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Factors Influencing Public Health Preparedness

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Factors Influencing Public Health Preparedness

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An abstract of
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Abstract

Factors Influencing Public Health Preparedness

By Parker Choplin

Introduction

Climate change, land encroachment, and world travel exacerbate the probability and frequency of emerging pathogens and extreme weather events. Public health preparedness is a country's first line of defense to prevent, detect, and respond to protect its people from catastrophic events and mass casualties. Unfortunately, many countries are not well equipped to protect their citizens from these events, as illustrated by the current COVID-19 pandemic.

Objective

This project determined the global preparedness strategies that currently exists, identified gaps in preparedness domains and strategies, and proposed new, innovative capacity building activities.

Methods

PubMed™, EMBASE™, CAB Direct™, and Cambridge Core™ were searched. After excluding duplicates and applying inclusion and exclusion criteria, 63 studies were selected for data extraction and inclusion in the review.

Results

Five themes in emergency preparedness emerged from data extraction: community resilience; healthcare workforce; health system's preparedness; governance and funding; and health security. Gaps were identified in healthcare worker training, laboratory capacity, and mental and psychological/psychosocial health preparedness.

Conclusions

This review was limited by most studies occurring in the United States (50%), with Latin American and South America not represented. Additionally, this systematic review was performed by one person, whereas most reviews were performed by at least two people to reduce bias. Future recommendations consisted of more funding and resources allocated towards building infrastructure and capacity among mental health, simulation exercises, and laboratory services. Additional reviews and research should examine gaps in preparedness systems that COVID-19 exploited. Overall, countries should invest resources into building preparedness capacity across all domains. It is no longer a question of *if* but *when* the next pandemic or natural or manmade disaster will occur; nations should be prepared to efficiently protect their populations.

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Chapter 1: Introduction

Increasing human population, urbanization, land encroachment, and travel are factors that exacerbate the likelihood and frequency of infectious disease outbreaks. [1] Meanwhile, natural disasters continue to intensify and grow in numbers due to warming waters and temperatures, and other drivers. [2] Interconnectedness allows for infectious diseases to quickly move from continent to continent. Therefore, every country has a responsibility to prioritize prevention, detection, and response infrastructure and strategies; this includes strengthening public health preparedness capacity. [3]

In the past, hospital systems, local governments, and other organizations had siloed, multiple preparedness plans and activities specifically targeting individual natural disasters, chemical disasters, and infectious disease outbreaks. [4] In recent years, health officials slowly switched preparedness efforts to an "All-Hazards" approach. [4] The all-hazards approach integrates emergency preparedness capacities and capabilities from a wide range of disasters and emergency situations as identified locally. [4] Additionally, this approach condensed all the different capacity and capability activities into a central plan applicable to the wide range of potential disasters that a certain region might experience. [4] These plans are amendable so different regions can adapt the plans to fit their commonly experienced emergencies. [4]

In the early 2000s, the U.S. Center for Disease Control and Prevention (CDC) recognized the need to increase preparedness capacity and created the Public Health Emergency Preparedness (PHEP) cooperative agreement. The PHEP contains 15 public health preparedness capability

standards that the agency uses to help local, state, and territorial public health departments build and fortify their public health preparedness and response capacity. [5]

PHEP has 15 capability standards as essential for public health preparedness for all types of outbreaks, natural disasters, and chemical attacks: community preparedness; community recovery; emergency operations coordination; emergency public information and warning; fatality management; information sharing; mass care; medical countermeasure dispensing and administration; medical material management and distribution; medical surge; nonpharmaceutical interventions; public health laboratory testing; public health surveillance and epidemiological investigation; responder safety and health; and volunteer management. [6]

Annually, PHEP distributes grants to public health departments across the United States, and its territories to aid in preparedness capacity building. These activities most likely aided in the United States ranking as the most prepared country to manage an epidemic by the Global Health Security Index in 2019 (GHS Index). [7]

There are few national preparedness evaluation tools available for countries to measure preparedness status. Currently, there are the Joint External Evaluation (JEE), the GHS Index, the World Organization for Animal Health Performance of Veterinary Services (OIE PVS), and the National Action Planning for Health Security (NAPHS). Experts at the Nuclear Threat initiative, Johns Hopkins Center for Health Security, and the Economist Intelligence Unit developed the GHS Index because of the increased probability of emerging pathogens and accidental or deliberate releases of one. [8] The GHS Index assesses a country's capacity to cope with infectious disease outbreaks. [3]

The GHS Index assesses six core concepts: prevention, detection and reporting, response, health systems, compliance with norms, and risk of infectious disease outbreaks. [8] Countries should be able to prevent the emergence of pathogens, have early detection and reporting systems in place, and have the ability to rapidly respond to and mitigate the spread of the pathogen. [8]

Additionally, countries should have a robust health system with a strong workforce, committed to improving national capacity, financing gap analysis and adhering to international norms. [8] Countries are scored on these six components, given a score out of 100, and provided feedback on areas for improvement. [3] The GHS Index pulls data from publicly available reports and studies under the approach that a country is safer and more secure when its citizens and other countries are able to freely access information on a country's preparedness capacities to better prepare themselves. [8]

The organization produced a 2019 final report on countries' preparedness scores and determined that not a single country was fully prepared for an epidemic, with the average GHS Index score of 51.9 among 60 high-income countries. [3] Even though not every country was fully prepared, the United States did achieve an overall score of 83.5, followed by other high-income countries. [7] Therefore, many of these high-ranking countries perceived themselves to be exceptionally prepared to handle a potential pandemic.

