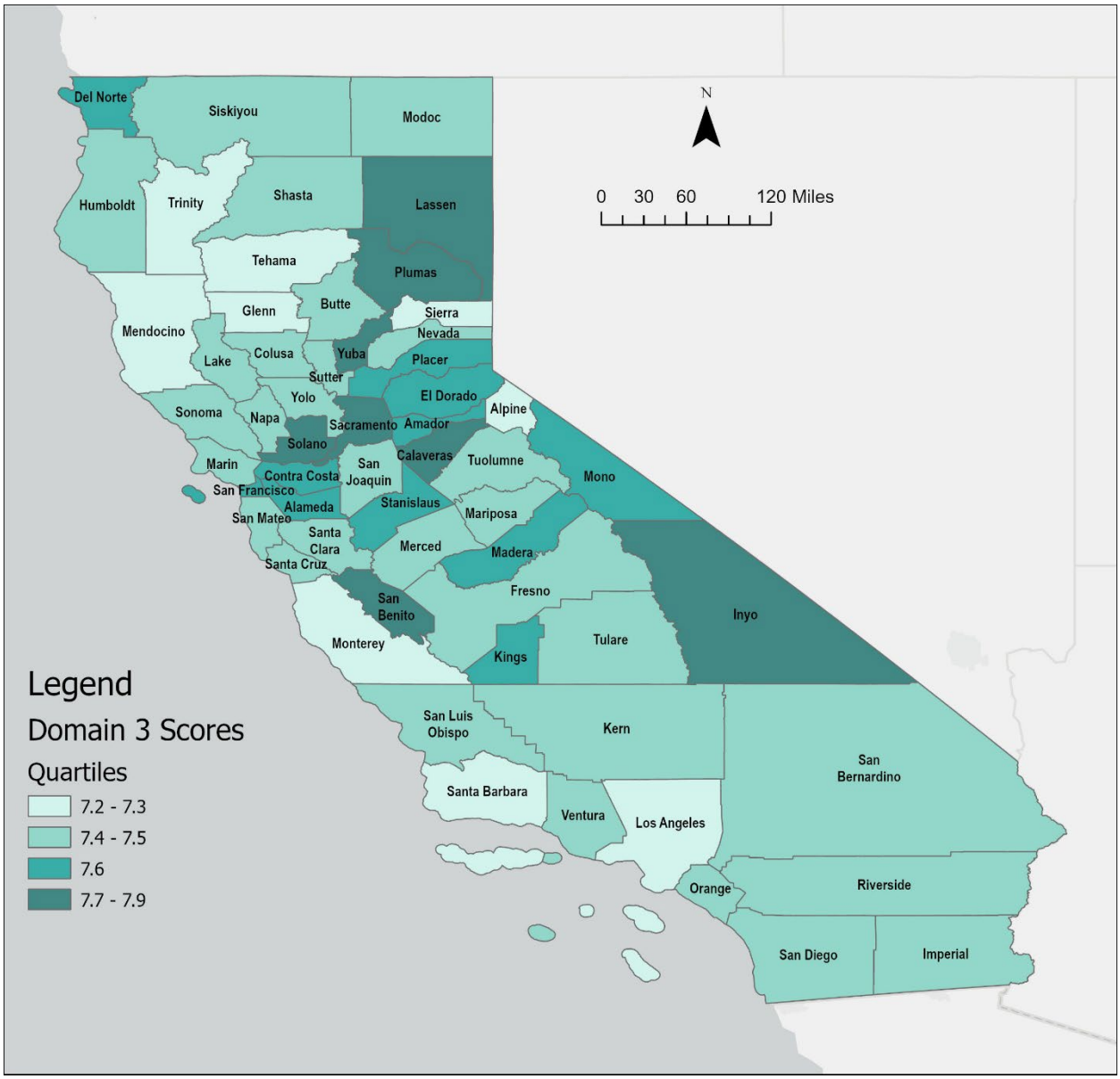

Figure 14. Domain 3 Scores in California Counties.

