The Global Nursing Workforce and Disasters: A Mixed-Methods Study of Nursing and System Resilience

by

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Dedication

To my children, Eleanor and Iris, who challenge me daily to answer important questions, be silly, and work to build a kinder, healthier, and more just world.

To my husband, Kevin, for making laughter a daily requirement in our home, and the bullish persistence that I can, in fact, "figure it out."

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Abstract

Health system resilience has emerged as a crucial objective for health systems globally, yet the critical role of the nursing workforce in achieving resilience targets remains insufficiently understood. Bridging this knowledge gap is essential to harness the full potential of nurses in strengthening health system resilience and to prepare for future climate-related threats. This dissertation study uses a mixed-methods design focused on expanding collective knowledge of key predictors and evidence-informed strategies for developing health system resilience. This study includes a secondary data linkage and analysis of globally representative data sets exploring the relationships between the nursing workforce, disasters, and resilient health systems; a primary qualitative data collection and analysis of global nursing leaders' perspectives on nursing inclusion in the leadership and development of resilient health systems. Study aims are to 1) describe a reproducible and novel data linkage process using publicly available datasets; 2) examine the relationship between the global nursing workforce and population health outcomes within disaster contexts; and 3) identify the facilitators, barriers, and key contributions of the role of the nursing workforce in contributing to health system resilience during disasters. The research project utilizes data from reputable open-access sources—including World Health Organization National Healthcare Workforce Statistics, country-level health data from the World Bank, country-level disaster data from the Emergency Events Database (EM-DAT), and country-level health statistics from the World Health Organization—as well as qualitative data from key-informant interviews with global nurse leaders.

This study examines mechanisms to address resilience as well as population and community health by investigating approaches to mitigate avoidable disadvantages of populations at the macro level. Specifically, this study examines approaches to foster health equity by improving disaster readiness and leadership within the nursing workforce. Findings from this study are critical for shaping future policy and research

agendas, for better identifying key predictors of health system resilience, and for effectively and efficiently facilitating resilience and health equity during disasters.

Chapter 1 Introduction

Climate change is driving an increasing number of disasters globally (Kerry & Murthi, 2024). These events have severe and devastating effects on the most vulnerable populations (Mazdiyasni & AghaKouchak, 2020). In fact, approximately 74,000 excess deaths were attributed to disasters globally in 2023 alone (CRED, 2024). Health system resilience has emerged as a crucial objective for health systems globally, yet the critical role of the nursing workforce in achieving these targets remains insufficiently understood (Kruger & Bell, 2024; World Health Organization, 2024a). Bridging this knowledge gap is essential to harnessing the full potential of nurses in strengthening health system resilience and preparing for future climate-related threats. Although the COVID-19 pandemic highlighted the urgent importance of improving readiness and resilience to address unexpected events, it similarly brought to light the extreme vulnerabilities of most countries in response to unpredictable but increasingly frequent crisis events (United Nations Office of Disaster Risk Reduction, 2023). Innovative and targeted readiness intervention strategies are essential for preserving world-wide population health.

1.1 Statement of the Problem

The global nursing workforce is critical to the resilience of health systems, especially in the face of disasters. Nurses are the largest health workforce globally, representing more than 50% of the healthcare workforce, and they are most frequently on the front lines of disaster events as clinicians, leaders, and advocates (World Health Organization, 2020a). Health system resilience for all communities is imperative to improving health outcomes as well as preserving

health equity (Gaynor & Wilson, 2020; United Nations, 2019). The World Health Organization (WHO) emphasizes the need to develop resilient health systems to "ensure countries can effectively prevent, prepare for, detect, adapt to, respond to and recover from public health threats while ensuring the maintenance of quality essential and routine health services in all contexts, including in fragile, conflict, and violence settings" (World Health Organization, 2024e). The scoping review "How nurses contribute to global health system resilience" has shown that, although nurses are frequently the front-line workers responding to disasters, they are not consistently included in the development or leadership of resilient systems of health care (Kruger et al., 2024). Further, understanding the dynamics between nursing workforce capacity and health system resilience during disasters is essential for strengthening global health and meeting global health equity goals. Findings from this study are critical for shaping future policy and research agendas, better identifying key predictors of health system resilience, and developing effective and efficient strategies to facilitate resilience and health equity during disasters.

1.2 Purpose

Understanding how the global nursing workforce can effectively and efficiently contribute to health system resilience during disasters is critical for addressing health equity and preserving population health. The project is among the first to assess these complex relationships by applying sophisticated mixed-methods techniques using large, diverse, and longitudinal datasets, combined with in-depth qualitative interviews of global nursing leaders. The knowledge gained from this study supports ways to better identify both key predictors of resilience and effective interventions for developing resilience and fostering health equity.

1.3 Theoretical Approach

The conceptual framework for this study is grounded in the Health Systems Dynamic Framework: examining not only the health system within its specific context (i.e. country) but also the interplay of resources, leadership, and governance on service delivery and, therefore, on outcomes and goals of the population (Olmen et al., 2012) (Figure 1).

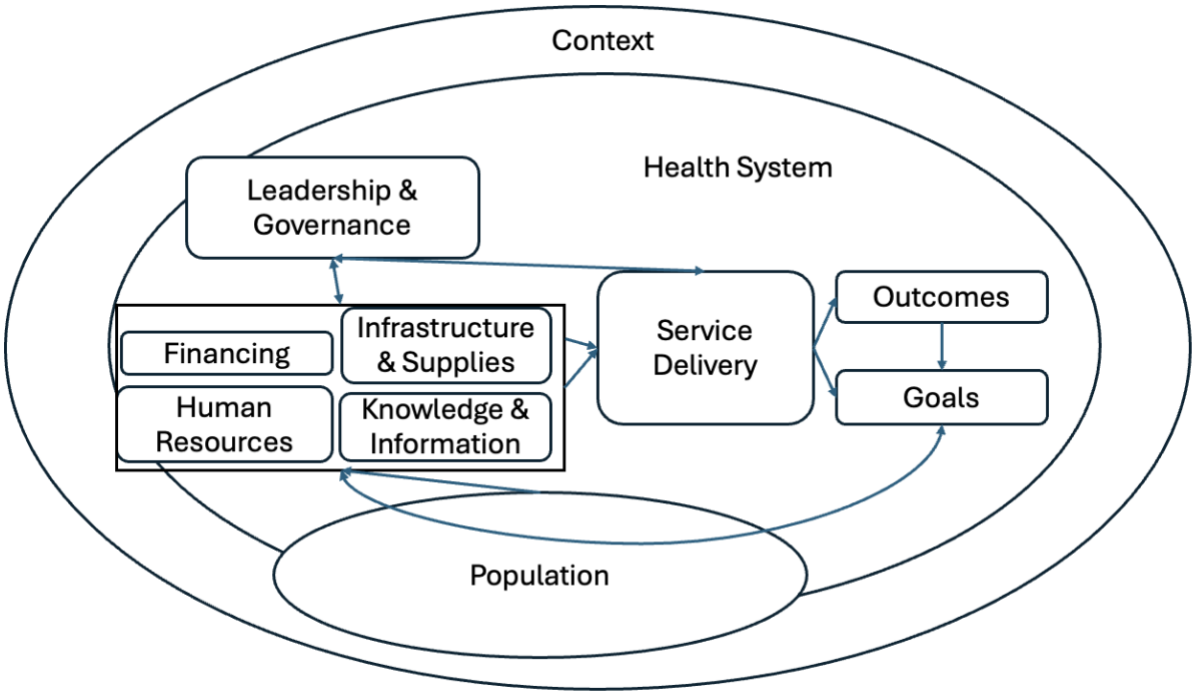

Figure 1. Health System Dynamics Framework (Olmen et al., 2012)

This framework is informed by the non-linear dynamical systems theory of complex adaptive systems described by Dooley (Dooley, 1997). By emphasizing the ability of health systems to absorb, adapt, and recover from emergencies, the framework provides a comprehensive and fluid approach that supports the development of robust leadership, effective communication, and strong interconnectivity. Additionally, this study is informed to a lesser degree by the Resilience Framework for Public Health Emergency Preparedness (RFPHEP) described by Khan et al. (Figure 2) (Khan et al., 2018). Because this framework—which describes the dynamic, interactive, and interdependent relationships that contribute to disaster resilience—is more

specific to the interaction between the healthcare workforce and disasters, this study uses it to examine the relationship between the nursing workforce and disasters. These elements identified in the RFPHEP are crucial for enhancing preparedness and ensuring a coordinated response to public health crises. Importantly, this study focuses on the following specific constructs of public health resilience—workforce capacity, practice and experience, adaptability, leadership, and planning process.

1.4 Specific Aims and Hypotheses

1.4.1 Aim 1: Develop and validate a reproducible and novel methodological, cross-country data integration process linking disaster exposure, health workforce density, economic context, and population level health outcomes.

This aim establishes a novel, transparent methodology for harmonizing heterogenous, publicly available global datasets (including disaster event records, nursing and physician workforce statistics, national economic indicators, and mortality outcomes) into a longitudinal country-year panel suitable for multivariate analysis. The described process addresses persistent challenges in global health systems research, including inconsistent variable definitions, temporal misalignments, missingness, and measurement error across sources. By creating a scalable and transparent data-merging methodology, this aim advances global health workforce research by enabling system-level analyses that have previously been constrained by fragmented and incompatible data infrastructures, while simultaneously supporting evidence-informed disaster readiness and workforce policy.

1.4.2 Aim 2: Examine the relationship between the global nursing workforce and population health outcomes during declared disasters.

Guided by the Health System Dynamics Framework (Olmen et al., 2012), this study use nursing workforce metrics (e.g., nurse-to-population ratios) from WHO Global Health Workforce Statistics, as well as data from World Bank World Development Indicators, Emergency Events Database (EM-DAT) to assess population-level outcomes (e.g., mortality rates) by country (all 194 WHO member countries) and respective disaster exposure. I subsequently use cross-sectional and longitudinal statistical models to determine the relationship between nursing workforce capacity, health system resilience, and population health outcomes.

H1: Nursing workforce characteristics (aggregate density) are positively associated with a decrease in mortality rates, controlling for disaster exposure.

1.4.3 Aim 3: Identify the facilitators, barriers, and key contributions of the role of the nursing workforce in contributing to health system resilience and health equity during disasters.

This study conducted in-depth interviews across a select group of global nursing leaders (e.g., directors of global NGOs, officers in national ministries of health, chief nursing officers of large health systems) to identify specific facilitators and barriers to encouraging nursing leadership and policy development in health system resilience. Using Resilience Framework for Public Emergency Preparedness, I have defined scalable resources, policies, and strategies that are both modifiable and generalizable across WHO member regions.

Chapter 2 Review of the Literature

This chapter begins with an overview of the contexts of disasters and health system resilience, followed by an in-depth investigation into the contributions of the global nursing workforce within this sphere. Also included is a previously published scoping review examining the current empirical studies exploring the contributions of the global nursing workforce in relation to the development and leadership of resilient health systems. Throughout this chapter, I synthesize the gaps in the literature and explain how my study addresses the identified gaps.

2.1 Disasters

Climate change and its resulting impacts will be the largest global health threat of the 21st century (Pan American Health Organization, 2024). In 2023 alone, there were 399 natural hazard-related disasters, affecting 93 million people globally (CRED, 2024). It is well established that these events disproportionately impact already disadvantaged and vulnerable populations, thereby widening health disparities through immediate physical injuries and deaths, subsequent mental health concerns, infectious disease outbreaks, exacerbations of chronic illness, long-term displacement, and infrastructure loss (Gaynor & Wilson, 2020; Mazdiyasni & AghaKouchak, 2020; United Nations, 2019). Defined by the United Nations Office for Disaster Risk Reduction (UNDRR), disasters are "a serious disruption of the functioning of a community or a society involving widespread human, material, economic, or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources" (United Nations Office of Disaster Risk Reduction, 2007a). Fitting within this

definition are disasters associated with extreme weather events and pandemics. Disasters exacerbate health inequities by disproportionately impacting vulnerable populations, who often have less access to healthcare resources and support systems, leading to higher morbidity and mortality rates among vulnerable groups (United Nations, 2019). Socioeconomic drivers such as poverty and lack of education can limit disaster preparedness and recovery efforts, further entrenching health inequities in affected populations (Mazdiyasni & AghaKouchak, 2020). Climate-induced/climate-related disasters are also notably associated with other disasters, including conflicts, terrorism, and migration, which have deep and lasting impacts on human health (Telford, 2023). Resource scarcity, civil disruption, and ecological threats all contribute to overall population level health outcomes (Scheffran, 2020; Telford, 2023). Although the estimates vary, global data suggests that 74-83% of disasters are directly attributable to, or made more severe because of, climate change (Environment, 2023; Prater, 2024). Therefore, for the purpose of this study, disasters of all nature and etiology are included.

2.1.1 Key Trends

With overall global temperature averages having risen by approximately 1.1°C (1.89°F) above pre-industrial levels, the United Nations body for assessing the science related to climate change—the Intergovernmental Panel on Climate Change (IPCC)—reports widespread and rapid changes to the global climate (Lee et al., 2023). Specifically, the IPCC attributes to human influence the warming of the atmosphere, ocean, and land, which cause droughts, sea-level rise, heatwave extreme, heavy precipitation, and tropical cyclones (Lee et al., 2023).

2.2 Future Projections

The IPCC reports estimate with high confidence that global warming and resultant climate change will continue to worsen over the next two decades without rapid and dramatic mitigation

efforts to reduce greenhouse gas emissions. Subsequently, continued global warming is projected to exacerbate heatwaves, intensify tropical cyclones, and create weather conditions that cause wildfires. Furthermore, with every incremental increase in global temperatures, climate change risks are projected to become more complex, with resultant impacts more difficult to manage (Lee et al., 2023).

2.2.1 Health Impacts of Climate-Induced Disasters

Climate change has variable impacts on human health, both directly and indirectly. Exposure to extremes in heat, droughts, floods, and extremes in heat--as well as to subsequent vector, food, and waterborne infectious diseases--has deep and lasting consequences for individual and community health (Ebi et al., 2018). Direct health impacts from climate-induced disasters are injuries and fatalities that can be attributed to the disaster, such as trauma from debris, drowning, and heat-related illnesses, including heat-stroke and burns (Pan American Health Organization, 2024). Beyond the initial direct impacts, disasters often lead to lasting and entrenched indirect health impacts, which are often difficult to anticipate. Broadly, climate-induced disasters can affect respiratory diseases, food- and water-borne disease transmission, vector-borne disease prevalence and distribution, food and water insecurity, forced displacement, subsequent mental illness, stress, and exacerbation of chronic illnesses (Pan American Health Organization, 2024).

2.2.2 Vulnerable Populations

Climate-induced disasters often unevenly affect populations, worsening health outcomes for already marginalized and vulnerable communities (Gan et al., 2021). It is well established that income inequality disproportionately distributes the effects of disasters across countries and contributes to significant variation within a country (Ngcamu, 2023). These populations include

those with socio-economical vulnerabilities, such as low-income individuals, indigenous groups, refugees, displaced persons, people with disabilities, and such healthcare-dependent populations as women, children, and older adults (Gan et al., 2021; United Nations, 2019). Similarly, with migration and development trends, vulnerable populations also include urban poor who live in densely concentrated settlements, in communities of Small Islands Developing States (SIDS), and in coastal regions at greatest risk of erosion, rising sea levels, and extreme weather events (Intergovernmental Panel on Climate Change, 2016).

2.2.3 Economic Impacts of Climate-Induced Disasters

The economic impacts of climate-induced disasters are increasingly staggering. In 2024, the top 10 most costly climate-induced disasters globally caused $229 billion in measured damages (Christian Aid, 2024). While the direct economic costs are often the highest in such developed and high-income countries (HIC) as the United States, climate-induced disasters have more significant indirect economic effects on developing countries, most likely attributable to the significant negative effect disasters have on economic growth (Botzen et al., 2019; Klomp & Valckx, 2014).