The JEE is a voluntary process a country can evaluate its capacity to "prevent, detect, and rapidly respond to public health threats". [9] The tool measures a country's specific level and headway in achieving preparedness targets. [9] The proposal is that the first evaluation will establish a baseline for countries capacities and capabilities. [9] Then, future evaluations will

assess progress and ensure improvements in capacity and sustainability. [9] The JEE assesses four major domains: prevention, detection, response, and the "IHR (2005) related hazards and points of entry". [9]

Moreover, there are multiple groups associated with public health preparedness capacity building across the world. For instance, multiple countries have established their own Centers for Disease Control and Prevention (called National Public Health Institutes [NPHI]). The World Health Organization plays a multifaceted role with member states (MS). Then, there are countries that have developed Field Epidemiology Training Programs (FETPs) and public health networks like the Global Health Development/Eastern Mediterranean Public Health Network (GHD/EMPHNET). GHD/EMPHNET has the scientific knowledge and technical support to provide the EMR with promotional material, workshops, guidelines, and trainings through case-studies and rapid response teams. [10] Further, there are the FETPs that were created to increase epidemiologic capacity of the public health and veterinary workforce. [10] FETPs are an essential tool to increase a country's preparedness capacity. The program focuses on strengthening its people's knowledge and skills through real time experiences and trainings. [10]

A search of the literature illustrated that there are a variety of programs and activities recommended to increase preparedness capacity. However, different organizations and governments have their own view on what activities are important for building public health preparedness capacity. For instance, the U.S. CDC categorizes preparedness activities into six domains: community resilience, incident management, information management, countermeasures and mitigation, surge management, and biosurveillance. [11] Whereas the European Union categorizes preparedness activities into seven domains: governance, capacity

building and maintenance, surveillance, risk assessment, risk and crisis management, post-event evaluation, and implementation of lessons learned. [1]

Further, WHO described aspects essential during emergencies: leadership, uniform language, coordination, economic resources, a ready support system, and a functioning administration. [12] The Pan American Health Organization (PAHO) contains a health emergencies department (PHE) that specially focuses on strengthening MS health sectors' all-hazards preparedness capabilities. [13] PHE works in six main sectors of public health preparedness: infectious hazard management, country health emergency preparedness and the IHR (2005), health emergency information and risk assessment, emergency operations, emergency core services, and disaster risk reduction and special projects. [13]

During the COVID-19 pandemic, many countries conducted assessments of their preparedness and response capacities. A recent study evaluated countries in the Eastern Mediterranean Region for the ability to respond to outbreaks and potential vulnerabilities. One major barrier to efficiently responding to the pandemic was the prolong conflict in many countries in this region. [10] Additionally, the report found multiple countries were deficient in variables, including prevention/control practices, lack of infrastructure, limited resources, and inadequate laboratory infrastructures. [10] Further, there is a need to increase capacity in public health surveillance and communication strategies.

1.1 Statement of the Problem

History illustrates outbreaks evolving to pandemics and natural disasters becoming "vessels for illness" when governments do not detect early and respond quickly or appropriately to public

health threats. [11] Though some MS ranked high on the GHS Index, the final report determined that national health security was *fundamentally weak* throughout the world. [3] As the coronavirus has spread worldwide, we have seen cracks in every country's preparedness system.

In Dec 2019, what public health officials had been predicting came true. A virus of unknown origins and recognition quickly swept across China and then to the rest of the world. Public health professionals across the country constantly reassured the American public that they were safe because the United States was one of the most prepared countries to handle an event like COVID-19. [14] Unfortunately, politicians, and medical and public health officials were overconfident in states' preparedness capacities. As of April 7th, 2021, the United States was the nation with the greatest total number of cases (31,637,243) and greatest number of deaths (572,842). [15]

1.2 Statement of Purpose

Building preparedness capacity is an essential aspect to prepare health systems and countries for handling inevitable infectious disease outbreaks and all-hazards events. The onset of the COVID-19 pandemic revealed how unprepared countries were to prevent and protect populations from large scale emergencies and disasters. This review will analyze the components of all-hazards capacity building domains and activities implemented by the United States and other countries to determine what preparedness capabilities are currently in place and identify gaps and novel and innovative capacity building activities.

1.3 Project Significance

The significance of this review is to determine strengths, gaps, and lessons in preparedness capacities to respond with the view of revamping preparedness for the next public health emergency.

1.4 Research Questions

1. What domains and strategies exist in building public health preparedness?
2. What activities are needed to strengthen public health preparedness?
3. What domains and strategies would strengthened public health preparedness?

Chapter 2: Methods

This study was a systematic review of the literature and documents addressing factors frequently used in building public health preparedness and strategies needed to strength preparedness. General preferred reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines were used for the descriptive review; this included an explicit research question, illustrating the rationale, defining clear search pathways, and study selection variables. [16]

This study reviewed the literature for articles published in PubMed™, EMBASE™, CAB Direct™, and Cambridge Core™ databases concerning building strategies and domains for public health preparedness. PubMed™, EMBASE™, and CAB Direct™ were accessed on Feb 24, 2021. Cambridge Core™ was searched on Mar 19, 2021.