Figure 16 shows the average scores for each of the subdomains within Domain 3. Scores for the Access to Unemployment Benefits subdomain were the lowest among California counties, averaging 6.1 and ranging from 5.5 (Trinity) to 6.5 (Merced). While unemployment benefit amounts are determined by state policy, local cost of living varies across California, as does access to broadband internet services,

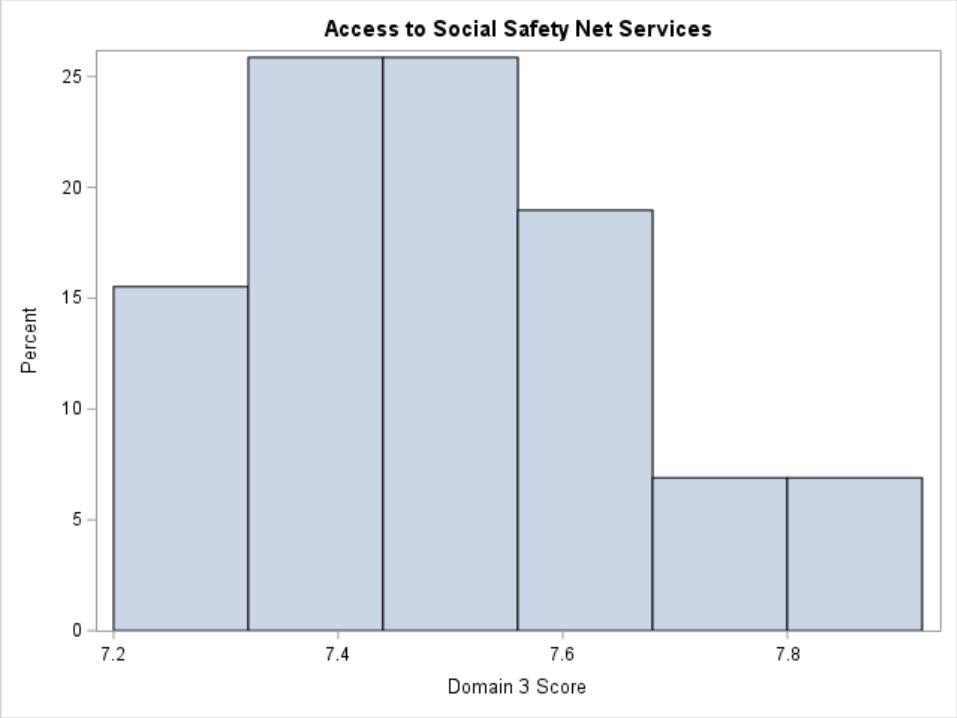

Figure 15. Histogram of Domain 3 Scores.

which are component indicators of this subdomain. Scores for Access to Health Insurance are highest among Domain 3 subdomain averaging at 9.3 (8.9 in Glenn to 9.6 in San Francisco). California expanded Medicaid eligibility following the passage of the Affordable Care Act (Wang & Trivedi, 2017), improving overall insurance access, which is reflected in the overall high scores for this subdomain. California recently implemented additional Medicaid eligibility expansions to provide health insurance to all eligible children under age 19 (beginning January 2020) (Department of Health Care Services, 2022) and all eligible adults over age 50 (beginning May 2022) (Department of Health Care Services, 2023), regardless of immigration status, and will further offer state-subsidized health insurance to all undocumented immigrants beginning January 2024 (Dietz et al., 2023); these policy changes will likely further reduce uninsurance rates across the state.