2.2.4 Mitigation and Adaptation Strategies

Mitigation and adaptation strategies aim to identify actions that "reduce anthropogenic [human induced] influences on climate" as well as "help human and natural systems accommodate changes." (Lawler et al., 2013, para 1). Primary mitigation strategies focus on reducing greenhouse gas emissions and sequestering carbon from the atmosphere. The scientific consensus suggests that current mitigation strategies are insufficient (United Nations Office of Disaster Risk Reduction, 2020). Primary adaptation strategies aim to minimize the impacts of climate-induced disasters by improving resilience and capacity to cope with climate risks,

including investments in resilient infrastructure, ecosystem restoration, development of early warning systems, and prioritization of disaster risk-reduction strategies (Lawler et al., 2013; Solecki et al., 2011).

2.2.5 Disaster Risk Reduction

Disaster risk reduction aims to prevent and reduce disaster risk as well as manage residual risk (United Nations Office of Disaster Risk Reduction, 2007b). These strategies, as outlined in the Sendai Framework for Disaster Risk Reduction 2015-2030, target "preventing the creation of disaster risk, the reduction of existing risk, and the strengthening of economic, social, health, and environmental resilience" (United Nations Office of Disaster Risk Reduction, 2007b). Key disaster risk-reduction strategies aim to address many underlying risk factors, most notably poverty and inequality, climate change, and unplanned urbanization (United Nations Office of Disaster Risk Reduction, 2007b).

2.2.6 Adaptation in Health Systems

To more effectively address climate change adaptation strategies within health systems, WHO developed the "Operational Framework for Building Climate Resilient Health Systems" (World Health Organization, 2023a). This framework consists of 10 integrated components, framed within the WHO building blocks of health systems, with a specific focus on developing a climate-smart health workforce. In addition to being able to engage in climate health policy, research, and service delivery, a climate-smart health workforce should be trained to prepare to respond to climate risks (World Health Organization, 2023a).

2.2.7 Global Collaboration

In November 2024, the UN Climate Change Conference (COP29) concluded with two key financing and global collaboration agreements: increase financing to developing countries to USD $300 billion annually by 2035; and secure collaboration to increase funding from "all actors" to developing countries by 2035 annually by USD $1.3 trillion (UN Climate Change, 2024). Similarly, recognizing that climate change requires global cooperation, there was agreement to empower all stakeholders—philanthropy, Indigenous Peoples, youth, international organizations, business, civil society, and scientists—to engage in climate action (UN Climate Change, 2024).

2.3 The Role of Global Health Policy in Resilience

Scholars and practitioners have proposed varying definitions of global health, ranging from an area of practice, study, and research that places a priority on improving health and achieving equity in health for all people (Koplan et al., 2009) to models ensuring health-promoting and sustainable sociocultural, political and economic systems (Janes & Corbett, 2009; Stillwell, 2025). Because "global health implies planetary health, which equals human, animal, environmental and ecosystem health" (Kahn et al., 2014; Stillwell, 2025), global health policy is deeply intertwined with climate change and climate-induced disasters.

2.3.1 Influences on Global Health Policy

Global health policy, while emphasizing transnational issues, is also attempting to disentangle from country and context specific concerns, priorities, and policies (Koplan et al., 2009). To best account for across-country health differences and identify transnational solutions, it is critical to first understand the key economic, political, and sociocultural factors influencing global health policy (Koplan et al., 2009).

2.3.2 *Economic Factors*

Global health policy is multifactorial, complex, and dynamic. Primary economic factors driving health policy on a global scale are per country economic growth and GDP (gross domestic product), with high-income countries (HICs) typically allocating more resources to healthcare than low- to middle-income countries (LMICs) (Banks et al., 2020). For HICs, individual government revenue, primarily through taxation, acts as the principal funding mechanism (Charani et al., 2022). For LMICs, however, healthcare funding is often provided through foreign aid, whether via non-governmental organizations (NGOs), private-public partnerships, or multilateral global payers and lenders such as the World Bank, International Monetary Fund (IMF), and the Global Fund (Charani et al., 2022; Viergever & Hendriks, 2016). Where global economic power is concerned, purchasing power parity (PPP) rates—rather than gross domestic product (GDP)—allow for the most equitable cross-country, cross-context comparisons (Organization for Economic Cooperation and Development, 2024).

Notably, higher investments in healthcare do not uniformly equate to increased population health outcomes. In the United States, health spending in 2024 was $4.9 trillion—consistently the highest in the world during that time period; at the population level, though, metrics such as life expectancy and maternal mortality continued to worsen (Amin et al., 2024). Other HIC countries (such as Sweden, Denmark, and Iceland) have consistently demonstrated more favorable population health outcomes, which researchers and clinicians have largely agreed can be attributed to significant and consistent investments in primary care and universal health coverage (Janlov et al., 2023).

Over the last 20 years, the United States recognized the importance of investment in global health—and thereby global health security—with significant support and expansion of United States Agency for International Development (USAID), as well as the passage and

continued financial support of the President's Emergency Plan For AIDS Relief (PEPFAR) (Congressional Research Service, 2025; State Department, United States, n.d.). With its annual financial support of $43.4 billion USD, impacting 130 countries, the United States' decision in early February 2025 to abruptly freeze foreign aid and international development funds (Congressional Research Service, 2025; The Guardian, 2025) is especially concerning for global health security and the preservation of human life. It remains unclear to what extent, both economically and humanitarian-wise, these massive political shifts will affect global health, security, policy, and development.

2.3.3 Political Factors and Power Dynamics

Despite prior calls to push policy towards evidence-based decision-making, and more recent calls for removing politics from global health policy-making, it is clear that local, national, and transnational politics are inseparable from global health policy-making (Gómez et al., 2022). By framing global health policy through the "interconnected concepts of interests, ideas, and institutions," it's possible to begin to understand the complex dynamics that politics bring to global health (Gómez et al., 2022).

Concerningly, at the beginning of 2025, amid political upheaval, the United States withdrew from the World Health Organization (Rosen, 2025). Although this exit will take a full year to finalize, the loss of the United States as a member to the WHO will have deep and lasting effects (Rosen, 2025). As the largest donor to the WHO, the United States contributed $1.25 billion USD in 2022-2023, and this loss of funding will result in challenges to global disease surveillance, data sharing, vaccinations, and management of humanitarian emergencies. Scholars and public health experts warn that this withdrawal will likely put the United States, as well as some of the world's poorest countries, at heightened public health risk (Rosen, 2025).

Additionally, scholars are concerned that this power shift will result in research and leadership vacuums, with unclear resolutions (Le Page, 2024; Rosen, 2025).

In a perceived rebuttal to liberalism, far-right politics have gained popularity and traction in the United States, as well as across Europe. These political parties often support isolationism and white nationalist ideals, and so they reject supporting social systems that value a "welfare state." While these ideological and political shifts likely reflect a growth in economic frustrations related to lasting challenges from the COVID-19 pandemic, they also reflect cultural and social angst related to forced migration and refugee crises around the world (Bieber, 2020; Hovis, 2024).

2.3.4 Cultural and Social Factors

Increasingly, scholars and practitioners have widely recognized that global health requires a transnational and transdisciplinary approach to move global health beyond a "collection of problems" (Farmer et al., 2013). Specifically, there have been increasing calls to make changes in global health practice and policy to address deeper structural issues (Arya & Allison, 2018; Guzmán, 2022).

By incorporating social and cultural competence and by refocusing the context in which persons and communities live, practitioners of global health can develop and implement more effective health strategies (Guzmán, 2022; Holst, 2020). It is estimated that 30-55% of health outcomes can be attributed to the social determinants of health (World Health Organization, 2025e) (See Figure 5). Similarly, by excluding these key factors of health outcomes when examining interventions and implementation strategies, one risks creating narrowly focused, siloed, and even harmful approaches to human health solutions (Farmer et al., 2013; Holst, 2020). Given this evidence, it is especially concerning for both global health and global security

that the United States is currently undergoing massively destructive and narrow-minded policy and ideological shifts (Wendling, 2025)

2.3.5 Global Disasters/Crises

Within the last five years, the world has seen dramatic shifts in global health policy, largely related to global disasters and emergencies. Notably, the COVID-19 pandemic has and continues to have broad and lasting impacts on reshaping policy priorities. There has been a global shift in political tone of many countries—moving increasingly nationalistic and isolationist, despite concerns that climate-induced disasters, pandemics, and even regional conflicts and violence are no longer contained within national borders (Rieder, 2016).

Over the last decade, climate change has increasingly driven health policy evolution. The Paris Agreement, an international treaty adopted in 2016, aimed to address global temperature increases and limit global warming to mitigate the severe risks from continued climate change (United Nations Climate Change Conference, 2015). The WHO released in 2020 the Global Strategy on Health, Environment, and Climate Change in response to member-state recognition of the overwhelming need for forward directions in the face of climate-related risks (World Health Organization, 2020c). Similarly, individual countries are increasingly incorporating climate risks into UHC frameworks; but the majority of the committed members are LMICs, and the United States—a top carbon emitter—withdrew from the Paris Agreement in early 2025 (*US Withdrawal from the Paris Agreement*, 2025; World Health Organization, 2021).

2.3.5.1 Inequities in Decision-Making

Broad and pervasive power imbalances permeate global health governance structures. Historically, decision-making and agenda-setting has taken a top-down approach. More recently, calls for "de-colonizing" global health and global health policy have sought to address long-

standing structural inequalities. Frustratingly, decolonization efforts currently rest in the hands of the self-aware few, and no current mechanism exists to force change for the powerful and myopic many (Lencucha, 2024).

A report from Politico in 2022 identified the glaring inequities in decision-making in the context of COVID-19. Four globally focused NGOs, without oversight or regulation, directed $10 billion in spending efforts, slightly more than the entire budget for the WHO in the same year (Banco et al., 2022). This is a lived and well-known reality of LMICs and disempowered countries: power and subsequently decision-making rests in the pocketbooks of the wealthy.

2.3.5.2 Power Sharing in Global Health

Given the multitude of agendas, priorities, and power imbalances, it is no wonder that efficiencies in global health are plagued by the fragmentation of efforts, lack of coordination among stakeholders, and duplication of initiatives. This fragmentation of efforts also leads to asymmetry in power dynamics and agenda-setting. For example, a more recent study which examined the funding priorities for developmental assistance for health, found that the three top funders—the United Kingdom, the United States, and the Bill and Melinda Gates Foundation—are the largest funders of the Global Fund, WHO, World Bank, US Foundations, UN organizations and GAVI (Bermudez & Prah, 2022). This raises the concern that a large percentage of global health agenda-setting is dictated by only three Western entities, potentially deprioritizing Global South priorities.

2.3.6 The Sustainable Development Goals

The Sustainable Development Goals (SDGs), stemming from the 2030 Agenda for Sustainable Development of the United Nations, targets 17 goals for global sustainable development and provides the "world's roadmap for ending poverty, protecting the planet and

tackling inequalities" (United Nations, 2015a). Figure 8 outlines the SDGs to be addressed by the proposed research. Specifically, this study focuses on improving education and capacity-building, both of which relate to SDGs 4 and 9: ensuring inclusive and equitable quality education and building resilient infrastructure (United Nations, 2015a). In strengthening disaster resilience in the context of climate-related disasters, this study aligns with SDGs 3 and 13. In addressing gender and health access equity, this study supports SDGs 5 and 10. Finally, by emphasizing the need for nursing leadership in systems and policy development, this study addresses SDGs 8 and 16 (United Nations, 2015b).

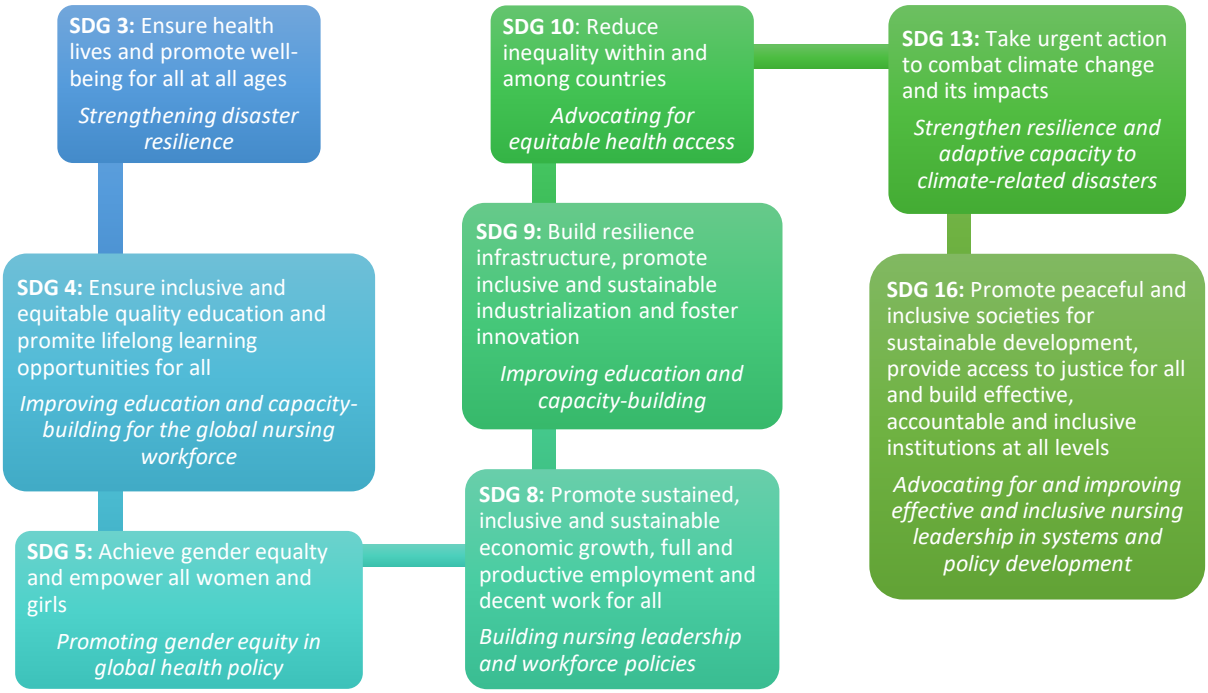

Figure 2. Sustainable Development Goals and Associated Outcomes of Proposed Research (United Nations, 2015b)

2.4 Global Health Systems

WHO defines health systems functionally as "all the activities whose primary purpose is to promote, restore or maintain health" (McKee, 2010). Specifically, these activities include health promotion, disease prevention, treatment and rehabilitation, and public health emergency preparedness. Global health systems include two more things: 1) the national health systems in

place for each of the 194 WHO member-states (192 United Nations member-states plus the Cook Islands and Niue; WHO will continue to include data from the United States despite its exit in 2026) and 2) the transnational global health actors, including NGOs and private funders, which are often more nebulous and difficult to account for (Hoffman & Cole, 2018).

2.4.1 *Key Components of Global Health Systems and Building Blocks of Resilience (World Health Organization, 2010a)*

Although no clear universal operational framework for health system resilience is agreed upon, commonly used measurement indices for resilience are the WHO's six building blocks of a health system framework (See Figure 9): 1) service delivery; 2) health workforce; 3) health information systems; 4) access to essential medicines; 5) financing; and, 6) leadership/governance. The six building blocks contribute to strengthening a health system by reflecting both inputs and outputs of a health system (World Health Organization, 2010a). Notably, this framework is limited and doesn't fully account for other influences, particularly people (i.e., the human factor) and quality (Jordan et al., 2018; World Health Organization, 2025a). Despite these limitations, the six building blocks remain the most commonly utilized indices of health-system functioning (Jordan et al., 2018).