With the help of a reference librarian at Emory University, three concepts were created to find relevant literature. Concept 1 included the combination of search terms related to factors ("concepts" OR "idea" OR "influencers"). Concept 2 included the combination of search terms related to "public health preparedness" ("outbreak preparedness" OR "emergency preparedness"). The final concept encompassed search terms related to "capacity building" ("systems strengthening" OR "systems building"). The first search was conducted in PubMed. Each concept was searched individually. Then, the final search included all three concepts connect with "AND". The results of the final, combined search were imported into Covidence (Melbourne, Australia) for further analysis. This exact process was performed for the other three databases, with 621 studies included in the text and abstract screening. Covidence

automatically omitted duplicates (N=45). These duplicates were screened to ensure studies were not misclassified. Then, titles and abstracts were reviewed for all potentially relevant studies and evaluated against further inclusion and exclusion criteria. To reduce bias across studies, all relevant articles were selected regardless of author or publisher.

Inclusion criteria included …

- empirical studies and "grey literature" that evaluated different strategies or domains of public health, all-hazards, infectious diseases, and multiple natural and biological disaster preparedness at the global, national, and local levels.
- general populations, or clinical, health, governmental, and organizational level participation.
- conducted in the United States and other countries in the world.
- published between 2015 and 2021.
- published in English.
- full text available through the Emory Library or other catalog system.

Exclusion criteria included …

- studies done on specific hospitals, clinics, or individuals.
- strategies that were based on one specific natural disaster, chemical weapon, and infectious disease that were not generalizable.
- published prior to 2015.
- published in a language other than English.
- full text not available through Emory Library or other catalog system.

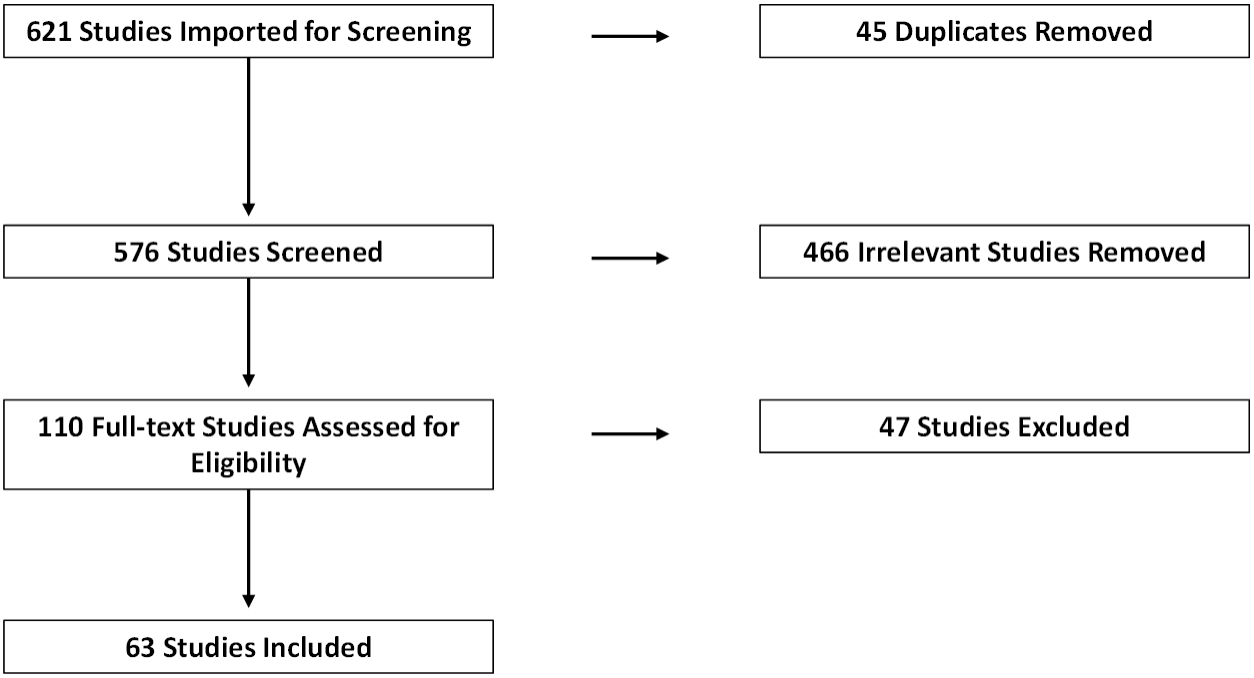
Articles were included beginning in 2015 to obtain the most up-to-date information on domains and strategies needing to be revised. This limitation was also introduced to increase the manageability of the vast amount of information regarding public health and disaster preparedness. Non-English articles were excluded. In some respects, studies regarding specific epidemics were included in the review because their methods and results were generalizable to other outbreaks and did not go into specific preparedness details that only pertained to handling Ebola, for instance. Additionally, articles about specific diseases were included in the review because of the increase in world travel and the ease of one person traveling across the world. Therefore, various infectious diseases (e.g., H1N1, Ebola, MERS-CoV, COVID-19) can easily be brought into another country; therefore, they should be included if strategies and domains are generalizable. Additionally, articles measuring metrics and indicator measurement tools were included in the review since countries and organizations need a method to evaluate whether their strategies and programs are increasing their preparedness capacity.