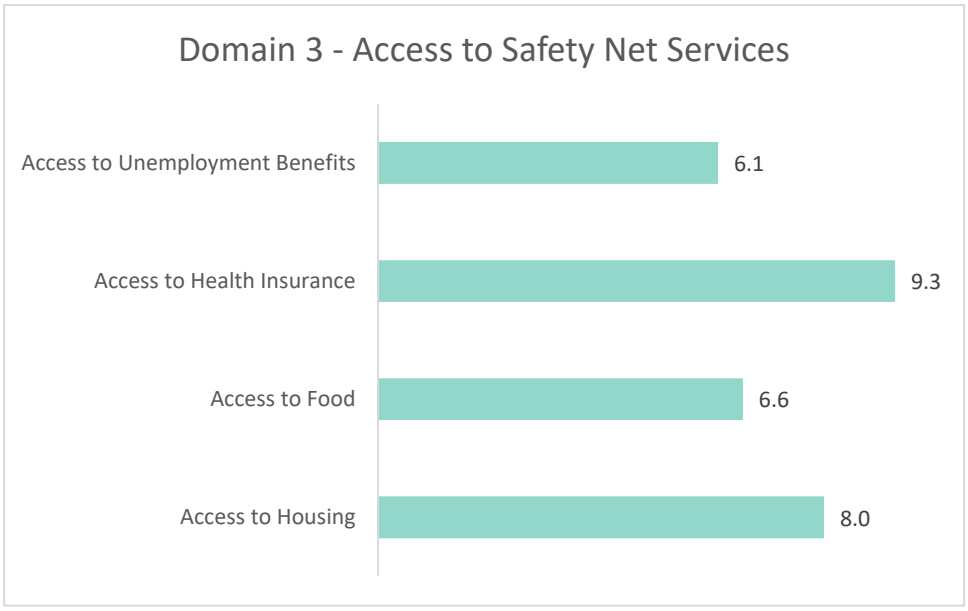

Figure 16. Domain 3 Subdomain Scores.

Domain 4 – Community Factors

The average score for community factors in California was 7.7, ranging from 0 to 10. Lower scores were observed in many traditionally agricultural counties, including counties in the Central Valley, Imperial County, and several counties in the Sacramento Valley and far northern region of the state (Figure 17). There were 22 counties with scores above 9, with eight counties having a maximum score of 10 (Colusa, Mono, San Benito, Napa, Santa Cruz, Sierra, Plumas, and Lassen). The left-skewed histogram of Domain 4 reflects this, showing the larger frequency of higher scoring counties within this Domain (Figure 18). Geographically, we can see lower community factor scores in the San Joaquin Valley and inland desert areas and relatively higher scores along the coast and in the eastern portions of Gold Country and the Shasta Cascades.

Since the Community Factors score was calculated from the already established Environmental Justice Index, subdomain scores were not calculated for Domain 4.