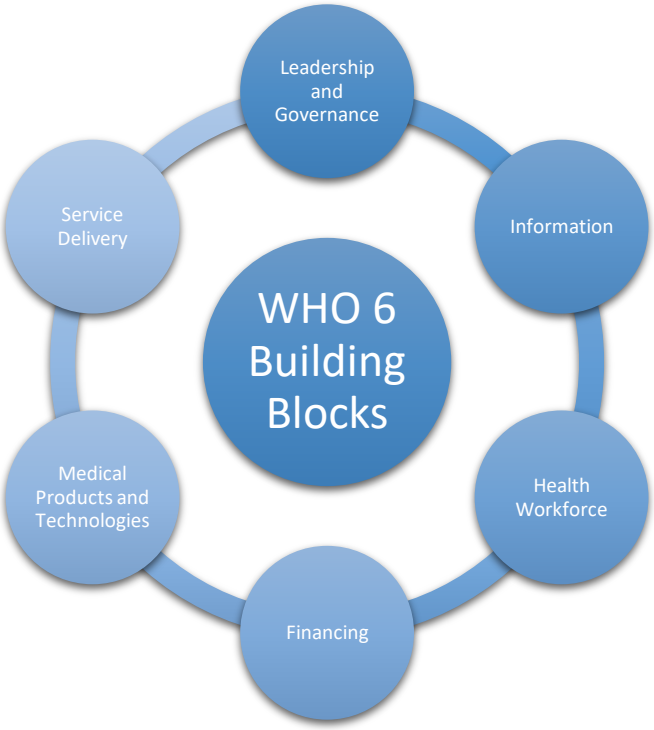

Figure 3. WHO 6 Building Blocks of Resilience (World Health Organization, 2010a)

2.4.1.1 Governance and Leadership

The role of governments, international organizations (WHO, UN), and NGOs is complex and they provide critical functions of all health systems (World Health Organization, 2010a). Within disaster contexts, this building block is essential for crisis management, as the implementation of policy-making and regulation, collaboration, and accountability mechanisms directly impacts the function of the respective health systems (World Health Organization, 2010a).

Health-system governance should be measured according to five criteria: 1) solidifying an understanding of how services are supplied; 2) financing to ensure that adequate resources are available to deliver essential services; 3) performance around the actual supply of services; 4) receipt of relevant information to evaluate or monitor performance; and 5) enforcement, such as imposition of sanctions or the provision of rewards for performance (Borghi & Brown, 2022;

World Health Organization, 2010a). Arguably—and in contrast to the layout of figure 4—effective and responsive leadership and governance form the pillar on which the other five building blocks stand.

2.4.1.2 Health Workforce

The health workforce is defined as "all people engaged in actions whose primary intent is to enhance health" (Borghi & Brown, 2022; World Health Organization, 2010a). Components of an effective workforce include nurses, physicians, community health workers, and allied health professionals. Retaining an adequately trained, satisfied, and appropriately distributed health workforce is essential to meeting population health goals, as well as for adapting to, responding to, and recovering from public health emergencies (Khan et al., 2018; World Health Organization, 2024a).

2.4.1.3 Health Service Delivery

As defined by the WHO, health service delivery is an "immediate output of the inputs into the health systems, such as the health workforce, procurement and supplies, and financing" (World Health Organization, 2010a). These outputs include preventative, curative, rehabilitative, and palliative care provided at all levels of the health system. As with the other building blocks, health service delivery is interdependent with the function of, and the investments made to and by, the other building blocks. The ability of a health system to deliver necessary care to its population is entirely reliant on the resource inputs at the local, national, and global levels (Borghi & Brown, 2022).

2.4.1.4 Financing

Health financing is defined as the "mobilization, accumulation, and allocation of money to cover the health needs of the people, individually, and collectively" (World Health

Organization, 2007). Financing sources vary considerably both within and across countries and include government budgets, donor funding, insurance schemes, global funding mechanisms (The Global Fund, the Global Alliance for Vaccines Initiative, World Bank, and IMF). This fragmentation of financing sources can lead to inefficiencies and inequality of resource distribution (Borghi & Brown, 2022). Therefore, more recently, global governing bodies—WHO and United Nations—have emphasized the goal of Universal Health Coverage (UHC) in all countries (World Health Organization, 2023b). An emphasis on UHC, with a refocus on primary health care, is purported to support more sustainable health financing and lower costs, while achieving 90% of the essential health services (World Health Organization, 2023b).

2.4.1.5 Medicines and Technology

As evidenced throughout the COVID-19 pandemic, medicines and technology are critical to the resilience of health systems; however, these are not equitably distributed throughout the world (Gaynor & Wilson, 2020). Resilient health systems require consistent and reliable access to essential medicines and medical devices. Upstream, this requires health systems to function alongside reliable, stable, decentralized, and regulated supply chains. The COVID-19 pandemic cruelly highlighted these relationships with the global shortage of personal protective equipment (PPE). Prior to the pandemic, China manufactured 50% of the global supply of surgical masks, and was the singular producer of mass-produced clinical gowns (Burki, 2020). When the pandemic exploded in China, the rest of the world scrambled to source PPE, and in many ways failed to safeguard their health workforce, resulting in unnecessary deaths and continued disease transmission. Similarly, in response to the global system, which relies on each country's power to negotiate with manufacturers, the COVAX scheme was developed to negotiate affordable vaccines for lower income countries. Even here, participation is voluntary, and there was

continued broad variability in the distribution of COVID vaccines; in one case, Canada reserved four vaccine courses per person, while some LMICs had less than one course for every two people (Borghi & Brown, 2022; So & Woo, 2020).

2.4.1.6 Health Information Systems

Resilient health systems require reliable and efficient information systems to facilitate decision-making (Borghi & Brown, 2022). The functions and effectiveness of the other building blocks are interdependent on the ability for health information systems to 1) generate data, 2) compile data, 3) analyze and synthesize data, and 4) communication and use data (Borghi & Brown, 2022). Increasingly, to facilitate decision-making and resource allocation, resilient health systems utilize and maximize technology in health monitoring and surveillance. Unsurprisingly, many countries lack these capabilities, and others lack integrated information systems, limiting the overall effectiveness of communication and data generation. Because of these local limitations, HIC and global multilateral organizations often lead these efforts, usually with limited nursing input. Because these non-local organizations often disregard local context and data collection mechanisms, the gathered data can appear unreliable and fail to be transparent (Borghi & Brown, 2022; International Council of Nurses, 2022a).

2.5 Health System Resilience

Health system resilience is an emerging concept, with numerous definitions and varying conceptualization without consensus (Abrahmson et. al., 2015; Bandari et al., 2020; Bergeron et al., 2017; Lafond et al., 2022; Kruk et. al., 2015; Poroes et al., 2023). The term refers to a newer concept, particularly within global health literature (Ling et al., 2017). Use of the term or concept "health system resilience" in the literature largely emerged after the Ebola epidemic in West Africa in 2014 (Meyer et al., 2018). The concept gained additional importance within the context

of COVID-19, and despite a significant increase in the number of published articles on health system resilience within the last several years, no single definition or universal understanding of the concept's essential components has emerged (Borzuchowska et al., 2023; Burke et a., 2021; Bingwaho et al., 2022; Paschoalotto et al., 2023; Zhao et al, 2023). Climate change, global sociopolitical disruption, terrorism, and the ever-present threat of pandemics all highlight the urgent need to develop an operationalizable framework for planning, building, and predicting health system resilience (Cassella, 2023; Ridde et al., 2019; WHO, 2021).

Building on the term's use in global health literature, this study advocates for understanding health system resilience as "the ability of health systems not only to prepare for shocks, but also to minimize the negative consequences of such disruptions, recover as quickly as possible, and adapt by learning lessons from the experience to become better performing and more prepared" (OECD, 2023). That is, resilient health systems are capable of absorbing shocks, while maintaining core functions and adapting to new challenges, each of which is essential for ensuring continuous and equitable healthcare delivery during and after disasters (Kruk et al., 2015; World Health Organization, 2024e). The COVID-19 pandemic, in particular, highlighted significant vulnerabilities in health systems worldwide, revealing the need for more robust frameworks that can withstand such disruptions (Foroughi et al., 2022). This understanding of the concept is important because research indicates that such resiliency in health systems can not only improve immediate crisis response but can also contribute to long-term public health outcomes by building capacity, enhancing preparedness, and promoting sustainable health practices (Burau et al., 2024; Copeland et al., 2023; Forsgren et al., 2022). As global health threats become more complex, the study of health system resilience provides valuable insights

for policy making, resource allocation, and the development of interventions that can mitigate the impact of future emergencies.

Furthermore, the resilient health systems this study promotes should emerge from a shock or disruption with improved preparedness and readiness for future shocks/disruptions (Augustynowicz et al., 2022). This readiness facilitates a sustainable cycle of preparedness, responsiveness, and resilience. By having a resilient health system, the community can expect quality of care, safety, and equity to be maintained (Poroes et al., 2023).

While there is significant discussion in the literature surrounding individual nursing and nursing workforce resilience (Henshall et al., 2020; Kunzler et al., 2020; Mcdonald et al, 2016; Yu, F., et al., 2019), the discipline of nursing is all but omitted in the examination and discussion of health system resilience (Kruger & Bell, 2024). To correct this omission, nurses must be actively involved in developing more resilient health systems. Approximately 28 million people comprise the global nursing and midwifery workforce, accounting for nearly half of the global health workforce (WHO, 2022). Nurses, as the largest profession within the global healthcare workforce, are often the only healthcare providers available in communities. Despite this, nursing's voice and influence have not historically matched the nursing profession's unique significance in global health (Salvage & White, 2020). Climate-induced disasters are continuing to increase beyond the world's current rates of adaptation and mitigation; therefore, to meet global health goals, address the changes and threats associated with global climate change, and meet the needs of aging populations, nurses must be at the forefront of developing sustainable and resilient health systems.

2.6 The Global Nursing Workforce

Nurses, comprising more than 50% of the global healthcare workforce, largely form the backbone of health systems around the world (Boniol et al., 2022a). Importantly, current projections suggest a global shortage of 18 million healthcare workers by 2030, of which 13 million of those missing professionals will be nurses (Boniol et al., 2022a; International Council of Nurses, 2022a). Over the past five years, ICN and the WHO have described the current and looming shortage of these essential health workers as a global health emergency, urging governments around the world to act immediately (International Council of Nurses, 2022b, 2024; World Health Organization, 2020a). Understanding the historical context, diverse roles, current state, and characteristics of the global nursing workforce is imperative to addressing the resilience of health systems and preserving population health.

2.6.1 History and Development of the Nursing Workforce

Considered the founder of modern nursing, Florence Nightingale revolutionized nursing during the Crimean War in the mid-1800s, moving the practice of nursing beyond volunteer caregiving, with early glimpses into nurses focused on sanitation and hygiene (Karimi & Masoudi Alavi, 2015). Soon thereafter, the establishment in 1860 of the first nursing school, the Nightingale Training School at Saint Thomas Hospital, initiated formal nursing education (Moody, 2021). Next, recognition and attention to the professionalization of nursing continued in the United States, and then gradually more globally throughout the late 1800s, often coinciding with wars, military engagements, and colonial expansion (Lusk, 2023).

By the end of the 19th century, nursing was formally established as a profession, with early recognition of the need for both regulation and global collaboration (Lusk, 2023). In 1899, the International Council of Nurses (ICN) was established, “born and raised on the busy

intersection of women's rights, social progressivism, and healthcare reform" (Lynaugh & Brush, 1999). In ways unforeseen by ICN's founders, these intersecting challenges remain deeply and problematically connected with the identity of the nursing profession.

By the mid-20th century, spurred by the needs of World War I and World War II, nursing roles expanded and were elevated in both the military and civilian realms, a significant response to changing healthcare needs and societal shifts (da Silva & Ferreira, 2021). In the later 20th century, nursing continued to expand education and training options, with the development of university, doctoral, and advanced practice programs (*1960 - 1989*, n.d.).

The "modern era" of nursing has unique challenges. In addition to the increasingly more complex health needs of ever-growing aging populations and the global burden of disease transmission, nursing is also dealing with the impact of globalization and migration, a new emphasis on advanced practice roles and specialization, and unstable workplace conditions affecting the persistence and availability of the global nursing workforce (International Council of Nurses, 2022b).

2.6.2 Distribution and Characteristics of Global Nursing Workforce

The global nursing workforce is estimated to consist of 29 million nurses worldwide (World Health Organization, 2022b). On average, there is a nursing density of 37.7 per 10,000 people, although this varies broadly around the world; from 4.5 per 10,000 at the lowest in Afghanistan to 118.8 at the highest in the United States (World Health Organization, 2024c). There is significantly unequal distribution of nurses globally, with more inequality across the world than in countries with high human development indices (HDI). Specifically, 80% of nurses are concentrated in countries with the highest Human Development Index (HDI) groups (Kharazmi et al., 2023). Additionally, regional disparities of nursing distribution highlight

geographical inequalities within countries: the poorest countries and those with severe nursing shortages have the highest rates of maldistribution (Boniol et al., 2022a). Further, while the recommendations for baseline nursing density for basic health system functioning is 2.5 medical staff per 1,000, over 50% of WHO member-states have fewer than three nursing personnel per 1,000 population (World Health Organization, 2024h).

The global nursing workforce is additionally demographically skewed, with varying demographics across income levels, gender composition, and age distribution. While the nursing profession is predominately female—76.9% of nurses are women—this percentage is higher in high-income countries, where 87.44% are female, and much lower—and more equally distributed—in lower income countries (Kharazmi et al., 2023). Interestingly, although the United States is experiencing an aging nursing workforce, with advocates concerned about significant workforce declines due to retirement, globally the nursing workforce is much younger, with nearly 30% falling in the 35 to 44 age group (American Nurses Association, 2017; Kharazmi et al., 2023).

2.6.2.1 Education and Training

Important barriers to consistently understanding, categorizing, and analyzing the global nursing workforce are the broad range of titles, paths to education, and regulation variability. In 2020, the U.S. National Council of State Boards of Nursing reported that at least 220 titles are attributed to nurses around the world (National Council of State Boards of Nursing, 2020). Similarly, the State of the World's Nursing report suggests there are 144 distinct titles for nurses (World Health Organization, 2020a). These inconsistencies make cross-country comparisons difficult, particularly given the underlying challenges with data reporting and collection.

Just as there are many titles for nurses around the world, there are across countries almost uncountable paths to education and training, as well as multiple levels of specialization and delineation. A somewhat unifying factor is the worldwide emphasis on continuing professional development to maintain licensure or authorization to practice, with 72% of jurisdictions requiring some form of continuing education (National Council of State Boards of Nursing, 2020).

Within the global nursing workforce datasets from the WHO, it is imperative to note that each country is self-reporting these values and using its own interpretation of the nursing role, a role that varies widely and can range from nursing assistants to advanced practice nurses (World Health Organization, 2024g). Because of this variability in role definitions, the Global Alliance for Leadership in Nursing Education and Sciences (GANES) has developed global education guidelines to invest in nursing education to better achieve consistency across nursing roles and definitions (Baker et al., 2021).

There are severe implications for the continued development of the nursing workforce with some forecasting suggesting nursing PhD enrollments will continue to decline over the next 10 years, thereby impacting the ability to train new nurses, as well as limiting nursing research, leadership, and policy developments (Halabicky et al., 2024; Stillwell, 2025). The problem is clearly expressed by a nursing leader in an interview found in a study examining barriers to nursing leadership (Newman et al., 2019):

> I must say..the challenges we face in leadership is recognition. I remember what pushed me to do a PhD. I went to a meeting after my masters' degree. I had a colleague of mine with a PhD and every time she spoke, everybody would listen. And me with my masters, I would say the same points, and nobody would acknowledge me. So, I said to myself: this is a status issue. So, I decided I should get my PhD. I also knew it was because I was a woman. Because men, if they speak even without a PhD, many times they receive recognition. And, also because many positions in our country is held by men.