With regards to exclusion criteria, articles and studies discussing solely one type of natural disaster, chemical exposure, etc. were excluded from the review because background literature illustrated the need for standard and more general guidelines and strategies; not every region and country experiences earthquakes, typhoons, or a nuclear event.

A total of 110 full-text studies were assessed for eligibility, with 63 studies marked for data extraction. A PRISMA flow diagram that depicts the different phases of the literature review and screening process is shown below (Figure 1). Data were extracted from the included articles using a researcher-produced form in Google Forms. The researcher collected data on sample

population, preparedness domains/strategies, type of emergency/disaster, and study outcomes. The data extraction tool was developed during the study.

Figure 1. PRISMA Screening and Article Inclusion Processes for Public Health Preparedness, 2021



Chapter 3: Results

The studies selected for data analysis were conducted across various countries and regions with half of the studies conducted in the United States (32) and six studies conducted in multiple countries (Table 1). Of the 63 studies selected, Latin America and South America were not represented. Additionally, there was only one study that discussed a summit amongst Caribbean countries.

Table 1. Countries and Regions in the Systematic Literature Review of Public Health Preparedness, 2021

Country/Region	Studies (N)
United States	32
Multiple Countries	6
India	3
Japan	3
West Africa	3
Israel	2
Bahrain	1
Canada	1
England	1
European Union	1
France	1
Hong Kong	1
Indonesia	1
Iran	1
Middle East	1
Caribbean	1
Republic of Senegal	1
South Korea	1
Sweden	1
Switzerland	1

The selected studies spanned 2015 to 2021, with the most (25%) studies published in 2020. Of the 63 articles screened, nine used quantitative methods and four applied qualitative methods. One article summarized a summit hearing; three were opinion pieces. Eighteen (29%) selected articles used surveys and questions to gauge health workforce's preparedness (e.g., physicians, nurses, childcare providers). Seventeen articles described programs and pilot studies aimed to build or evaluate preparedness. They discussed current and novel simulations, exercises, and evaluation tools used in groups to gather preliminary data to expand their programs. Finally, 10 articles where literature or systematic reviews.

Five themes surfaced from the wide range of domains and strategies reported: community resilience; healthcare workforce; health systems preparedness; governance and funding; and health security. Articles either focused on one preparedness strategy or assessed multiple domains. Each theme had subthemes that primarily came from the screened literature. For instance, community resilience consisted of 41 articles examining topics from mental health to public-private preparedness partnerships to emergency support. Health workforce contained 15 articles that discussed subthemes like willingness to come into work during a disaster to pharmacist preparedness to long-term care provider. Health systems preparedness contained 22 articles specific to health systems infrastructure and resources to hospital preparedness to surge capacity. The fourth theme was governance and funding which contained 11 articles covering topics from policy to governance and coordination to preparedness funding and national plans. The final theme was health security, which included six articles discussing subthemes like electronic medical records to laboratory capacity to border security preparedness.

Community Resilience

RAND Corporation's key components of community resilience were used to determine which subthemes encompass it. The RAND Corporation determined that key building blocks of community resilience were social and economic well-being; individual, family, and community knowledge and attitudes towards disaster preparedness; risk communication; community partnerships with government and non-government organizations; and community connectedness. [17]

This review found articles that fit RAND Corporation's key components, such as personal preparedness; household preparedness; risk communication; mental health and psychological health; community-private-public partnerships; emergency support groups; childcare provider preparedness; with nine articles specifically discussing community preparedness and resilience.

Personal preparedness was evaluated across all themes (13 articles), with another four articles examining household preparedness. Overall, personal and household preparedness is not a priority for most people across the world until they are in imminent risk. People tend to have a false sense of security and do not tend to participate in preparedness plans. [18-21] A study conducted in Israel discovered that even in an area that experiences many emergencies, individuals generally postpone preparedness activities until an immediate threat is recognized and confirmed. [18] Additionally, some articles discovered that a small percentage of individuals and households do have an emergency plan. [22,23] Another concerning factor is that a study conducted in Hong Kong discovered that few healthcare workers felt personally prepared for a disaster and had a low perceived risk of a major disaster occurring. [24] Some articles highlighted the importance of making emergency plans with neighbors and family members, with

quantitative data illustrating a positive association between preparedness and community connectiveness. [23,25,26] Additionally, Ashida et al. discussed the importance of having a strong relationship with family members that live close enough to help during a disaster (2017).

Further, seven articles directly addressed community preparedness and resilience. A few articles discuss incorporating new stakeholders and community members into preparedness plan development and activities such as youth, childcare providers, and creating partnerships with clinics, universities, and private/public organizations. [27-30] One article briefly discussed gaps found in community preparedness [12], while others discussed potential avenues for strengthening capacity such as improving health information systems and incorporating behavioral economics into disaster preparedness activities to foster community engagement. [31,32]

A few articles compiled data on childcare provider preparedness. One article discovered that 88% of childcare centers had preparedness plans. [28] Another study developed and tested a training video that describe the process of making emergency plans that incorporate children. [33] A second studied surveyed childcare providers and discovered that scores were much higher among teachers who previously participated in disaster trainings. [34]

Moreover, four articles examined the importance of community-private-public partnerships. Three of the four articles discussed the importance of trust between the communities and public/private organizations. [35-37] Two other articles summarized that public-private partnerships increased resource access and community resilience. [29,36]