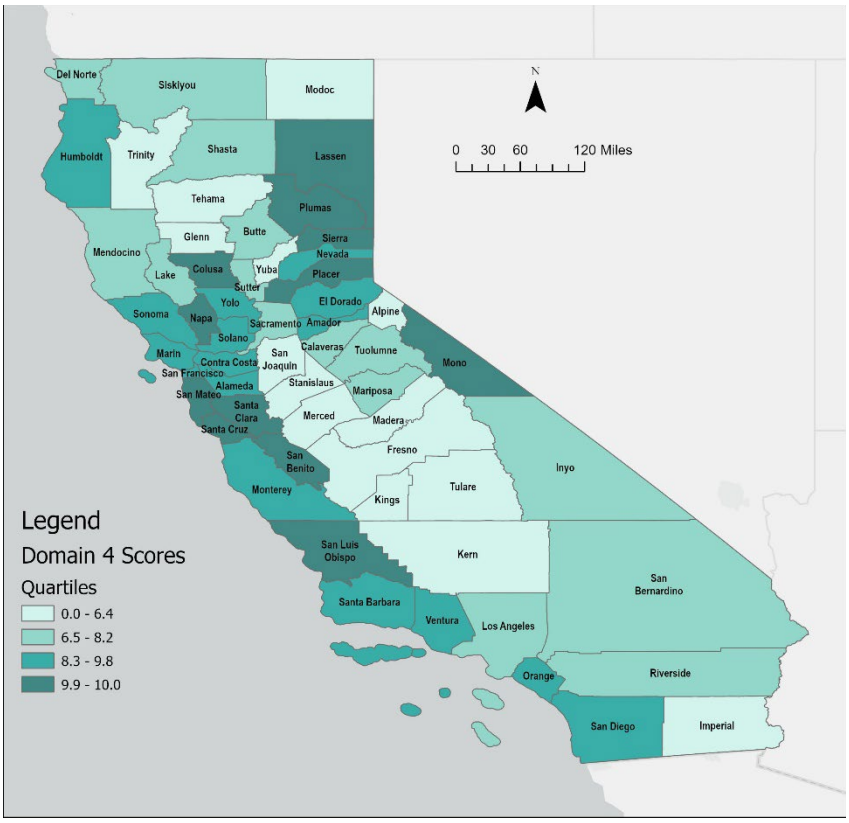

Figure 18. Domain 4 Scores in California Counties.

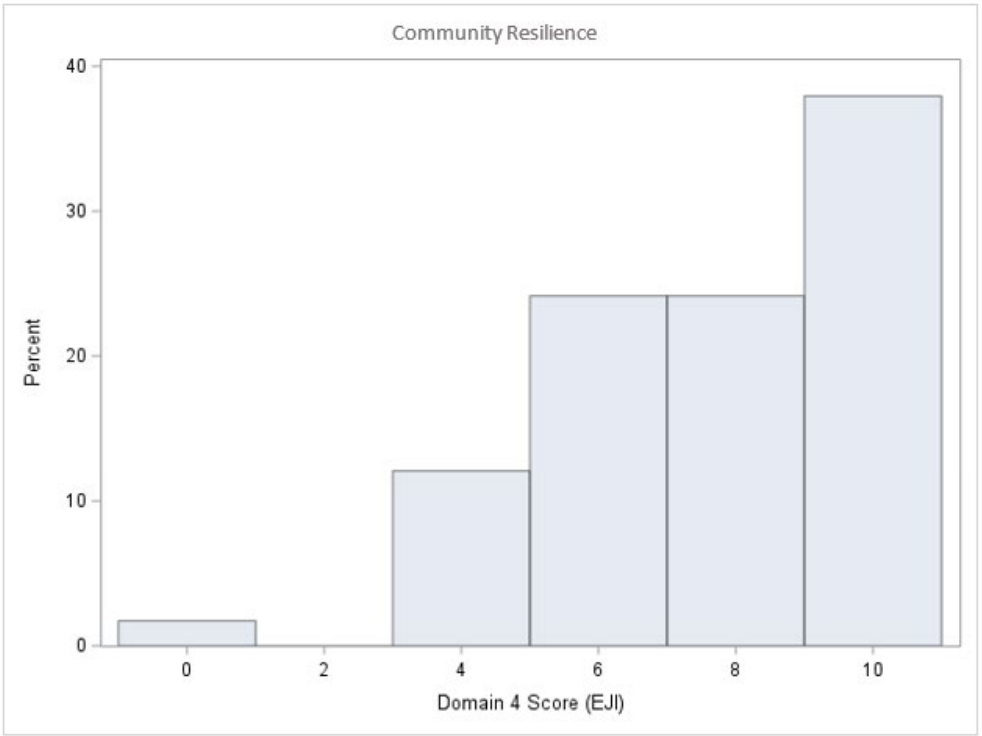

Figure 17. Histogram of Domain 4 Scores.

Population Characteristics

To identify factors associated with counties with higher outbreak preparedness scores, we categorized California counties scoring in the top 25th percentile ("higher scoring", n=15 counties) and lower 75th percentile ("lower scoring", n=43 counties) for overall community outbreak preparedness, based on the overall COPI scores. We compared these groups of counties in terms of sociodemographic characteristics, as well as rurality.

The characteristics of the full sample, as well as the differences between higher and lower scoring counties appear in Table 1 and Table 2. Compared to lower-scoring counties, higher scoring counties were significantly more likely to be metropolitan counties (93% vs. 54%, $p=0.006$), to have larger Asian populations (14% vs. 6%, $p=0.02$), to have larger percentages of college graduates (40% vs. 23%, $p<0.02$), and slightly higher female populations (50% vs. 49%, $p=0.01$). Higher scoring counties were also more likely to have smaller AIAN populations (0.4% vs. 2%, $p<0.05$) than lower scoring counties. In terms of household income, high scoring counties were significantly more likely than low income counties to have larger populations with higher incomes ($75,000-$149,000, $p<0.01$; above $150,000, $p<0.01$) and more likely to have smaller populations with incomes below $75,000 (less than $25,000, $p<0.01$; $25,000-$49,999, $p<0.01$; $50,000-$74,999, $p<0.01$).