As she explains, for nurses to be heard, they must pursue the highest level of education, a factor that complicates the nursing workforce development.

2.6.2.2 Workplace Conditions & Workforce Migration

Despite consistently being ranked among the most trusted professions globally, nursing remains a dangerous and sometimes unrewarding (financially and otherwise) profession. During COVID-19, 115,000 front-line healthcare workers, many of them nurses, died largely as a direct result of inadequate workplace protections (International Council of Nurses, 2021a). Globally, nursing workforce conditions remain poor and reflect underinvestment in the workforce. These conditions, including inadequate pay compounded with a persistent gender-pay gap, violence against nurses, and short staffing, have directly exacerbated the global nursing shortage (Catton, 2025). ICN forecasts the global shortage to only worsen by 2030, projecting a deficit of over 13 million nurses (International Council of Nurses, 2024). Most concerningly, the majority of these vacancies are anticipated in LMICs, which will only deepen existing disparities between the "haves and have nots" in both workplace conditions and health outcomes (Catton, 2025).

As HICs seek to ameliorate their own nursing shortages, their ethical and unethical recruitment practices, along with climate disasters and global conflict, pull nurses from lower income countries in search of higher wages and security (Stillwell, 2025). Globally, 1 in every 8 nurse is practicing in a country other than the one they are from or were trained in, with most countries reporting a significant proportion of their workforce comprising migrant nurses (Boniol et al., 2022b; Stillwell, 2025; World Health Organization, 2022b). This trend is unlikely to reverse anytime soon, with continued and ever-present push-pull factors mentioned above. Ethical recruitment practices, balancing the right to migrate while protecting health systems, are dependent upon HICs abiding by the UN Global Compact for Migration and the WHO Global

Code of Practice on International Recruitment of Health Personnel (United Nations, 2025; World Health Organization, 2010b).

2.6.2.3 Devaluation and Invisibility of Nursing

Nursing is a gendered profession, based in the "traditional stereotypes of self-less, hardworking females" (Stillwell, 2025, p. 110, para 3). In 2020, the Lancet declared that without nurses, global health systems would collapse (The Lancet, 2020). Despite the critical importance of the world's largest health profession, nursing work remains all but invisible (All-Party Parliamentary Group on Global Health, 2017). Much of this invisibility is due to the gendered concept of nursing as an activity which presents medicine as rational and nursing as not scientific, while some of its invisibility can be attributable to the inconsistency in role delineation of nursing mentioned earlier (Stillwell, 2025).

2.6.2.4 Nursing Involvement in Disasters

Although the concept of disaster nursing began as early as the turn of the 20th century, it was not until 2009 that ICN first formalized the roles of nurses in disasters by establishing the Disaster Nursing Competencies Framework (Fletcher et al., 2022). In a bibliometric mapping analysis of the evolution of disaster nursing research between1990-2019, researchers found that although 1075 publications on disaster nursing were retrieved, the field was still quite immature; the authors called for continued empirical and theoretical research (Molassiotis et al., 2021). Another review of current disaster models similarly identified the lack of any contextualized and adaptable conceptual model specific to nursing and disasters (Pourvakhshoori et al., 2017). These two studies are part of a growing body of research from the past 15 years beginning to explore the many ways that nurses can and should be involved in disaster nursing (National Academies of Sciences et al., 2021a; Veenema et al., 2017, 2016). As they suggest, nursing, by

its nature, has perpetually been adaptive and responsive to emergencies throughout its professional history. Further, they show how nursing will remain essential to responses in future global health emergencies (Stillwell, 2025; Veenema, 2018), playing a crucial role in enhancing global health due to their extensive reach, diverse skill set, and ability to provide continuous care (International Council of Nurses, 2022b; National Academies of Sciences et al., 2021b).

2.6.2.5 Nursing Involvement in Health System Resilience

Although the WHO has highlighted the urgent need for continued investment in the nursing workforce in order to achieve resilient health systems, actionable change depends on participation and engagement of individual countries, factors that have proven to be widely variable (World Health Organization, 2022b). Previous research has examined the relationships between disasters and health system resilience, prioritizing conceptualization, definition, and the beginnings of how to potentially operationalize system resilience (Copeland et al., 2023; Foroughi et al., 2022; Kruk et al., 2015). Additional research has examined the positive association of the nursing workforce on population health outcomes (Bigbee et al., 2014; Dunton et al., 2007; Liu & Eggleston, 2022; National Academies of Sciences et al., 2021b). Further, preliminary evidence supports positive relationships among the global healthcare workforce, a specified disaster (COVID-19), and population health outcomes (Liu & Eggleston, 2022). However, to my knowledge, no studies have examined the specific intersection of the nursing workforce characteristics, health system resilience, and disaster exposure on population health outcomes. To date, studies have not examined whether the nursing workforce, which typically comprises the front-line response during disasters, can more effectively engage in the development and leadership of more resilient health systems. When studies explore the associations between disasters and health equity, they highlight how disasters exploit and worsen

health equity, particularly among already vulnerable populations; those studies do not offer scalable interventions to address these inequities (Méndez et al., 2020; Ngcamu, 2023). Additionally, a large body of global health literature has examined the unique roles of the nursing workforce in capacity- and resource-limited settings, where nurses are often the only healthcare providers available for large population areas (Holmér et al., 2023; Maier & Aiken, 2016; Stuart-Shor et al., 2017). The National Academy of Medicine cites the urgent need for research to understand morbidity and mortality associated with disaster events (MacKenzie et al., 2020), yet there remains an unmet need for research that explains how the advancing impacts of climate change, manifested through extreme weather events, disrupt systems of healthcare. The work described above provides key insights into relationships between disasters and population health.

2.6.2.6 Nurses in Leadership & Policy Development

Nurses' involvement in policy development is quite variable globally (Ditlopo et al., 2014; Etowa et al., 2022; Gimbel et al., 2017). Largely, nursing-forward organizations, such as Sigma Theta Tau International Honor Society of Nursing and The Burdett Trust for Nursing, tend to recommend models for nursing initiatives and advocacy efforts, although more recently, global health organizations have been more supportive of and vocal about recommending increased nursing leadership (World Health Organization, 2020a).

Despite these calls for increased engagement in policy development, a noted lack of political interest—compounded by organizational barriers, working environment constraints, and persistent stereotypes of the nursing profession (including undervaluation of the profession as well as gender-based stereotypes)--has resulted in the nursing workforce being underutilized in policy engagement (Han & Kim, 2024). In fact, nurses' involvement in policy making has not

significantly improved over the last 25 years (Rasheed et al., 2020). Understanding these barriers, nurse researchers have called for increased organizational culture conducive to proactive leadership among nurses, health policy capacity development, and increased support from national nursing organizations (Ditlopo et al., 2014; Han & Kim, 2024).

Nurses are essential in achieving the Sustainable Development Goals (Fields et al., 2021; Rosa & Iro, 2019). More focally, increasing nursing presence, authority, visibility, and leadership is essential to allow for effective and safe work environments for nurses and the patients they serve (Schlak et al., 2022). As noted above, the over 29 million nurses worldwide constitute the largest sector of the healthcare workforce, allowing them to impact health outcomes significantly on a global scale (World Health Organization, 2020a). Nurses are often the first and primary point of contact for patients, providing essential services such as disease prevention, health education, and chronic disease management--all services critical for improving population health. Their comprehensive training enables them to work across various settings, from hospitals to community clinics to remote rural areas, making healthcare more accessible and equitable. Finally, nurses are trained and experienced patient advocates, and in this way serve as natural leaders to improve global health outcomes (Veenema et al., 2017, 2016). Leadership is essential to a strong and effective nursing workforce (Institute of Medicine (US) Committee on the Robert Wood Johnson Foundation Initiative on the Future of Nursing, at the Institute of Medicine, 2011). Despite the above, nurses are the most underrepresented health profession in leadership positions and decision-making (World Health Organization, 2020b).

In a critical examination of who should and does speak for nurses, Daly et al. highlight the juxtaposition that the while the global public is comfortable revering nurses for their work, nursing voices were omitted in policy decisions and the media (Daly et al., 2020). Similarly, this

discrepancy remains even in the Nurse Education Partnership Initiative, a large capacity initiative aimed at training nurses around the world. While this program aims to specifically address nursing education to improve nursing and midwifery workforce capacity, that goal is undermined by the facts that the organization is led by a physician and that only one out of the five senior leadership positions is held by a nurse (ICAP, 2025). This inequality further perpetuates the narrative that, although nurses are critical for achieving quality health outcomes, leadership and decision-making should remain within the medical hierarchical model, with physicians in charge.

2.7 Addressing Gaps in the Literature

Based on extensive review of the literature, Table 1 describes the gaps in the science surrounding the contributions the global nursing workforce currently makes to fostering resilient health systems in the face of increasing climate-induced disasters.

Table 1. Summary of Identified Gaps in the Literature and plans for Addressing the Gaps in This Proposal

Gaps in the Literature	Addressing Gaps in the Literature
There is a paucity of research examining how nurses can engage with and directly influence the development of resilient health systems.	This study will include targeted qualitative research to explore the experiences, perceptions, and strategies of global nurse leaders for influencing health system resilience
There is a lack of generalizability in prior health system resilience research given the variability among countries.	This study will use a cross-country longitudinal analysis to allow for more accurate understanding of context-specific changes over time and across country differences, and to better control for confounding and unmeasured variables.
There is a need for core stakeholder (nursing workforce) engagement in developing more resilient health systems.	This study will adapt and develop a nursing-inclusive resilience framework, to allow for nurse driven engagement with the development of resilient health systems.

2.8 Significance

Studies have yet to understand the mechanisms by which characteristics of the global nursing workforce influence health system resilience and which may improve adaptation strategies to climate-induced disasters. Previous studies investigating health system resilience on a global scale have largely omitted any examination of the nursing workforce, focusing either on

the health workforce as a conglomerate or on physician-related metrics, despite the prevalence and significance of the nursing workforce. Additionally, to date, no longitudinal studies have examined these important relationships, leaving the limited studies examining health system resilience and disasters open to potentially unmeasured variable bias (Kasza et al., 2017). Disproportionate health outcomes among disadvantaged populations experiencing disasters have been well documented, including Hurricane Katrina in 2005, Turkey-Syria earthquakes in 2023, the Haiti earthquake in 2010, and Malawi's Tropical Cyclone Freddy in 2023, yet this area of science remains understudied on a global level (Mazdiyasni & AghaKouchak, 2020). The findings from this dissertation will advance global efforts to identify and implement effective disaster-readiness strategies. More specifically, it will not only identify targeted areas for further study but also use the results of this study to develop implementation strategies that effectively utilize nurses and facilitate their participation in leadership and decision-making in the field of disaster readiness. The potential public health impact of these findings includes contributing new knowledge about the ways that the nursing workforce can participate in health system resilience within disaster contexts.

Chapter 3 Building the Global Picture: A Novel Method for Linking the Nursing Workforce to Population Health within Disaster Contexts

3.1 Abstract

Background: Publicly available datasets contain rich information on global health workforce capacity, disaster exposure, and population level health outcomes, but are rarely integrated in a systematic manner. Fragmentation across data repositories, inconsistent variable definitions, temporal misalignment, and missingness have limited cross-national analyses examining how health workforce density, particularly nurses and midwives, as well as physicians interacts with disaster exposure to shape population health outcomes. Addressing these methodological barriers is essential for advancing comparative health systems research and informing disaster preparedness policy.

Objective: To describe and validate a novel, reproducible, cross-national methodology for combining nursing, midwifery, and physician workforce datasets, along with disaster exposure and population level health outcome datasets.

Methods: The study aggregated global datasets from the World Health Organization, World Bank, Emergency Events Database (EM-DAT), standardizing variables across countries and years, harmonizing coding schemes, and merging data into a final longitudinal structure database. Finally, sensitivity analyses were conducted to evaluate missingness, alternative workforce definitions, and workforce threshold effects.

Results: The process described produced a harmonized longitudinal dataset suitable for comparative health workforce and disaster analyses. Sensitivity testing demonstrated the

robustness of the associations related to workforce distinction and data completeness. The resulting approach enables examination of interactions between workforce capacity and disaster exposure across heterogenous health settings and contexts.

Conclusion: This study presents a reproducible and transparent data integration process to inform future health workforce and disaster research. This process provides a foundation for future empirical work examining workforce investment, health system resilience, and population health outcomes at a global scale.

3.2 Introduction

The global health workforce forms the foundation of health system capacity and population health (Correia et al., 2025). Nurses and midwives constitute the largest components of the global health workforce and deliver the majority of direct, hands-on patient care worldwide (World Health Organization, 2025f). In many settings, particularly in low-resourced or rural contexts, individuals and communities may interact exclusively with nurses throughout their lifetimes. Physicians, nurses, and midwives collectively underpin health system functionality, contributing to the delivery of essential services, continuity of care, and public trust in health institutions. Strong health workforce capacity has been linked to improved population health outcomes, including reduction in maternal and child mortality, higher life expectancy, and better management of chronic diseases (Catton, 2025; Liu & Eggleston, 2022). As such, the nursing and midwifery workforce is central to achieving universal health coverage and improving population health at a global scale (International Council of Nurses, 2019b; World Health Organization, 2025f). Emerging evidence suggests that countries with more robust nursing capacity experience improved health outcomes; however, the existing global literature remains fragmented, methodologically heterogenous, and limited in generalizability (Aiken et al., 2014; Liu & Eggleston, 2022).

Concurrently, disasters, public health emergencies, and systemic shocks are increasing in both frequency and severity worldwide (CRED, 2024; Romanello et al., 2025). Hazards are increasingly affecting communities with little prior exposure and limited preparedness, exacerbating vulnerabilities and constraining health system capacity to mitigate adverse population-level health and economic consequences (Intergovernmental Panel On Climate Change (Ipcc), 2023). Understanding how health workforce capacity interacts with disaster

exposure to shape population-level health outcomes is therefore critical for informing global health planning, workforce investment, and disaster preparedness strategies.

Despite the abundance of publicly available data on the global health workforce, disaster exposures, and population health outcomes, these datasets are rarely integrated. Workforce data are often reported separately for nurses, midwives, and physicians, while disaster datasets such as the Emergency Events Database (EM-DAT) are maintained independently of national population health statistics. Differences in coding schemes, temporal alignment, country definitions, and missing data further complicate efforts to conduct cross-national analyses. Existing studies tend to focus on single workforce cadres; outcomes are often limited to descriptive or cross-sectional designs that rarely account for the compounding effects of disasters or systemic shocks. This fragmentation limits the ability to rigorously examine the relationships among workforce capacity, disaster exposure, and population health outcomes at a global scale.

Addressing these methodological challenges requires the development of a systematic, reproducible, and transparent approach to integrating diverse global datasets. Therefore, the objective of this study was to develop, document, and validate a cross-national process for integrating nursing, midwifery and physician workforce datasets with disaster exposure, and population health outcome data. Secondary aims included assessing the robustness of key data integration decision, such as handling missing data, applying alternative workforce definitions, and evaluating threshold effects of workforce density, to ensure the resulting dataset can support reliable, reproducible analyses. Ultimately, this methodology seeks to provide a foundation for future global health workforce and disaster research, enabling rigorous investigation of how investments in health human resources can strengthen health system resilience, and improve population health in disaster-prone and lower resourced contexts. By providing a robust and

reproducible workflow, researchers can generate evidence to guide workforce planning, disaster preparedness, and equitable resource allocation worldwide.

3.3 Methods

3.3.1 Study Design

This study employed an integrative data analysis to develop a replicable, longitudinal dataset at the country level that integrates global health workforce, disaster exposure, and population-level health outcome data. The process included three main stages: 1) identification and acquisition of global datasets, 2) harmonization and integration of variables across countries and years, and 3) sensitivity analyses to evaluate the robustness of key analytic decisions.