Another six articles discussed risk communication and assessment. Four of the six articles discussed specific training exercises that aimed to increase different domains of public health preparedness, in addition to risk communication. [38-41] Most of the screened articles discussed communication impediments experienced during each exercise. People had issues communicating across sectors and with neighboring country liaisons and governments. [38] During some simulations, character roles and responsibilities were not always clear. [39] Even studies that did not assess preparedness exercises and activities found clear issues with risk communication. [42,43] Two articles specifically looked at the language used by federal agencies to communicate risks and preparedness information. Researchers found a clear disconnect between the current literature literacy demands and the targeted population's literacy capabilities. [44,45] Another study found that word choice is very important with preparing communication documents for the public. An analysis of a focus group's attitudes towards different communication pieces revealed that choice restricting language such as "you must" and "you have to do it" lead to participants very reluctant to participate in the behavior. [40] Whereas, when communication pieces incorporated more choice-enhancing language such as "consider" and "the choice is yours", participates were more willing to participate in proposed behaviors. [40]

Meanwhile few articles discussed mental health and psychological/psychosocial health preparedness. [29,46] Agarwal et al. wanted to assess individuals' psychological preparedness for an extreme event such as the COVID-19 pandemic (2020). Researchers used an evaluation tool to identify specific risks and features of severe mental illness in addition to strategies for individuals to practice for managing anxiety in extreme conditions such as the COVID-19

pandemic. [46] In the second article, Hansel et al., discussed the formation of a multistate coalition in southern United States where part of the coalition is working on improving access to behavioral health coordination (2015).

Healthcare workforce

According to the WHO, health systems need competent and committed health workers to function optimally. [47] This review found articles discussing health workforce preparedness; health workers' willingness to come into work during a disaster; pharmacist preparedness; and long-term care provider preparedness. Eight articles discussed health workforce preparedness. Multiple studies conducted scenario trainings and simulations to assess health care workers' disaster preparedness. These studies found that emergency preparedness training can enhance knowledge and boost performance skills vital for a diverse group of workers to navigate a clinical disaster scenario. [48,49] Further, six articles determined that more training was needed to elicit a better response from healthcare professionals. [24,42,48,50,51] Specifically, one study found physicians need increased decontamination training [52], in addition to emergency communications, psychological first aid, disaster law and ethics, and media coordination. [24] Moreover, other articles found more concerning gaps in health workforce knowledge such as low preparedness among physicians to handle a bioterrorism attack or large-scale disasters in the United States. [48] Or the discovery that physicians were unaware of preparedness practices in their practice [42], and the majority had a poor understanding of emergency preparedness activities [53] and knowledge gaps surrounding potential threats in general. [54] The extraction phase discovered three articles that analyzed health care workers' willingness to come into

work during a disaster. One article found that health workers were less likely to respond to CBRN incidents. [24]

Then, there were three screened articles that analyzed pharmacist preparedness across different regions of the world. In general, pharmacist need to be included in preparedness activities and trainings. [55] One study in rural counties in the United States found that a lot of pharmacies did not have emergency power, and lower-income or high elderly areas were less likely to have a certified immunizer. [56] Additionally, another study found that most pharmacies lacked disaster protocols. [57]

Finally, only one article discussed disaster preparedness among long-term care (LTC) providers. Researchers conducted a couple of case studies among rural LTC facilities. Radcliff et al. discovered that there were a lot of gaps in LTC provider preparedness (2020). The study found that LTC providers had issues with communication and coordination across local, state, and federal government levels. [58] Additionally, Radcliff et al. found that LTC stakeholders were rarely invited to participate in emergency preparedness meetings and exercises which limited their facilities' overall preparedness capability (2020). Similar to other health fields, LTC facilities are not spared from high staff turnovers and low financial margins, which appear to be a trend across national corporations and local institutions. [58]

Healthcare system preparedness

Natural disasters, mass casualty events, and medical surge have always been persistent threats to hospitals and healthcare systems. [59] Hospitals, healthcare systems and their partners need to be prepared to prevent, respond, and recover from these threats to efficiently defend and

solidify a country's healthcare system and public health infrastructure. [59] The authors describe 8 main capabilities: healthcare system preparedness; healthcare system recovery; emergency operations coordination; fatality management; information sharing; medical surge; responder safety and health; and volunteer management. [59] The reviewed literature discussed subthemes like those suggested by the Office of the Assistant Secretary for Preparedness and Response, surge capacity; health systems infrastructure and resources; and hospital, emergency department, and primary care preparedness.