Table 1. Characteristics of California Counties, by COPI Scores.

	All Counties		Higher Scoring Counties		Lower Scoring Counties		p-value
	Mean	SD	Mean	SD	Mean	SD	
Age Distribution							
Minors (ages 0-19)	24.2	4.3	22.8	3.1	24.8	4.6	0.06
Adults (20-64)	56.8	3.6	58.9	3.8	56.1	3.4	**0.02**
Seniors (65+)	18.9	5.7	18.5	4.4	19.1	6.1	0.68
Sex							
Female	49.6	2.0	50.3	0.8	49.3	2.2	**0.01**
Male	50.4	2.0	49.7	0.8	50.7	2.2	**0.01**
Race/Ethnicity							
Hispanic	31.5	18.3	26.8	13.3	33.2	19.6	0.17
Non-Hispanic White	52.4	20	52.1	18.0	52.6	20.8	0.93
Non-Hispanic Black	3.1	2.9	3.0	3.2	3.1	2.8	0.87
Non-Hispanic American Indian/Alaska Native	1.8	3.1	0.4	0.2	2.3	3.5	**<0.05**
Non-Hispanic Asian	7.8	9.1	14.0	12.4	5.6	6.5	**0.02**
Non-Hispanic Non-White	19.9	11	24.4	14.2	18.3	9.3	0.13
Education							
Less than high school	15.3	7.1	11.0	3.9	16.8	7.4	**<0.01**
High school	23.6	5.5	17.9	3.9	25.5	4.5	**<0.001**
Some college	33.8	6.0	30.8	6.7	34.9	5.4	**0.046**
College graduate	27.3	12.0	40.3	11.0	22.8	8.5	**<0.001**
Household Income							
Less than $25,000	19.1	6.0	12.8	3.1	21.0	5.3	**<0.001**
$25,000-$49,999	21.0	4.6	15.6	3.0	22.8	3.5	**<0.001**
$50,000-$74,999	17.0	2.8	14.6	2.3	17.7	2.5	**<0.001**
$75,000-$149,999	27.8	3.6	30.9	3.1	26.8	3.2	**<0.001**
More than $150,000	15.1	9.4	26.1	8.7	11.7	6.5	**<0.001**

Table 2. Rurality and COPI Scores.

	All Counties		Higher Scoring Counties		Lower Scoring Counties		p-value
	Freq	Pct	Freq	Pct	Freq	Pct	
Rural-Urban Continuum							**0.04**
Metropolitan Counties	37	63.8	14	93.3	23	53.5	
Urban Population (>20,000)	6	10.3	1	6.7	5	11.6	
Urban Population (2,500-19,999)	11	19.0	0	0	11	25.6	
Rural Area (<2,500 population)	4	6.9	0	0	4	9.3	

Sensitivity Analysis Results

Sensitivity analyses were conducted to help evaluate the robustness of the index. First, to test the influence of each individual indicator, we conducted a leave-one-out analysis. This test was conducted on every indicator with the exception of the single Domain 4 (Community Factors) indicator, because that indicator constitutes an entire domain. The percent change for the overall COPI score and the corresponding domain score was calculated removing one indicator at a time, and the absolute value of the percent change was calculated for each variable by county. In this sensitivity analysis, none of the indicators caused more than a 10% change in the overall COPI score for any county. For each indicator in the leave-one-out analysis, we identified the largest percent change in the overall COPI score for a single county, and averaged these "maximum percent changes" across all indicators. The average maximum percent change in the overall COPI score for all indicators was 2.00% with the largest maximum change within a county being 7.1%. The five indicators responsible for the largest changes in overall COPI score (averaged across all counties) were Hospital Medical Surge Capacity (5.1%), Hospital Accreditation (2.4%), Quality of Unemployment Benefits (1.9%), Broadband Access (1.8%), and Social Capital Index (1.5%).