3.3.2 Data Sources

3.3.2.1 Health Workforce Data.

Country-level data on nurses, midwives, and physicians were obtained from the World Health Organization's Global Health Observatory (World Health Organization, 2024g). Workforce density was defined as the number of professionals per 10,000 population. Given the similarity in scope and training in many contexts between nurses and midwives, these professions were combined into a single variable, referred to as either "nursing density" or "nursing workforce."

3.3.2.2 Population Health Data.

Population-level health outcomes, including infant, maternal mortality, and aged 15-60 adult mortality, were sourced from the World Health Organization, while under-five mortality was sourced from the World Bank's Development Indicators (World Bank, 2024a, p. 5; World Health Organization, 2024f, 2025b, 2025d). Infant mortality is measured as the number of deaths aged 0-11 months per 1,000 population (World Health Organization, 2025b). Under-five mortality is

measured as the number of deaths under age five per 1,000 live births (World Bank, 2024a). Maternal mortality is measured as a ratio is measured as the number of maternal deaths per 100,000 live births (World Health Organization, 2025d). Adult mortality is measured as the probability of dying between the ages of 15-60 per 1,000 population (World Health Organization, 2024f).

3.3.2.3 Disaster Exposure Data (Lifeyears Index).

Data on disaster events were obtained from the Emergency Events Database (EM-DAT), which includes country-level information on the occurrence, type, and severity of disaster events. Only events meeting EM-DAT inclusion criteria (e.g. >10 deaths, >100 affected, or declaration of a state of emergency) are included in the database. To quantify and equalize disaster exposure across contexts, the Lifeyears Index was used (Doan & Noy, 2021). The Lifeyears Index helps to quantify disaster exposure and standardize disaster effects across varying contexts. While a qualitative index—the Universal Disaster Severity Classification System—has been developed, it does not fully account for country context and global variability, thus losing granularity and detail needed for making cross-national comparisons (Caldera & Wirasinghe, 2022; Doan & Noy, 2021) (Table 3). The life expectancy component of the Lifeyears Index was obtained from the World Health Organizations' Life Tables Database (World Health Organization, 2025c), and the median age component was obtained from the World Bank's Development Indicators (World Bank, 2024b). The Lifeyears Index dataset was developed first, according to the process described by Doan & Noy (2021) and subsequently merged with the master dataset by country/year.

3.3.2.4 Gross National Income (GNI).

Gross national income, measured in purchase power parities (PPP) are the "rates of currency conversion that try to equali[z]e the purchasing power of difference currencies, by eliminating the differences in price levels between countries" (Organization for Economic Cooperation and Development, 2024).

3.3.2.5 Year.

The study period was chosen based on data availability across datasets. At time of data merging (September 2025-November 2025), many countries had yet to report on multiple variables in 2023, and only one country reported in 2024. Initially, 2015 was included in the study period; however, the missingness for the primary predictor variable "total nurse and midwifery density" was unacceptable, with only 3/189 (1.6%) countries reporting this variable. Therefore, the study period of 2016-2022 provided the longest continual timeframe data availability.

Table 2. Variables and Respective Data Sources

Table 2. Variables and Respective Data Sources			
Variable	**Construct**	**Objective Measure**	**Data Source**
Independent Variables			
Aggregate Nursing & Midwifery Density	Nursing Workforce	# Nurses & midwives per 10,000 population	World Health Organization *Global Health Workforce Statistics Database(World Health Organization, 2024d)*
Lifeyears Index	Disaster Exposure	Table 3	EM-Dat, World Bank
Dependent Variables			
Infant Mortality	Population Health Outcomes	Total deaths between 0 and 11 months per 1,000 births	World Health Organization *Child Mortality and Causes of Death Database* (World Health Organization, 2024b)
Under 5 Mortality	Population Health Outcomes	Total deaths of children 0-5 years old per 1,000 live births	World Bank (World Bank, 2024a)
Maternal Mortality	Population Health Outcomes	Number of maternal deaths per 100,000 live births	World Health Organization *Maternal Mortality Database* (UNICEF, 2025)
Mortality Rate	Population Health Outcomes	Number of deaths per 100,000 of people aged 15-60 years	World Health Organization *Mortality Database* (World Health Organization, 2024f)
Covariates			

Aggregate Physician Density	Health System Quality	# Physicians per 10,000 population	World Health Organization *Global Health Workforce Statistics Database (World Health Organization, 2024d)*
Gross National Income	Socioeconomic Factors	Continuous, total gross domestic product using PPP (standardized rates) per capita	Office of Economic Co-Operation and Development (Organization for Economic Cooperation and Development, 2025)

Table 3. Lifeyears Index Components (Doan & Noy, 2021)

Variable	Construct	Objective Measure	Data Source
Y	Monetary damages	Damages in USD	EM-DAT
M	Mortality	# of people killed in the disaster	EM-DAT
A^{exp}	Life expectancy	92	World Health Organization's *Life Tables* (World Health Organization, 2025c)
A^{med}	Median age	Median age for country	World Bank's *World Development Indicators*
N^{EMDAT}	People affected	Number of people affected by the disaster	EM-DAT
E	"welfare-reduction weight" of being exposed to a disaster	0.054	WHO's weight for disability
T	Time it takes an affected person to return to normality	3 years	
$PCGDP$	Opportunity cost of spending effort on reconstruction	Per capita gross domestic product	World Bank's *World Development Indicators*
C	Discounted measure of 75% to account for the observation that time is not always spent on work-related activities	75%	

3.3.3 Data Harmonization and Integration

To create a coherent dataset we performed several harmonization steps at the country-level using Stata 18e (Stata 18e, 2024)(Appendix 1):

1. Standardization of country identifiers: Country names and International Organization for Standardization (ISO) codes were aligned across datasets. Discrepancies due to name changes,

split/merged countries, or missing codes were resolved using World Health Organization member country lists.

2. Temporal alignment: Annual observations were matched across all datasets, prioritizing the latest available data for each year. Missing years were coded as missing.

3. Variable harmonization: Workforce densities, covariates and population outcomes were standardized to common units and scales. Disaster exposure data were aggregated to annual country-level counts. GNI and cumulative annual disaster exposure were log transformed (ln[x+1]).

4. Dataset construction: Cleaned and standardized variables were merged to create a country-year longitudinal Lifeyears Index (disaster exposure) dataset which was then subsequently merged with the master dataset to cover all 194 WHO member countries between 2016 and 2022.

3.3.4 Missing Data & Sensitivity Analyses

We conducted multiple sensitivity analyses to evaluate the robustness of the dataset and analytic decisions. Analyses included varying the thresholds for nursing density and disaster exposure, excluding countries with missing data. The results were largely consistent with primary analyses, suggesting that our findings were not substantially influenced by specific assumptions or analytic choices. Further, patterns of missingness across variables were evaluated by income group, individual countries, as well as year.

3.4 Results

3.4.1 Descriptive Statistics

This study focused on the 194 World Health Organization Member States during the 2016-2022 study period. Additional data are available for territories and autonomous regions

such as the occupied territory of Palestine and Hong Kong, although for this study they were not included as neither is a recognized WHO Member State. A total of 1,358 observations were included, representing 194 Member States over a seven year period. The resulting dataset was unbalanced, reflecting heterogenous reporting practices across countries and over time. Workforce indicators tended to be more complete in later years of the study, consistent with known data missingness associated with the global transition from the Millenium Development Goals to the Sustainable Development Goals (Table 4 & Figure 6).

Table 4. Description of Variables in Master Dataset (2016-2022)

Table 4. Description of Variables in Master Dataset (2016-2022)				
Variable	*n*	Mean	Std. Deviation	Min-Max
World Health Organization Member States n=194				
Total Nurse and Midwifery Density	959	48.06	39.45	1.21-187.6
Physician Density	932	22.29	18.41	0.2-95.42
Disaster Exposure (Lifeyears Index)	1,015	217,951.6	1,913,653	0-56.4 M
Gross National Income (PPP)	1,233	744,000 M	2,330,000 M	73.6 M-29,200,000 M
Infant Mortality	1,540	21.27	19.65	1.32-189.1
Under Five Mortality	1,544	28.64	31.02	1.5-387
Maternal Mortality Ratio	1,543	142.97	209.98	1.09-1,700
Age 15-60 Mortality	1,281	164.10	92.35	42.76-629.5
Low Income Group n=25				
Total Nurse and Midwifery Density	116	7.97	5.59	1.51-43.82
Physician Density	117	2.36	5.44	0.2-36.45
Disaster Exposure (Lifeyears Index)	149	237,935.3	598,944.7	96.88-4,278,165
Gross National Income (PPP)	146	5.42e+10	6.33e+10	1.72e+09-3.3e+11
Infant Mortality	203	49.40	20.05	12.74-189
Under-5 Mortality	207	75.34	39.55	15.8-387
Maternal Mortality Ratio	207	455.96	298.52	20.73-1,700
Age 15-60 Mortality	174	261.74	71.02	130.6-481
Low- and middle- Income Group n=50				
Total Nurse and Midwifery Density	200	20.29	17.93	1.21-110.83
Physician Density	209	6.86	6.48	0.45-28.51
Disaster Exposure (Lifeyears Index)	309	400,898.2	3,263,047	0-56.4 M

Gross National Income (PPP)	337	463,000 M	1.61e+12	492 M-11,900,000 M
Infant Mortality	400	32.55	16.37	5.55-79.17
Under-5 Mortality	400	42.77	24.97	6.5-126.2
Maternal Mortality Ratio	400	210.99	196.29	14.39-1,168
Age 15-60 Mortality	350	211.08	99.47	63.51-629.5
Upper-middle Income Group n=54				
Total Nurse and Midwifery Density	267	40.10	22.69	3.11-109.48
Physician Density	247	24.68	17.79	1.52-95.42
Disaster Exposure (Lifeyears Index)	278	150,711.3	788,718.8	0-11.8 M
Gross National Income (PPP)	318	577,000 M	1,820,000 M	73.6 M-29,200,000 M
Infant Mortality	432	15.47	10.14	1.93-67.81
Under-5 Mortality	432	18.45	13.30	2.6-93.5
Maternal Mortality Ratio	431	68.56	59.80	1.09-475
Age 15-60 Mortality	357	153.34	56.86	61.73-371.4
High-Income Group n=64				
Total Nurse and Midwifery Density	375	81.04	37.26	7.4-187.6
Physician Density	359	36.02	12.97	6.87-90.27
Disaster Exposure (Lifeyears Index)	278	71,782.55	830,112.9	0-13.8 M
Gross National Income (PPP)	431	1,320,000 M	3,240,000 M	215 M-24,400,000 M
Infant Mortality	504	5.85	5.24	1.32-27.37
Under-5 Mortality	504	6.85	6.00	1.5-33.1
Maternal Mortality Ratio	504	23.31	41.03	1.59-317.3
Age 15-60 Mortality	399	89.69	43.38	42.76-271.6

In the final dataset, nurse-midwife density ranged from 1.21-187.6 per 10,000 population, with substantial variation across income groups. Physician density exhibited a similarly wide distribution (0.2-95.42 per 10,000), while disaster exposure varied markedly across both countries and years, with some countries experiencing repeated high-impact events and others reporting none during periods. Population health indicators showed income-related variation. Low-income and lower- middle income countries generally exhibited lower workforce densities and overall poorer population health outcomes. Additionally, despite higher percentages of

missing data in the LMICs as well as fewer observations overall for these groups, they represent significantly higher mean disaster exposures compared to higher income countries (HIC).

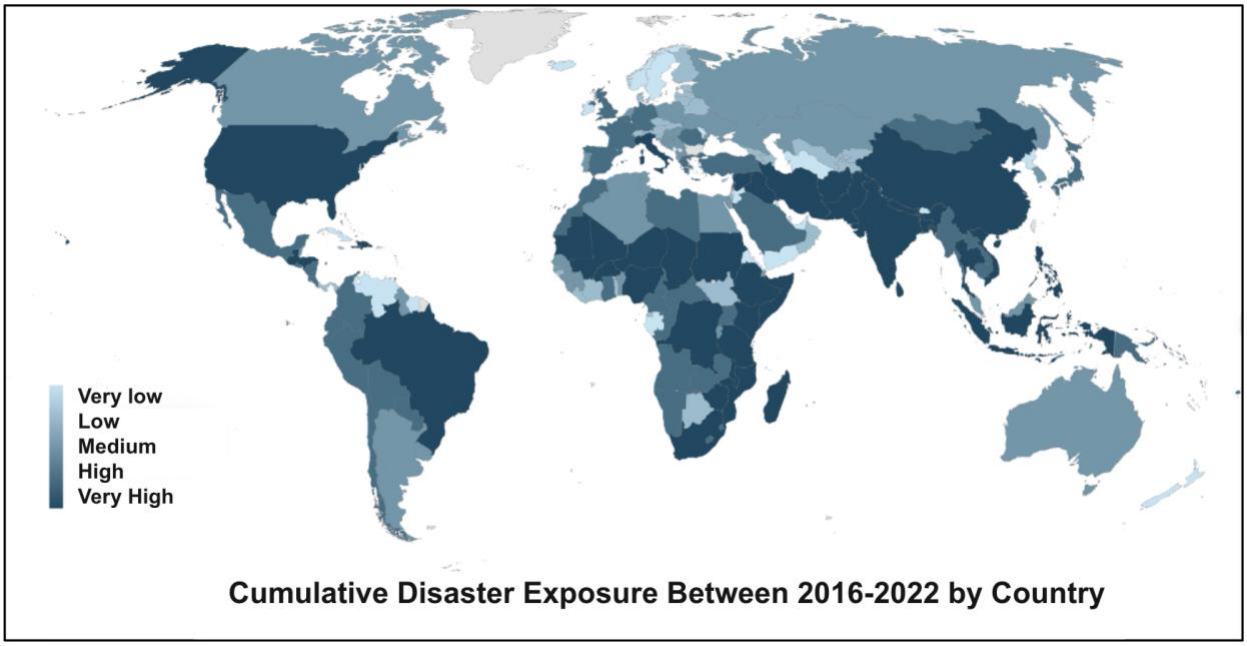

Figure 4. Country-Level Cumulative Disaster Exposure by Quintile over the Study Period

3.4.2 Patterns of Missingness

Assessment of missing data revealed substantial variation across variables. Approximately, 38% of country-year observations lacked nurse-midwife density, while physician density was missing in 40% of the cases. Population-level health outcomes were largely complete, with infant, under-five, and maternal mortality outcomes reporting less than 1% missingness. The economic indicator, GNI, exhibited moderate missingness of 21%. Finally, disaster exposure, the Lifeyears Index also had moderate missingness of 35%.

Missingness was not randomly distributed, as shown in Table 5 and Figure 6; workforce data were more frequently absent in low-and middle income countries and in earlier years of the study period.