Three articles assessed hospital surge capacity. There was no clear consensus between articles as to what areas in surge capacity are working and what gaps exist. One article examined the differences between rural and urban hospitals. Vick et al. discovered that rural and urban hospitals prepare for surge capacity in different ways (2019). For one, the different locations have different perceptions of disaster risk and therefore have different plans, if at all, for preparing surge capacity. [60] This appears to dictate what resources and materials they keep stockpiled. [60] One article found an issue with no specified criteria for evaluating a hospital's surge capacity. [61] The authors did find that reverse triage of patients increased the hospitals surge capacity. [61] Thankfully, one research team piloted a novel instrument, Surge, for hospital staff to test their surge capacity by inputting specific details pertaining to their hospital. [62]

Several articles, six, examined health systems infrastructure and resources. There was a clear consensus across the articles for the importance of communication and collaboration between multiple sectors, public health organizations, and government entities. [41,50,51] Further, multiple articles expressed a dire need for continued funding for capacity building and maintenance. [39,50,51,63] Other articles provided potential solutions for increasing health systems infrastructure

and resources such as implementing and improving health information systems which will reduce “fragmentation and costs”, and help with resource allocation. [31] In addition, hospitals should increase their focus on testing decision support tools, and increasing diagnostic resources. [50]

Hospital preparedness had the second highest number of articles across themes and subthemes (11). A couple of main concepts arose across multiple articles. First, there is a need for more training and practical programs for all-hazards preparedness. [60,63-66] One article suggested utilizing mass casualty incident exercises to assess individual’s decision making behaviors and to teach different preparedness capabilities. [64] A couple of articles discussed physicians needing increased guidance for handling pediatric patients during an emergency. [60,67] Other articles expressed concern for the low levels of preparedness [12,68], with some hospitals not having a preparedness plan in place [19], and an apparent disconnect between current guidelines and what is actually implemented and observed in the hospital. [12] Finally, one article suggested that healthcare stakeholders and practitioners need to be incorporated into whole system preparedness meetings and involved in every step of capacity building. [39]

Only two articles discussed the importance of disaster preparedness for emergency departments and primary care centers. One article analyzed emergency department preparedness in France and concluded that on average there was a low capacity in quality, organization, resources, management, training, and responsiveness in these departments across France. [69] These types of healthcare facilities are apparently consistently understaffed, making it difficult to prepare for a disaster. [69] Correspondingly, a study of primary care centers

determined that these physicians are an important aspect of emergency management and need to be implemented into more disaster preparedness plan meetings. [70]

Governance and Funding

Governance and funding are essential aspects of public health preparedness capacity building. Governance and funding incorporated four subthemes, policy; governance and coordination; preparedness funding; and national plans. Two articles primarily discussed policies in public health preparedness. The first study found that legislation is typically proposed after a disaster has occurred and that most legislation is incident specific which makes it difficult for countries and health systems to incorporate into an all-hazards approach. [71] The second study proposed different avenues for future policies to incorporate. Authors suggested that more holistic policies and policies that reduce probability and collateral of disasters are needed. [72] Adini et al. also proposed the possible use of think tanks to create effective preparedness policies (2019).

The subtheme governance and coordination contained six articles. These articles did not produce a consensus of what concepts are working and what needs improvement. Two articles stated that clear communication with the media is vital. [31,63] A similar article promoted increased communication between world leaders and governments. [38] One article discussed improving education among government leaders on disaster management and awareness. [51] A study that has been discussed in previous sections claimed that health information systems improved coordinated governance and ensured timely, transparent data sharing. [31] A Canadian study also discussed modification of their incident management systems to make it more public health friendly and therefore the tool will be incorporated more into emergency preparedness activities. [73]

The next subtheme was preparedness funding. The main concept discussed across all articles was that healthcare systems need increased funding for preparedness capacity and activities, and that funding needs to be sustained in order for systems to maintain a high level of preparedness. [38,39,50,51,63]

National preparedness plans was the final subtheme, with four articles discussing various concepts. Two articles primarily focused on influenza pandemic plans. These two articles discussed how current plans need to be revised to strengthen areas in the recovery and transition phases, and more plans need to communicate how health systems should accommodate special groups and settings. [41,74] The second article further highlighted that plans require collaboration and teamwork across a wide range of stakeholders, and investors come from various sectors and industries involved with influenza response. [41] Further, one article suggested that nations need to continue to practice simulations and exercises to test plans, surveillance tools, and perform a full risk and hazard vulnerability assessment. [38] Another article suggested creating sectorial plans in addition to following the generalized national plan. [51]

Health Security

Health security is an essential part to public health preparedness since pathogens can spread to other countries within 36 hours. [75] Therefore, public health agencies spend resources on building front lines of defense to better prevent and detect diseases. [75] To increase global health security, the CDC focuses on strengthening disease surveillance and outbreak response; emergency management; safe laboratory systems and diagnostics; and developing the workforce. [75] This review found a minimal number of articles that discussed aspects such as electronic medical records (EMR) systems; surveillance capacity and networks; border crossings

preparedness; and laboratory capacity. Only one article mentioned EMRs and the authors stated that further implementation would increase communication and coordination between public health agencies and health care providers. [50] A few articles discussed surveillance capacity and networks, with one study stating that hospitals did not have the capacity to detect outbreaks at an early stage. [66] Another article discussed the underfunding of hospital surveillance systems. [43] Additionally, little information was found regarding border crossings preparedness. Only one article discussed the issues observed at border crossings in Northern India. Researchers found inadequacies in cold storage capacity and study participants discussed the inability to keep perishable items. [76] Study participants also highlighted a need for more staff, equipment and resources in order to be properly prepared to respond during an emergency. [76] Furthermore, local laboratory capacity was nonexistent at the observed border sites. [76] Correspondingly, two other articles referenced laboratory capacity. One study discussed the work the CDC has put into to strengthen relationships between public health laboratories and private and commercial laboratories to strengthen emergency response capacities. [77] The other study was a literature review and one of the authors' conclusions was that little studies discussed laboratory preparedness. [43]

Chapter 4: Discussion, Recommendations, and Conclusions

4.1 Discussion

This review synthesized published evidence from qualitative and quantitative studies, literature reviews, and grey literature on current public health preparedness capacity domains and activities and proposed strategies to strengthen preparedness and response capacities. It highlighted several discrepancies in current public health preparedness capabilities across sectors and countries. It also, however, highlighted pilot and case studies that provide ample evidence on strategies to increase preparedness capacity.