When calculating the maximum percent change in the corresponding domain scores when each indicator was removed, we identified three indicators for which one or more counties exceeded a 10% change: 1. Hospital Accreditation (31 counties exceeded a 10% domain score change, maximum domain score change = 20.0%) , 2. Hospital Medical Surge Capacity (all 58 counties exceeded a 10% domain score change, maximum domain score change = 19.7%), and 3. Preventable Hospitalizations (2 counties exceeded a 10% domain score change, maximum domain score change = 17.1%). All three of these indicators are part of Domain 1. Two of these indicators constitute their entire subdomain (Medical Surge and Healthcare & Medical Response Coordination), so it is reasonable to expect that eliminating an entire subdomain could cause significant changes to the domain score; both these indicators are complex measures, requiring substantial resource investments to demonstrate accreditation and/or improve hospital medical surge capabilities. The Preventable Hospitalizations indicator is one of five indicators in the Healthcare Quality subdomain; while leaving out this indicator caused more than a 10% change in the Domain 1 score for two counties, the average percent change across all counties was 1.9% and 0.66% for the Domain 1 score and overall COPI score.

In the sensitivity analysis evaluating the impact of using an equal-weighted scenario, the largest change in score was for Alpine County (by 10.5%), but all other counties' COPI scores changed by less than 10% when comparing the two weighing schemes. In terms of ranking, the overall ranking of the index score changed for 7 (12%) California counties comparing the two weighting schemes for the COPI scores, but no county's score changed by more than one quartile.

Limitations

There are some limitations to our index that are important to highlight. Firstly, preparedness science is still evolving and there is no consensus as to what measures should or should not be part of such an index. Although the frameworks that guided the development of our index have performance measures developed for their grant programs, the intention of our index is to take a broader view of preparedness rather than to measure grant performance. To build a more comprehensive assessment of preparedness, we developed indicators based on multiple data sources, each with a different range of available years. These differences in timeframes resulted in the indicators not always being temporally aligned with one another. Furthermore, because of lags in data availability, the COPI does not currently capture many of the improvements which may have resulted from COVID-19-related increases in funding for healthcare providers, local health departments, and municipalities. We also acknowledge that county level measures do not capture the variation in risk and preparedness that can exist within a county, and that more granular data could be helpful in guiding targeted improvements. However, we believe our effort to identify these indicators and develop a composite score with the available data is an important first step in quantifying county-level outbreak preparedness.

While the indicators are formulated to appropriately reflect specific aspects of preparedness, there were some data limitations that are noteworthy. Within the Domain 1 indicators, while the domain includes measures of healthcare coalition participation by emergency management agencies, local health departments, and acute care hospitals, we were unable to assess the quality of this engagement for each of these types of entities, and we were unable to find reliable data on participation from emergency medical services organizations. Similarly, although the index includes measures of hospital and nursing home capacity, there may be variation in health department policies regarding whether nursing homes are required to accept certain patients who are ready to be discharged from hospitals; this tension between nursing homes and hospitals was a critical issue during the COVID-19 pandemic when nursing homes lacked infection prevention resources (such as PPE) but hospitals were pressed for space and needed to discharge patients who were still infectious but no longer needed hospital care (Graham, 2020). Missing data also impacted some of the indicators, particularly, the indicator of medical surge capacity, which relies on a previously developed and validated index that is calculated using sums. This approach resulted in lower scores for hospitals with large amounts of missing data in the dataset, which pertained to many California hospitals, and resulted in generally low scores for the Medical Surge subdomain. The current iteration of our index does not include a measure of continuity of care, but we acknowledge that continued access to services and medications for individuals with chronic conditions such as diabetes, renal failure, heart disease, and cancer are crucial and can be disrupted in the context of an outbreak emergency. Furthermore, the index currently does not capture the willingness and/or ability of local health departments to provide support or intervene during healthcare evacuation processes, which could be important in some emergency situations, although it is less pertinent to outbreak emergencies where hospital evacuations are rare.