Table 5. Missingness by World Bank Income Group

Table 5. Missingness by World Bank Income Group % (*missing/total)*

World Bank Income Group	Total Nurse and Midwifery Density	Physician Density	Disaster Exposure (Lifeyears Index)	Gross National Income	Infant Mortality	Under-5 Mortality	Maternal Mortality Ratio	Age 15-60 Mortality
Low Income Group n=25	44% (91/207)	43% (90/207)	28% (58/207)	29% (61/207)	1.93% (4/203)	0%	0%	15.9% (33/207)
Low- and middle- Income Group n=50	49.9% (200/400)	47.8% (191/400)	22.8% (91/400)	15.8% (63/400)	0%	0%	0%	12.5% (50/400)
Upper-middle Income Group n=55	38.2% (165/432)	42.8% (185/432)	35.6% (154/432)	26.4% (114/432)	0%	0%	0.23% (1/431)	17.4% (75/432)
High Income Group n=64	26.8% (137/512)	29.9% (153/512)	45.7% (234/512)	15.8% (81/512)	1.6% (8/512)	1.6% (8/512)	1.6% (8/512)	22.1% (113/512)

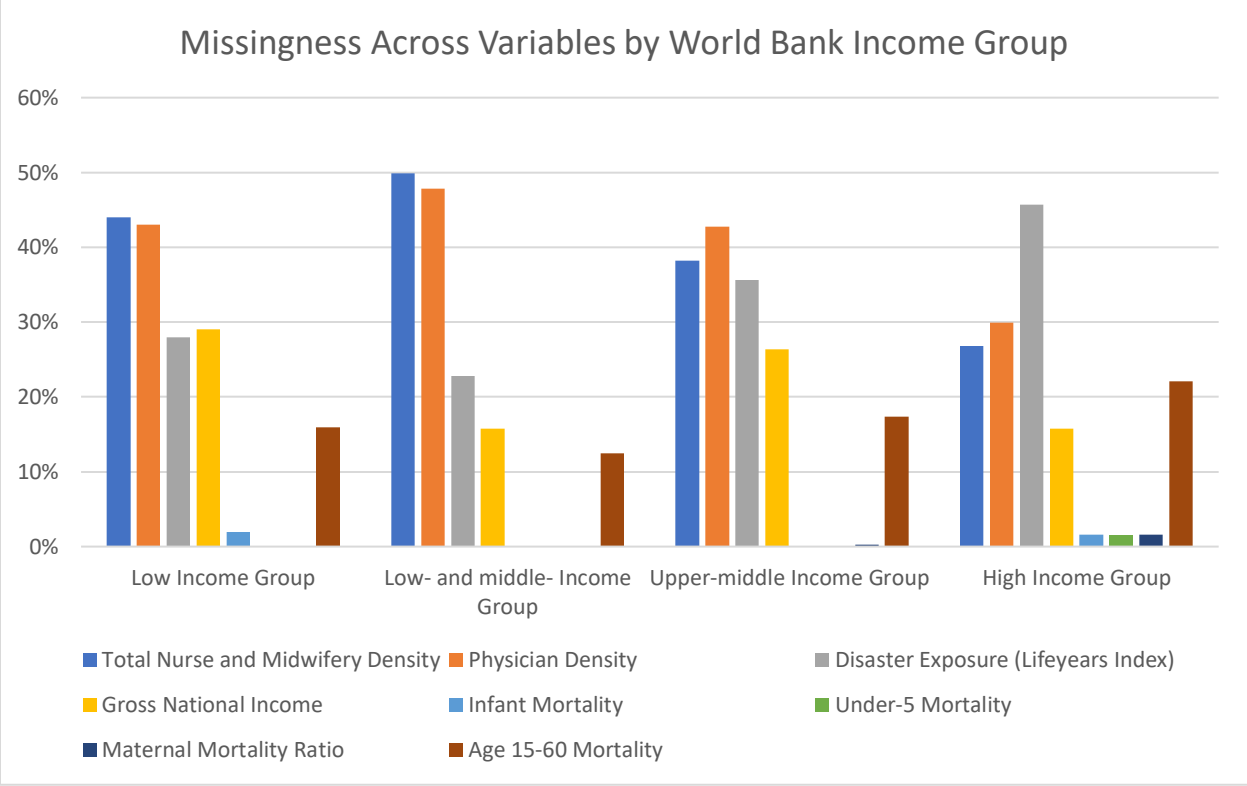

Figure 5. Missingness Across Key Variables by World Bank Income Group.[1]

[1] Low Income *n*=25; Low- and middle- Income *n*=50; Upper-middle Income *n*= 55; High income *n*= 64

3.5 Discussion

To address global, regional, and national health workforce needs in the setting of increasing disaster events, this study developed a replicable and transparent process to create a global longitudinal dataset linking health workforce, disaster exposure, and population-level health outcomes. By marrying disparate data sources from the World Health Organization, the World Bank, and the Emergency Events Database (EM-DAT), we demonstrate the process and feasibility of constructing a longitudinal dataset capable of supporting rigorous analyses exploring the relationships between nursing, midwifery, and physician workforces and their interactions with country level shocks to shape health outcomes around the world. Sensitivity analyses indicated that key decisions regarding workforce definitions, missing data strategies did not significantly alter descriptive patterns. Together, these contributions address a critical methodological gap in global health services research (Romanello et al., 2025; UN Climate Change, 2024).

This approach aligns with broader calls in disaster science and climate-health research for systems-level data infrastructures capable of capturing complex interactions among hazards, social vulnerability, and institutional capacity (Romanello et al., 2025; UN Climate Change, 2024). Recent research is increasingly framing the health workforce as a cornerstone of resilient health systems. Clarke et al. (2025) argue that workforce capacity is both essential for climate adaptation and chronically under-prioritized in national climate policy agendas, noting that only 14% of countries explicitly reference the health workforce in their national determined contributions (NDCs) under the Paris Agreement (Clarke et al., 2025). It is concerning that countries most vulnerable to climate change are often the those facing the most severe health workforce shortages. This pattern is consistent with calls by ICN and WHO to urgently address the global projections of an 11 million health worker shortage by 2030, as well as persistent

maldistribution across regions (Governo Do Brasil, 2025; International Council of Nurses, 2022b; World Health Organization, 2025f).

Importantly, this study suggests that workforce density, composition, and thereby capacity are not merely background characteristics of health systems, but instead, core determinants of adaptive capacity in the face of environmental and epidemiological shocks. Over the last 20 years, there have been persistent calls and recommendations to address ethical workforce migration (International Council of Nurses, 2024; Stillwell, 2025; World Health Organization, 2010b). Recognizing the link between health workforce stability and effective climate and health adaptation plans, national and global organizations should commit to the WHO Global Code of Practice on the International Recruitment of Health Personnel (World Health Organization, 2010b). To ensure compliance and inform bilateral agreements, reliable and available data infrastructure capable of capturing inter-country and cross-country migration patterns will be needed. While more robust data systems are needed, it is imperative to leverage currently available data to understand the relationships among health workforce governance, organizational structures, and data-driven policy making (Correia et al., 2025).

3.5.1 Limitations and Strengths

This study is not without limitations. Despite extensive harmonization efforts, workforce indicators remained incompletely reported across countries and years, particularly in LMICs, and particularly during earlier periods of observation. Disaster datasets may also be subject to underreporting in fragile and conflict-affected contexts. Although lower income countries experienced higher disaster exposure that upper-middle and high income countries, due to the underlying data missingness, this is largely a substantial underrepresentation of the true disaster exposure experienced by LMICs.

Additionally, the Lifeyears Index requires an annual cumulative value by country; this aggregation of disaster exposure may obscure subnational heterogeneity, which may be especially notable in large and geographically diverse countries. The aggregation also makes repeated or compounded disaster exposures challenging to isolate at the subnational or local level. Yet, these limitations reflect structural challenges inherent to global data systems, rather than shortcomings unique to this study.

Despite these limitations, this study has several notable strengths. The framework uses multiple reliable, trusted global data sources into a novel dataset. The study employs transparent, scripted data management processes, and incorporates appropriate sensitivity analyses to evaluate robustness. The ability to flexibly operationalize workforce constructs and disaster exposure enhances the utility of the dataset for a wide range of research questions. Further, the dataset structure facilitates longitudinal analyses that are rarely possible using existing datasets, making this framework a valuable resource for advancing global health science. Nonetheless, they underscore the need for investment in health workforce surveillance and disaster reporting infrastructure, particularly in settings most vulnerable to climate-related hazards and health system shocks.

3.5.2 Implications for Policy and Future Directions

Providing a harmonized global longitudinal dataset linking workforce capacity to disaster exposure has important implications for policy. Integrated workforce-disaster datasets can inform national and global workforce planning efforts related to surge capacity, workforce deployment, workforce migration, and disaster preparedness. These analyses may support monitoring of progress toward universal health coverage and help guide decision by ministries of health and global development partners. Given the central role of nurses and midwives in

frontline service delivery—particularly in disaster-prone and resource limited settings—this process provides a mechanism for generating evidence to support targeted workforce strengthening strategies as part of broader health system resilience agendas.

Future work could extend database in several important ways. Incorporation of subnational analyses of workforce and disaster data would allow more granular analyses of health systems within countries, while also deepening our understanding of more local impacts of disaster exposure. Linking the dataset to governance indicators, workforce migration flows, and climate projections could further differentiate mechanisms of resilience, as well as help to predict the high-hazard communities which could most benefit from targeted workforce investment strategies. That linkage can also help predict the high-hazard communities that would most benefit from targeted workforce investment strategies. Finally, regular updates using new data releases from international organizations will ensure the integrated dataset remains relevant as disaster risk and workforce dynamics continue to evolve.

3.6 Conclusion

In an era characterized by escalating climate-related hazards, public health emergencies, and persistent workforce shortages, the ability to rigorously examine the intersection of health workforces and system shocks is increasingly urgent. This study provides a novel and reproducible approach for combining global workforce, disasters, and population-level health outcomes data. The workflow can easily be adapted for other health systems research, and it can help support national, regional, and global evidence-based policy on workforce planning and disaster preparedness. By strengthening the empirical foundation of nursing and health workforce capacity, health system resilience, and disaster preparedness, this framework

contributes to evidence-based policymaking aimed at building more equitable and resilience health systems worldwide.

Chapter 4 Nursing Density and Key Health Indicators During Disasters:

A Cross-Country Global Comparison

4.1 Abstract

4.1.1 Introduction

Disaster—whether climate-related, biological or conflict-driven—disrupt health services, strain workforce capacity, and threaten population health. The global nursing workforce plays a critical role in advancing health equity and system resilience, yet nurses are often underrepresented in health systems research. Despite these intersecting phenomena, little quantitative evidence exists on the relationship between nursing workforce capacity, disaster exposure, and population level health outcomes.

4.1.2 Methods

This study uses open-source data from the World Health Organization (WHO), the World Bank, and the Emergency Events Database (EM-DAT) in a global, longitudinal design. The primary independent variables are nursing workforce density and disaster exposure. The primary dependent variables are population-level health outcomes (mortality rates age 15-60, maternal mortality ratios, and infant and under-five mortality). Country-level covariates including gross national income proxied for governance functioning and physician density proxied for health system financing and function.

4.1.3 Results

Across all empirical models, higher nursing density was consistently associated with lower infant, under-five, and maternal mortality, while controlling for disaster exposure. Countries with total health workforce (nursing, midwifery, and physician) density above the WHO safe staffing threshold (>49 per 10,000 population) experienced even stronger negative associations with similar mortality rates.

4.1.4 Conclusion

This study provides the first evidence on the relationship between nursing workforce, disaster exposure, and population-level health outcomes. Adequate nursing density, and sufficient total clinical workforce capacity, is strongly associated with mortality during disasters. These findings underscore the central role of workforce investment as a core component of disaster preparedness and health system resilience. Strengthening health workforce staffing, especially the nursing workforce may mitigate disaster-related mortality and improve system-level adaptive capacity.

4.2 Introduction

In 2025 alone, the world experienced 55 billion-dollar disasters (Masters, 2026). As defined by the United Nations Office for Disaster Risk Reduction (UNDRR), disasters are "a serious disruption of the functioning of a community or a society involving widespread human, material, economic, or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources," (United Nations Office of Disaster Risk Reduction, 2007a, para. 1). Disasters are known to disproportionately impact communities already experiencing structural disadvantage, deepening existing health disparities through immediate trauma and loss of life, long-term psychological distress, infectious disease spread, worsening chronic conditions, mass displacement, and damage to essential systems and services (Gaynor & Wilson, 2020; Mazdiyasni & AghaKouchak, 2020; United Nations, 2019).

Beyond structural factors that further entrench health inequities, climate related hazards are also closely intertwined with broader destabilizing forces, including population displacement, conflict, and terrorism, that have deep and lasting consequences on human health and well-being (Mazdiyasni & AghaKouchak, 2020; Telford, 2023). These overlapping pressures, coupled with resource scarcity, political instability, and ecological degradation, all shape population health in significant and lasting ways (Scheffran, 2020; Telford, 2023).

For populations and communities to adapt to the consequences of climate change, and mitigate the negative effects on population health, world leaders and global health organizations such as the World Health Organization (WHO) have called for developing, fostering, and sustaining resilience within health systems (OECD, 2023; Romanello et al., 2025; World Health Organization, 2024e). Health system resilience is defined as "the ability of health systems not

only to prepare for shocks, but also to minimize the negative consequences of such disruptions, recover as quickly as possible, and adapt by learning lessons from the experience to become better performing and more prepared" (OECD, 2023). Resilient health systems are more capable of absorbing shocks, while maintaining core functions, and adapting to new challenges, each of which is essential for ensuring continuous and equitable healthcare delivery during and after disasters (Kruk et al., 2015; World Health Organization, 2024e). Research indicates that such health systems not only improve immediate crisis response but also contribute to long-term public health outcomes by building capacity, enhancing preparedness, and promoting sustainable health practices (Burau et al., 2024; Copeland et al., 2023; Forsgren et al., 2022). As global health threats become more complex, the study of health system resilience provides valuable insights for policymaking, resource allocation, and the development of interventions that can mitigate the impact of future emergencies on population health.

The healthcare workforce is a key component to developing and sustaining resilient health systems. Within that, a strong and adequately supported and resourced nursing workforce is critical to health system resilience, especially in the face of escalating disaster risks. As the largest group of healthcare professionals worldwide, comprising over 60% of the global health workforce, nurses are positioned at the forefront of disaster response, serving as clinicians, leaders, coordinators, and advocates. Early evidence highlights a persistent gap specific to the health workforce: although nurses are deeply involved in on-the-ground response to disasters, it is essential to make the nursing workforce partners in planning, creating and maintaining resilient health systems. Despite the nursing workforce's obvious role, they are not consistently engaged in designing or leading the structures that underpin resilient health systems (Firouzkouhi

et al., 2021; Kanbara et al., 2023; Kruger et al., 2025; National Academies of Sciences et al., 2021b). ,

To date, there has been limited examination of the objective contributions and measurable impacts the nursing profession has on population health during disasters. Understanding how nursing workforce capacity interacts with resilience during disasters is therefore crucial to addressing policy needs, educational and training frameworks, as well as educational and training frameworks. This interaction between capacity and resilience should also determine how investments in the nursing profession can most efficiently be directed. These insights can inform global health strategies, strengthen system performance, and advance health equity for populations facing the growing threats of climate-related and other disasters. Therefore, the purpose of this study is to examine the association among national nursing density and population health outcomes during disaster events across a global sample of countries.

4.3 Methods

Guided by the Health System Dynamics Framework (Olmen et al., 2012), this study will use nursing workforce metrics (e.g., nurse-to-population ratios) to assess population level outcomes (e.g., mortality rates) by country (all 194 WHO member countries) and respective disaster exposure (Figure 1). Disasters of all nature and etiology which meet The Centre for Research on the Epidemiology of Disasters Emergency Events Database inclusion criteria are included (at least ten deaths, at least 100 persons affected, or a call for international assistance or an emergency declaration) (EM-DAT, 2023). Given the similarities in training and role delineation, the nursing and midwifery workforces have been aggregated together and will be referred to as “nursing workforce.”