There is a vast amount of literature concerning public health preparedness capacity building. Sixty-three articles were analyzed after screening articles for inclusion criteria. These studies only represent those published in academic journals. Further information may be available in the grey literature solely published on organization and government webpages.

The review produced a broad view of the different preparedness domains and strategies that exist across the world. Five themes were created based on PHEH and WHO literature to organize the various domains and strategies discussed among the 63 articles. The main themes were community resilience; healthcare workforce; health systems preparedness; governance and funding; and health security. Various subthemes were placed under the main themes such as personal preparedness; community-private-public partnerships; hospital preparedness; pharmacist preparedness; surge capacity; and preparedness funding just to name a few. Below, we highlight some areas that need strengthening to increase public health preparedness.

Trainings and Simulations

This review discovered articles reporting on exercises, simulations, and other activities that show promise in strengthening specific public health preparedness. For instance, the Youth Resilience Corps was piloted during one summer in Washington D.C. It sees value in involving children in community preparedness and response activities. [30] Multiple studies assessed simulation and exercise programs for building preparedness among healthcare workers. One study conducted by Pikoulis et al. assessed healthcare worker preparedness over a 4-year period in the United States (2020). Researchers discovered that simulations and exercises need to be more kinesthetic and tactile based. [64] The study continued follow-up and found evidence that 10-12 months after the exercises, healthcare providers were still scoring high in preparedness proficiencies. [64] Each study found an increase in preparedness when comparing baseline and post exercise data. Further, multiple studies stress the need for more simulation and preparedness activities in healthcare settings and country wide. [38,48,51,64] This need has previously been recognized; the IHR (2005) recommends MS test their preparedness capacity, specifically risk communication, twice a year. The IHR (2005) suggests exercises such as stress tests, table-top exercises, and simulation exercises to evaluate stakeholder capacities across public health preparedness sectors. [78] One such exercise, Event 201, was conducted in 2019 right before the COVID-19 pandemic emerged. Johns Hopkins Center for Health Security, the World Economic Forum, and the Bill and Melinda Gates Foundation hosted this pandemic exercise which incorporated senior leaders from the United States, international governments, and leaders in global industries. [79] The goal was to educate participants, lawmakers, and the public on urgent challenges facing public health preparedness capacity building. [79] This event

illustrates the usefulness of governments, organizations, and health systems performing and participating in simulation and table-top exercises as Event 201 identified many areas that crippled during the beginning of the COVID-19 pandemic.

Mental and Psychological Health

Another area that needs strengthening is mental and psychological/psychosocial health preparedness. Large-scale disasters disrupt social networks and create a massive mental health burden on those directly and indirectly impacted. [80] The review yielded two articles focused on mental and psychological health. [26,46] This outcome is concerning considering most recorded injuries from public health emergencies are psychological. [81] Multiple national planning scenarios calculated a ratio of 4:1 to 50:1 when comparing psychological and physical trauma. [81] This concern clearly played out since health officials observed how the coronavirus pandemic is impacting people's mental status.

The Kaiser Family Foundation (KFF) recently published a report on COVID-19's impact on mental health and substance abuse. Their research found that 40% of adults in the United States reported symptoms of anxiety or depressive disorder in 2020. [82] This number increased from the 10% of adults relaying symptoms between January 2019 to June 2019. [82] Correspondingly, since July 2020, many adults report significant negative impacts to their mental health and well-being. [82] Thirty-six percent of adults have trouble sleeping, 32% are developing poor eating habits, and 12% increased their alcohol and substance use intake. [82] Situations like unemployment and isolations greatly impact individuals' mental well-being. [82] KFF's report also discovered that young adults (18-24 years) experienced mental health distress at a much higher

rate than older adults. Fifty-six percent of younger adults reported symptoms of anxiety and depressive disorder, 25% reported substance use, and 26% reported suicidal thoughts. [82]

Along with other health outcomes, this pandemic unequally impacted communities of color with Non-Hispanic Black adults and Hispanic or Latino adults reporting symptoms of anxiety and depression 5%-7% greater than Non-Hispanic White adults. [82] At the beginning, mental health resources were not readily available to aid people in combating stress, depression, and suicidal thoughts. Even resources that were in place before the pandemic were shut down for months due to lock-down restrictions. Thankfully, public health organizations such as the CDC, WHO, and United Nations (UN) recognized this increased threat to people's well-being and published general guidelines and resources to address the population's mental health. [82] Further, in the U.S., Congress passed two stimulus bills containing funding for mental health and substance services and expanding these services through the telemedicine platforms. [82]

Laboratory Capacity

The review produced two articles on laboratory capacity. One article was regarding the CDC's work to strengthen partnerships between public health laboratories and corporate laboratory systems. [77] The other study was a review of literature published on infectious disease preparedness and found little information on laboratory capacity building. [43] Literature is lacking information on laboratory capacity building in general, but also across countries. Laboratories are essential in detecting outbreaks and preventing further spread of a disease by effectively and swiftly identifying infected individuals. From reading Salerno et al.'s review, it appears that the U.S. was prepared to handle a pandemic like COVID-19 (2020). However,

issues quickly arose as break downs in supply chains, accurate testing, and supply versus demand quickly incapacitated laboratories in the United States and across the world.