With regard to Domain 2, there are few existing datasets that contain comprehensive information about all local health department attributes. The NACCHO Profile of Local Health Departments survey is one of the few unique datasets with this information, and we used the available data; however, the NACCHO survey is intended to reflect a representative sample of LHDs across the country, so it was never designed to provide data for every county. In particular, we were missing data on the majority of LHDs within the Incident Management subdomain. While we included measures of health information exchange participation and meaningful use of electronic health records, we were unable to assess the extent to which these were used or incorporated into the operations of local health departments, as limitations with data usability have been identified (The Office of the National Coordinator for Health Information Technology, 2017). Several indicators within Domain 2 are based on participation in a program that supports jurisdictions in developing plans (e.g. CRI, PPHR, etc.); these indicators are intended as proxies and we acknowledge that some jurisdictions may have developed plans without having participated in those programs. We included indicators of having a local public health laboratory, and some statewide measures of laboratory capacity, but we were unable to assess laboratory capabilities for next generation sequencing technologies, which are emerging as powerful tools for biosurveillance. We included wastewater testing as a type of biosurveillance technology used in some jurisdictions, but given that this is a relatively new method of public health surveillance testing, many questions remain in terms of its public health impact and cost feasibility. Another policy mechanism that is pertinent to outbreak preparedness is whether local or state public health agencies have the authority to suspend licensure requirements or to determine what types of healthcare professionals are allowed to administer vaccines during declared emergencies. These licensure policies can affect staffing availability during emergency situations.

Lastly, we did not include measures to reflect the specific needs of people who are unhoused or housing unstable, who are among the most vulnerable populations during outbreaks. Mental health and substance use programs are important safety net services that can help address the needs of unhoused and other vulnerable populations. The specific resources needed to reach these populations' and address their needs are important considerations in a county's outbreak activities.

Importantly, counties that are missing data for some indicators are not penalized for that missing data; those indicators simply do not factor into their overall score. Future iterations of our index will aim to identify more detailed data to capture important elements of county-level preparedness, add appropriate indicators to augment the index, and improve data completeness.

Chapter 7: Use of the index and future work

The COPI is a new tool that helps identify factors that contribute to systems level preparedness for communicable disease outbreaks. The first release of the COPI includes data for California counties and includes a wide range of measures reflecting the many resources and activities needed to bolster outbreak preparedness, and accounts for the importance of understanding community vulnerability when it comes to preparedness planning. The tool is intended to be used as a guide for assessing county-level outbreak preparedness and may be helpful in identifying areas where additional resources may be needed to improve such preparedness.

Although there were some data limitations in the construction of this tool, this research project provides a window into the possibilities of developing such a county-level tool for assessing outbreak

preparedness. Future revisions of the tool will attempt to address these data limitations to provide more nuanced measures of preparedness and to fill some key data gaps. The tool may also be expanded to other states where county-level entities are major players in outbreak preparedness.

Appendix I: External advisors

The COPI was developed with input from the following external advisors. We thank the advisors for giving their time and energy to this project.

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Appendix II: Related publications

Beck C, Rogers C, Martinez B, Bhamidipati K, Ghosh JK. Differences in County-Level Access to Social Safety Net Services Across the United States [data brief]. Heluna Health. 2023.

Martinez B, Rogers C, Bhamidipati K, Ghosh JK. Understanding access to safety net services in U.S. counties. Annals of Behavioral Medicine. 2023;57(Supplement_1):S1-S646. Abstracts from the Society of Behavioral Medicine 44th Annual Meeting & Scientific Conference. doi:10.1093/abm/kaad011

Martinez B, Ghosh JK, Cutler B. Developing a Novel Tool to Assess Public Health Outbreak Preparedness in California Counties [poster presentation]. National Association of City and County Health Officials (NACCHO) Preparedness Summit. Atlanta, GA. 2023.

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