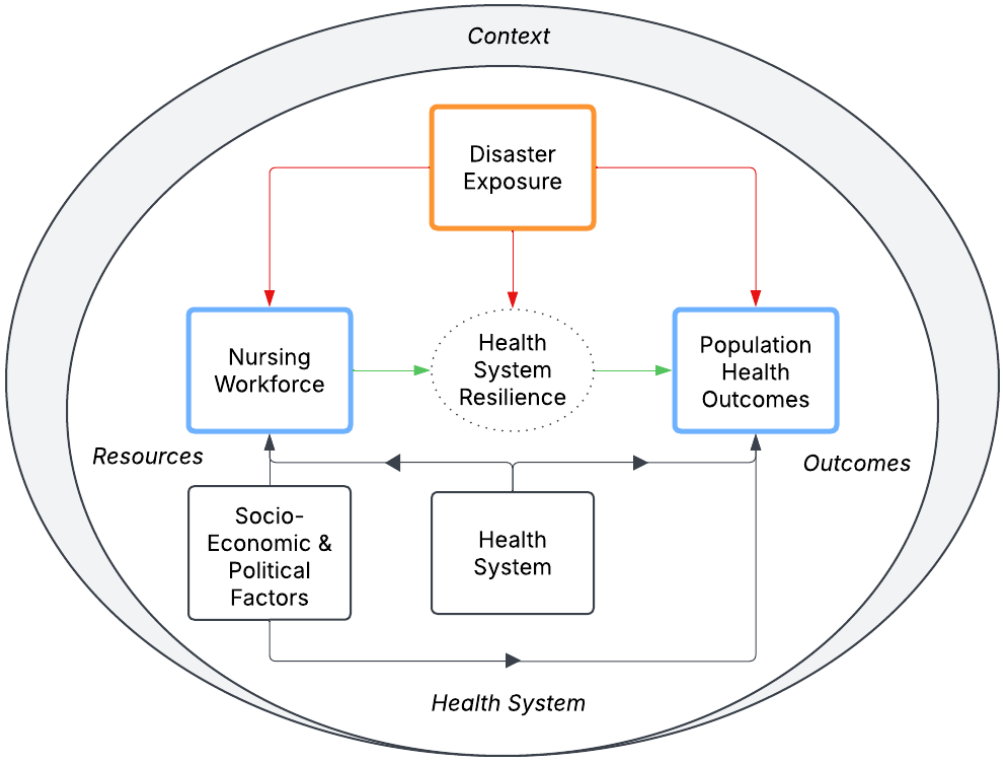

Figure 6. Nursing Disaster Resilience Framework, adapted from Olmen et al. 2012

4.3.1 Variables

4.3.1.1 Independent variables

Global Nursing Workforce (major independent variable).

The WHO uses aggregate nursing density per 10,000 population to measure the nursing workforce. This workforce includes licensed, registered, or country specific definition of nurses. It includes, but is not limited to professional nurses, midwives, enrolled nurses, and dental nurses and primary care nurses (World Health Organization, 2024g). The data are gathered at the country level, often annually, but it is not always available for all years across all countries. While this variable does specifically include advanced practice nurses (APNs), APNs are not easily distinguishable from other types of nurses in the data. Therefore, we did not evaluate for APN level associations.

Disaster Exposure (major independent/moderating variable).

Using the EM-DAT database, a publicly available database of global disaster events, and population and economic losses, total disaster events were aggregated to each country by corresponding year (EM-DAT, 2023, 2024). Historically, it has been extremely difficult to quantify the effect of disasters, with some prior research using only direct mortality rates as proxies for disaster severity, and other research focusing on economic metrics, such as immediate monetary losses to establish impact of disaster severity (Caldera & Wirasinghe, 2022; Kayona et al., 2023). This study uses a quantitative index, the Lifeyears Index (Doan & Noy, 2021) to quantify disaster exposure. The Lifeyears Index integrates disaster event mortality, morbidity, and economic loss into a single population-adjusted metric that enables meaningful cross-country national comparisons across diverse contexts. It is designed to account for the country specific contexts, recognizing that the consequences of disaster losses differ substantially across settings; for example, a dollar lost to disaster in Sudan does not carry the same implications as a dollar lost in the Netherlands. This index has been used by the United Nations in their development of Disaster Risk Reduction agendas (United Nations Office of Disaster Risk Reduction, 2021). The included measures, their respective sources, and the Lifeyears Index equation are referenced in Supplemental Table 1.

4.3.1.2 Dependent variables

Infant Mortality

Infant Mortality is defined as a continuous measure of total infant (0 to 11 months) deaths per 1,000 live births (World Health Organization, 2025b). Infant mortality has been consistently considered an important indicator of population health (Reidpath & Allotey, 2003).

Under Five Mortality

Under Five Mortality is defined as a continuous measure of total deaths of children aged 0-5 years per 1,000 live births (World Bank, 2024a). Similar to infant and maternal mortality, under 5 mortality reflects the overall population health, with high rates signifying poor population health and issues with healthcare access (World Bank, 2024).

Maternal Mortality

Maternal Mortality is defined as a continuous measure of total maternal deaths per 100,000 live births (UNICEF, 2025). Maternal mortality is considered a reflection of the inequalities in access to high quality health services. High maternal mortality rates have also been consistently associated with conflict and public health emergency events (World Health Organization, 2025d).

Adult Mortality (Aged 15-60)

Adult mortality is defined as a continuous measure of total deaths (all cause) per 100,000 population (World Health Organization, 2024f). Adult/adolescent mortality reflects the overall health of a population within the most productive age range (World Health Organization, 2025d).

4.3.1.3 Covariates

Aggregate Physician Density

Like aggregate nursing density, aggregate physician density is the total number of physicians per 10,000 population of a country. It is inclusive of all physicians or medical doctors and does not reflect medical specialties. The current global average is 17.2 physicians per 10,000.

Gross National Income per capita (GNI)

This variable is used to control for economic disparities that can significantly influence health outcomes, education levels, and access to resources, ensuring more accurate comparisons between countries. Purchase power parities are the "rates of currency conversion that try to equalize the purchasing power of difference currencies, by eliminating the differences in price levels between countries" (Organization for Economic Cooperation and Development, 2024). The data is available from the World Bank *Development Indicators* (World Bank, 2025).

Year

Study period from 2016-2022. The transition from the Millenium Development Goals to the Sustainable Development Goals resulted in significant data missingness across most variables for 2015. Additionally, 2023 has significant missingness, possibly due to delays in data reporting.

4.3.2 Statistical Analysis

Datasets were first cleaned individually, then merged into a master dataset, using country/year as the observation level. Generalized Estimating Equations (GEE) using Poisson regressions were performed after confirming right-sided skew distribution of all major independent and dependent variables (Hanley et al., 2003; Zeger et al., 1988). To account for repeated measures within countries, all GEE analyses used an exchangeable correlation structure. Final covariates were selected after evaluating for collinearity. Consistent with prior research health spending per capita had covariance with GNI (greater than 5), and was excluded as a confounding variable from final analyses (Boz & Kurnaz, 2025). Gross National Income and

Lifeyears Index (Disaster Exposure) were log transformed [ln(x+1)] to reduce skewness and improve interpretability of results. Incidence rate ratios (IRR) are reported using disaster and GNI log transformations. 95% confidence intervals are reported consistent with the β coefficient. A p-value of less than 5% was set at level of significance. Analyses were performed in Stata 18e (Stata 18e, 2024), with the guidance of a statistician.

I employed a sequential modeling strategy to examine the associations between the nursing workforce and population health outcomes controlling for disasters, across countries and over time. First, I estimated multivariable regression by modeling nursing density. This allowed me to assess profession-specific associations with mortality controlling for disaster exposure. These models adjusted for physician density, gross national income, and year; and included country-level random effects to account for repeated observations over time within countries.

Second, we created a composite health workforce measure by summing nursing and physician densities to evaluate the association of overall clinical workforce supply with disaster associated mortality. These models retained the same covariate structure and longitudinal specification, allowing direct comparison with profession-specific models.

Finally, we dichotomized the composite workforce measure using WHO's benchmark for relative shortage of national stock density (>49 health workers per 10,000 population) and re-estimated regressions for each outcome (World Health Organization, 2024i). By comparing countries above and below the threshold, this approach tested whether reaching or surpassing minimum workforce adequacy levels was associated with different mortality patterns during disasters compared with countries below the threshold.

Across all analyses, disaster exposure was quantified using the Lifeyears Index to capture severity weighted population impact rather than simple event counts. Together, this tiered

modeling framework allowed evaluation of discipline specific workforce effects, combined workforce capacity, and workforce adequacy thresholds, while simultaneously holding constant the macroeconomic context, temporal trends, and disaster burden.

4.3.3 Sensitivity Analyses

Sensitivity analyses were conducted to assess the robustness of the primary findings to alternative model specifications and assumptions. These included different covariate sets, and accounting for country income level and missingness across variables. Across all empirical specifications, the direction and statistical significance of the association between nursing and health workforce density and the four primary outcomes were largely unchanged; the effect sizes were comparable to those observed in the primary models. No sensitivity analysis significantly altered the substantive conclusions of the study; the sensitivity analyses are available in the Supplementary Material.

Ethics Statement

This study used only publicly available, population-level data and did not involve human subjects. As such, it does not meet the regulatory definition of human subjects research or require review or approval by an Institutional Review Board. All data were handled in accordance with applicable ethical standards for research and data privacy.

4.4 Results

4.4.1 Descriptive Statistics

All 194 World Health Organization countries between the years 2016 and 2022 were included in this study (Table 11 & Supplemental Table 2). Table 11 reports the 2016 values for nursing density per 10,000 population, physician density per 10,000 population, cumulative Lifeyears Index, Gross National Income (PPP), as well as each country's infant, under 5,

maternal, and aged 15-60 mortality rates. Data completeness varied significantly across variables and country-year observations. Of the initial analytic sample, 28% of observations had missing data on at least on variable. Missingness was most common for nursing density, Lifeyears Index, and physician density. Given the nature of the missingness and overall patterns, it could not be reasonably assumed that the missingness was completely at random, and therefore, multiple imputation was not performed. When examined across World Bank country income groups [low income, low- and middle income (LMIC), upper-middle income, and high-income] missingness varied from 50% for nursing density (low-income) to 40% (high-income). Thus, the data appears to be skewed towards higher-income countries.

Table 6. Description of Variables in Master Dataset (2016-2022)

Table 6. Description of Variables in Master Dataset (2016-2022)				
Variable	*n*	Mean	Std. Deviation	Min-Max
World Health Organization Member States n=194				
Total Nurse Density	959	48.06	39.45	1.21-187.6
Physician Density	932	22.29	18.41	0.2-95.42
Disaster Exposure (Lifeyears Index)	1,015	217,951.6	1913653	0-56.4M
Gross National Income (PPP) (in millions)	1,233	744,000 M	2.330,000M	73.6 M-29,200,000 M
Infant Mortality	1,540	21.27	19.65	1.32-189.1
Under Five Mortality	1,544	28.64	31.02	1.5-387
Maternal Mortality Ratio	1,543	142.97	209.98	1.09-1,700
Age 15-60 Mortality	1,281	164.10	92.35	42.76-629.5
Low Income Group n=26				
Total Nurse Density	116	7.97	5.59	1.51-43.82
Physician Density	117	2.36	5.44	0.2-36.45
Disaster Exposure (Lifeyears Index)	149	237,935.3	598,944.7	96.88-4,278,165
Gross National Income (PPP)	146	54,200 M	63,300M	1,720 M-330,000 M
Infant Mortality	203	49.40	20.05	12.74-189
Under-5 Mortality	207	75.34	39.55	15.8-387
Maternal Mortality Ratio	207	455.96	298.52	20.73-1,700
Age 15-60 Mortality	174	261.74	71.02	130.6-481
Low- and middle- Income Group n=50				
Total Nurse Density	200	20.29	17.93	1.21-110.83
Physician Density	209	6.86	6.48	0.45-28.51

Disaster Exposure (Lifeyears Index)	309	400,898.2	3,263,047	0-56.4 M
Gross National Income (PPP)	337	463,000 M	1,610,000 M	492 M-11,900,000 M
Infant Mortality	400	32.55	16.37	5.55-79.17
Under-5 Mortality	400	42.77	24.97	6.5-126.2
Maternal Mortality Ratio	400	210.99	196.29	14.39-1,168
Age 15-60 Mortality	350	211.08	99.47	63.51-629.5
Upper-middle Income Group n=54				
Total Nurse Density	267	40.10	22.69	3.11-109.48
Physician Density	247	24.68	17.79	1.52-95.42
Disaster Exposure (Lifeyears Index)	278	150,711.3	788,718.8	0-11.8 M
Gross National Income (PPP)	318	577,000 M	1,820,000 M	73.6 M-29,200,000 M
Infant Mortality	432	15.47	10.14	1.93-67.81
Under-5 Mortality	432	18.45	13.30	2.6-93.5
Maternal Mortality Ratio	431	68.56	59.80	1.09-475
Age 15-60 Mortality	357	153.34	56.86	61.73-371.4
High-Income Group n=64				
Total Nurse Density	375	81.04	37.26	7.4-187.6
Physician Density	359	36.02	12.97	6.87-90.27
Disaster Exposure (Lifeyears Index)	278	71,782.55	830,112.9	0-13.8M
Gross National Income (PPP)	431	1,320,000 M	3,240,000 M	215 M-24,400,000 M
Infant Mortality	504	5.85	5.24	1.32-27.37
Under-5 Mortality	504	6.85	6.00	1.5-33.1
Maternal Mortality Ratio	504	23.31	41.03	1.59-317.3
Age 15-60 Mortality	399	89.69	43.38	42.76-271.6

4.4.2 Nursing Density Associations with Disaster Exposure on Population Health Outcomes

Across regressions including 435 to 518 country-year observations representing 135 to 142 countries, nursing density demonstrated largely consistent associations with population health outcomes while controlling for disaster exposure, while the covariates: disaster exposure, gross national income, and temporal trends showed more varied patterns (Table 7 & Figure 8).

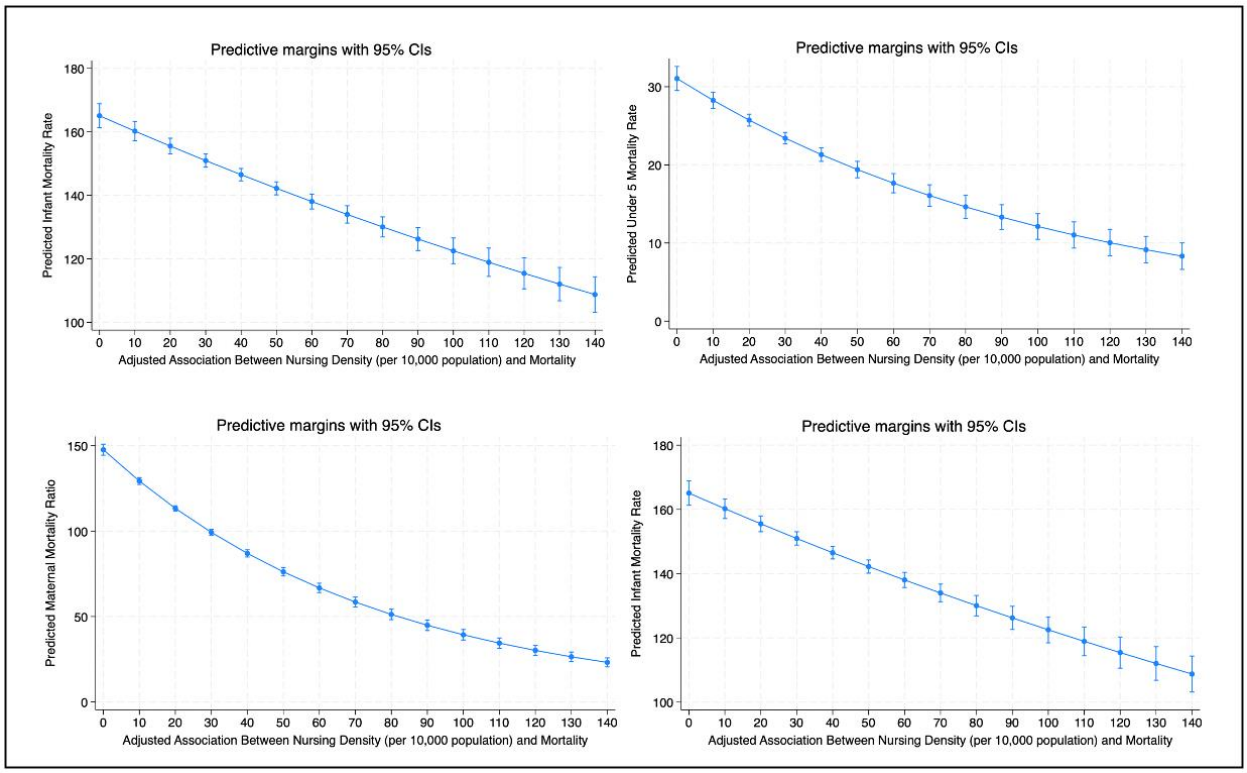

Figure 7. Predicted margins of associations between nursing density and population level health outcome-

High nursing density was statistically significantly associated with lower infant (β= -0.008; 95% CI: -0.013 to -0.004; IRR=0.992; p<0.001), under-five (β= -0.010; 95%CI: -0.014 to -0.005; IRR = 0.990; p< 0.001), and maternal mortality (β= -0.015; 95%CI: -0.024 to -0.006; IRR= 0.985; p=0.001). The associations were however not statistically significant for adult mortality.