First, scientists had issues with defining the clinical sensitivity of SARS-CoV-2 real-time PCR because the virus is more prominent in one area of the body compared to another depending on the time of infection. [83] This predicament quickly induced mistrust in the tests and the laboratory technicians performing the tests due to the high variability in test accuracy. Then, there was the persistent issue with supply chain shortages throughout the first six months of the pandemic. Laboratories were struggling to secure test reagents, pipette tips, well plates, and swabs. [83] This dilemma brought forth an innovative yet controversial technique of specimen pooling. Specimen pooling allowed laboratories to run multiple samples at a time, while reducing the amount of reagent and other resources used. [83] Corresponding, with shortages in supplies and staffing, people waited weeks to secure a test, waited hours in testing lines, and in the end had to wait days to weeks to receive their results. The laboratory systems were not well adapted to handle such an extreme event as the COVID-19 pandemic.

Limitations

Many of the relevant studies included in this review do not come without limitations in study design, differences in study location, and potential limited generalizability. Randomized control trials are considered the gold standard for study designs in public health interventions but are rare in the grey literature and often inappropriate for analyzing behaviors and piloting evaluation tools and simulations. None of the studies screened in this review performed randomized control trials. Most studies were surveys, followed by literature reviews and cross-sectional studies. The cross-sectional studies focused on specific groups of people in a single

region or country which makes it difficult to draw generalizations across populations. Seven out of eighteen surveys pulled national participation. In these seven studies, results could be generalized to the nation's population that met participant criteria such as emergency department workers, physicians, and nurses. There was only one study that surveyed the entire population, and that was to gather information on psychological disaster preparedness during COVID-19 pandemic in India. [46]

Another limitation is that the review did not incorporate studies from every region in the world. Fifty percent of studies were conducted in the United States. Other countries had 1-4 studies analyzing their emergency preparedness (Table 1). Meanwhile, the literature search produced no studies conducted in Latin America or South America. It is unclear why these countries did not appear in the search considering the Pan American Health Organization has a specific health emergencies department that helps countries in the region strengthen emergency preparedness capacity. [13] One hypothesis is that these articles were published before 2015 or were written only in Spanish and Spanish-language journals, and therefore were excluded from the review. Another possibility is that these countries store guidelines and studies on emergency preparedness internally in their organizations and governments. This idea brings up the next limitation in conducting studies on preparedness capacity building. Public health professionals know that countries and organizations are participating in capacity building activities and guidelines. Unfortunately, most of the time the results of the tests and other capacity information are kept internal and rarely published in academic journals or on the country's or organization's website potentially due to cybersecurity concerns. This concept applies to countries and organizations located across the world. Additionally, even if

information were published on the country's website, it would require extensive searching to gather articles from every single website.

In terms of limitations within the review, systematic literature reviews are typically performed by at least two people to reduce bias, however, this review was conducted by one person. Therefore, there is the possibility of the introduction of bias into screening phases. Additionally, as more literature was screened, different key words were discovered that may have produced different results during the database search phase. Unfortunately, due to time constraints the literature was not searched using the new key words (domains, strategies, all-hazards).

4.2 Recommendations

Though the United States and other countries increased funding for mental health services during the pandemic, these services should have been available before the pandemic started. Mental health issues were a public health concern before the pandemic and then, were exacerbated by the pandemic. Permanent funding and resources should be allocated to health system's infrastructure and other mental health and substance use services to increase access and help. Further, real life simulation and exercises need to be performed on a regular basis and the results and recommendations from these activities should be implemented into action within 1 year of activity completion. As seen with Event 201, emergencies can occur at any length of time after a simulation or exercise. Therefore, recommendations should be implemented in a timely manner so future emergencies can be met with a prepared and fortified system. Further, as COVID-19 has revealed, limitations in laboratory capacity need to be addressed. More resources and infrastructure need to be put into reinforcing supply chains and the workforce. It has been over a year since this pandemic started, and there are still

restrictions in place on who and who cannot receive a test. There is a potential for SARS-CoV-2 to develop into a seasonal virus [84], and therefore, steps need to be employed to offset the perceived demands. Finally, further studies should be conducted once this pandemic is over to summarize gaps in preparedness systems that COVID-19 exploited. Further studies should also delve deeper into the grey literature that exists on government and organization websites to gain a more comprehensive view of what activities and preparedness strategies are being applied in different countries.

4.3 Conclusions

This review assessed the literature to determine what public health preparedness capacity building domains and strategies countries are currently implementing. Additionally, gaps in preparedness capabilities are discussed thoroughly in this review: healthcare worker training; laboratory capacity; and mental and psychological/psychosocial health preparedness. Each preparedness domain needs some level of capacity building to effectively prevent and respond to future pandemics, and natural and manmade disasters. Besides the gaps, some promising capacity building activities were discovered during the review that should be analyzed further. The question is not *if* but *when* a new disaster will occur and therefore policymakers, government officials, academics, and communities should efficiently evaluate what preparedness domains need strengthening and immediately start to implement capacity building efforts.

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