Physician density exhibited robust inverse associations across all four outcomes, including infant (β= -0.040; 95%CI: -0.045 to -0.030; IRR=0.961; p<0.001), under-five (β= -0.046; 95% CI: -0.057, -0.036; IRR=0.955; p<0.001), maternal (β=0.068; 95% CI: -0.086 to -0.050; IRR=0.934; P<0.001), and adult mortality (β= -0.013; 95% CI: -0.020 to -0.006; ORR= 0.988; p<0.001). Disaster exposure was not significantly associated with any of the mortality outcomes examined. GNI was statistically associated with lower adult mortality (β= -0.074; 95%

CI: -0.111 to -0.037; IRR= 0.937; p<0.001) but not infant, under-five, or maternal mortality. Temporal trends also varied by outcome. Year was not significantly associated with infant, under-five, or maternal mortality, but was positively associated with adult mortality (β= 0.028; 95% CI: 0.018- 0.037; IRR= 1.024; p<0.001).

4.4.3 Aggregated Health Workforce (Nursing and Physician Density) Associations with Population Health Outcomes Controlling for Disaster Exposure

Table 8 represents longitudinal regression estimates examining associations between a combined health workforce measure—incorporating nursing and physician densities—and population mortality outcomes while controlling for disaster exposure across 135 to 142 countries.

Across all four mortality indicators, higher combined health workforce density was significantly associated with lower mortality. This association was observed for infant mortality (β= -0.017; 95% CI: -0.020 to -0.014; IRR= 0.983; p<0.001), under-five mortality (β= 0.020; 95% CI: -0.023 to -0.017; IRR= 0.980; p<0.001), maternal mortality (β= -0.030; 95% CI: -0.035 to -0.025; IRR= 0.970; p<0.001), and adult mortality (β= -0.005; 95% CI: -0.007 to -0.004; IRR= 0.995; p<0.001).

GNI was also consistently inversely associated with mortality across all outcomes, including infant (β= -0.103; 95% CI: -0.185 to -0021; IRR= 0.902; p= 0.014), under-five (β= -0.117; 95% CI: -0.221 to -0.012; IRR=890; p= 0.029), maternal (β= -0.104; 95% CI: -0.197 to -0.011; IRR =901; p= 0.028), and adult mortality (β -0.080; 95% CI: -0.119 to -0.041; IRR= 0.923; p<0.001).

Disaster exposure was not significantly associated with any mortality outcome. Temporal trends varied by outcome with year being statistically significantly associated with maternal

mortality (β= 0.025; 95% CI: 0.004 to 0.047; IRR=1.026; p= 0.022) and adult mortality (β= 0.027; 95% CI: 0.018 to 0.037; IRR= 1.028; p<0.001).

4.4.4 Shortage Threshold (>49 per 10,000 population) Aggregated Health Workforce (Nursing and Physician Density) Associations with Population Health Outcomes Controlling for Disaster Exposure

Table 9 presents longitudinal regression estimates examining associations between achieving a health workforce threshold of >49 health workers per 10,000 population and mortality outcomes while controlling for disaster exposure across 160 to168 countries.

Meeting or exceeding the workforce threshold was statistically significantly associated with lower infant (β= -0.089; 95% CI: -0.122 to -0.055; IRR= 0.915; p<0.001), under-five (β= -0.050; 95% CI: -0.071 to -0.030; IRR= 0.951; p<0.001), and maternal mortality (β= -0.185; 95% CI: -0.264 to -0.106; IRR =0.831; p<0.001). In contrast, achieving the health workforce threshold was not significantly associated with adult mortality (β= -0.048; 95% CI: -0.100 to 0.005; IRR= 0.953; p= 0.074).

GNI was consistently protective across all outcomes, including infant (β= -0.140; 95% CI: -0.200 to -0.083; IRR= 0.869; p<0.001), under-five (β= -0.113; 95% CI: -0.181 to -0.044; IRR= 0.893; p=0.001), maternal (β= -0.0172; 95% CI: -0.246 to -0.099; IRR= 0.843; p<0.001), and adult mortality (β= -0.122; 95% CI: -0.154 to -0.090; IRR= 0.885; p<0.001).

Disaster exposure was not significantly associated with mortality across any outcomes, while temporal trends again varied by outcome. Year was negatively associated with infant mortality only (β= -0.024; 95% CI: -0.029 to -0.018; IRR= 0.977; p<0.001) and positively associated with adult mortality (β= 0.016; 95% CI: 0.009 to 0.023; IRR= 1.016; p<0.001).

4.5 Discussion

As global and multilateral organizations seek to identify and implement mitigation and adaptation strategies to address the increase in disasters and extreme-weather events, leveraging the full range of health system resources is essential (Romanello et al., 2025). Within this context, nurses are the largest, most broadly available segment of the healthcare workforce; they are central to the delivery of preventative, emergency, and mental health care across the lifespan (International Council of Nurses, 2022b). Their clinical versatility, geographic distribution, and sustained presence within communities make them especially well-suited to support and lead adaptation strategies to maintain service delivery and protect human health during and after crises. This study adds to the growing body of research quantifying the protective capacity the nursing workforces have on population health outcomes (Amiri & Solankallio-Vahteri, 2019; Anand & Bärnighausen, 2004; Liu & Eggleston, 2022).

In this multi-country examination of health workforce capacity during disasters, the availability of nursing personnel was consistently associated with decreased infant, under-five, and maternal mortality. These associations persisted across multiple modeling strategies and analyses, while controlling for physician density, disaster exposure, and economic context. The persistence of the nursing effect suggests that workforce composition, and not simply workforce volume or national wealth, may be particularly relevant in disasters. Although economic development and physician supply are foundational to health system performance, this study's findings suggest that the nursing workforce may represent an additional structural dimension of resilience.

Although the purpose of this paper was to look at the nursing and midwifery workforces, nursing and physician roles are complementary and interdependent. Therefore, we performed additional analyses combining the workforces into a single variable. Nurses and physicians,

along with additional care providers and team members, increasingly operate interdependently; task-shifting, and collaborating to execute coordinated healthcare delivery (Bransby et al., 2023; Mayo et al., 2021). These findings suggest that nursing density, while necessary and protective, may not be sufficient in isolation to ensure optimal population health outcomes during disaster contexts. Measures incorporating the combined density of nurses, midwives, and physicians appear to more fully capture system-level resilience. Notably, the association between disaster exposure and mortality varied according to overall clinical workforce availability, underscoring the importance of total workforce density. Further, the interdependent roles of nurses and physicians during emergencies suggest that the composition and adequacy of the combined health workforce may serve a key facilitator for a health system's capacity to absorb shocks, adapt operationally, and redistribute clinical tasks while sustaining essential services (Ahmat et al., 2022). Our findings support this interpretation: while nursing density alone was significantly associated with lower infant, under-five, and maternal mortality; physician density contributed additional protective effects across all mortality outcomes, including adult mortality. This suggests that the presence of multiple professions may create synergistic effects, allowing health systems to more flexibly allocate tasks and maintain care when individual provider types are strained (Clarke et al., 2025; Liu & Eggleston, 2022).

Additionally, analyses using a combined health workforce measure demonstrated consistent inverse associations with all four mortality outcomes. These results support the notion that a multi-disciplinary workforce enhances the system's ability to sustain critical services during periods of heightened demand, potentially reflecting both absorptive and adaptive capacities. The threshold analyses further reinforce this interpretation. Countries that achieved a combined health workforce threshold above 49 per 10,000, experienced significantly lower

infant, under-five, and maternal mortality. Meeting this benchmark may indicate that the health system has reached a critical mass of personnel sufficient to support operational resilience. Adult mortality was not significantly associated with achieving this threshold, which may reflect differential vulnerability of specific populations or the relative reliance of maternal and pediatric services on frontline nursing care.

Standing alone, physicians have an important role; however, this study underscores the importance of nursing workforces alongside physician workforces for supporting population health and health-system resilience. While physician density demonstrated protective associations across all mortality outcomes, nursing density was particularly critical for infant, under-five, and maternal mortality, highlighting the unique contributions of these cadres to both frontline care and universal health coverage goals (Haakenstad et al., 2022; World Health Organization, 2025f, 2025h). Importantly, this supports the notion that investment in nursing may offer pragmatic advantages; these workforces can be trained more quickly and more cost-effectively than physicians, enabling more rapid scale-up to meet population health needs and respond to emergencies. These findings provide strong empirical support for global health strategies that prioritize expanding nursing capacity as a cost-effective and high-impact approach to improving population health outcomes (International Council of Nurses, 2022b; World Health Organization, 2025f).

4.5.1 Strengths and Limitations

This study is unique in that it leverages a novel method of merging publicly available data into a multi-country longitudinal dataset spanning diverse geographic and disaster contexts, thereby enhancing generalizability across regions and income settings. The use of multiple mortality outcomes across the lifespan provides a comprehensive assessment of population

health impacts during crises. Further, the consistency of findings across complementary modeling strategies strengthens confidence in the robustness of the observed associations. This study explicitly examined nursing density both as a primary predictor as well as part of an aggregate health workforce with physician density. This disaggregation plus combined workforce contributes novel empirical evidence that has rarely been explored, particularly in disaster contexts. Finally, this study seeks to begin to operationalize a minimum workforce threshold by moving beyond linear assumptions to offer policy-relevant recommendations to support health system functioning during emergencies.

Several limitations should be considered when interpreting these findings. First, the country-level design precludes causal inference and limits conclusions about mechanisms. Associations observed at the population level may not reflect relationships within subnational regions or specific communities, particularly in countries characterized by substantial geographic heterogeneity in workforce distribution and disaster exposure.

Second, as previously stated, a significant limitation to this study is data quality and availability. Given the breadth of the study and its overall objective, the study is limited to using publicly available data. This limitation can present missingness, caused by the lack data quality, and the unavailability of data for all years. As a result, the study lost granularity and its data is skewed more towards HIC, and away from LMICs which bear more disadvantage during disasters (Romanello et al., 2025). Further, the highest proportion of missingness is attributed to the primary predictor of interest—nursing density. This limitation further underscores the need for better data collection, reporting, and consistency to improve global nursing workforce studies.

Third, although this study adjusted for economic context and temporal trends, residual confounding by unmeasured health system characteristics such as governance, individual facility readiness, supply-chain resilience, exposure to prior disaster events remains possible. Finally, while the Lifeyears Index is comprehensive in addressing recovery, socioeconomic context and burden of disaster impact, it is limited to the data publicly available through EM-DAT and therefore likely underrepresents total disaster exposure due to data availability.

4.5.2 Implications for Policy and Practice

Despite these limitations, the findings from this study carry important policy implications for both disaster readiness and health workforce planning. First, the consistent protective associations observed for nursing suggest that investments in these professions should be viewed not only as routine health system strengthening, but also as a core component of national disaster-risk reduction, and climate adaptation strategies. Addressing workforce expansion—ideally retention in preventative services like maternal and pediatric service lines—may support absorptive and adaptive capacity of health systems when confronted with acute shocks. The results support prioritization of universal health coverage and primary care access as integral strategies to protect population health outcomes during emergencies.

Second, the effect sizes observed in the threshold-based models point to the potential importance of achieving minimum workforce density targets as part of disaster readiness and national preparedness plans. Establishing and monitoring workforce adequacy benchmarks aligned with universal health coverage could provide governments and multilateral agencies with concrete planning tools for climate adaption and disaster risk reduction strategies. These potential targets may also inform investment prioritization, particularly in settings facing chronic and severe workforce shortages, where incremental gains in staffing could yield disproportionate

health protections during crises. Future research should further examine how different configurations of the health workforce shape population health during disasters. While this study demonstrates the importance of combined clinical workforce capacity, more granular analyses distinguishing roles, skill mix, and scope of practice across nurses, midwives, physicians, as well as community health workers are needed to identify which combinations most effectively support surge capacity, continuity of care, and recovery. Future work should seek to improve data reliability, granularity, and consistency regarding the nursing workforce across countries and regions.

4.5.3 Conclusion

Strengthening global health and meeting long-term resilience goals will require investment in the nursing profession's expertise, leadership, and direct experience with the communities most affected by disaster. Further, broader investments in health workforce training, support, and retention may increase system-level capacity to respond effectively to disasters and mitigate their negative impacts on population health outcomes.

Table 7. Longitudinal Regressions of Nursing Density Associations with Population Health Outcomes Controlling for Disasters

Table 7. Regressions of Nursing Density Associations with Population Health Outcomes During Disasters							
Infant Mortality Rate n=517; 142 countries							
Variable	Coef. β	IRR	SE	Z	P value	95% CI	
Nurse Density	-0.008	0.992	0.002	-3.71	<0.001*	-0.013	-0.004
Physician Density	-0.040	0.961	0.005	-7.89	<0.001*	-0.045	-0.030
Disaster Exposure	0.019	1.019	0.014	1.31	0.189	-0.009	0.046
Gross National Income	-0.076	0.927	0.042	-1.83	0.067	-0.158	-0.005
Year	-0.001	0.999	0.004	-0.35	0.725	-0.009	0.006
Constant	8.246	3,812.066	7.430	1.11	0.267	-6.317	22.809
Under 5 Mortality Rate n=518; 142 countries							
Nurse Density	-0.010	0.990	0.002	-4.07	<0.001*	-0.014	-0.005
Physician Density	-0.046	0.955	0.005	-8.49	<0.001*	-0.057	-0.036
Disaster Exposure	0.027	1.027	0.023	1.16	0.244	-0.018	0.071
Gross National Income	-0.088	0.916	0.543	-1.62	0.105	-0.194	0.018
Year	0.005	1.005	0.010	0.46	0.645	-0.015	0.025
Constant	-3.277	0.038	19.712	-0.17	0.868	-41.912	35.358
Maternal Mortality Ratio n=518; 142 countries							
Nurse Density	-0.015	0.985	0.005	-3.35	0.001*	-0.024	-0.006
Physician Density	-0.068	0.934	0.009	-7.43	<0.001*	-0.086	-0.050
Disaster Exposure	-0.008	0.992	0.009	-0.94	0.349	-0.025	0.009
Gross National Income	-0.067	0.935	0.049	-1.35	0.176	-0.164	0.030
Year	0.019	1.019	0.010	1.83	0.067	-0.001	-0.039
Constant	-30.707	4.61e-14	21.106	-1.45	0.146	-72.074	10.660
Aged 15-60 Mortality Rate n=435; 135 countries							
Nurse Density	-0.003	0.996	0.002	-1.51	0.130	-0.006	0.001
Physician Density	-0.013	0.988	0.004	-3.50	<0.001*	-0.020	-0.006
Disaster Exposure	-0.001	1.017	0.003	-0.40	0.690	-0.007	0.005

Gross National Income	-0.074	0.937	0.019	-3.91	<0.001*	-0.111	-0.037
Year	0.028	1.024	0.005	5.69	<0.001*	0.018	0.037
Constant	-48.974	1.41e-18	9.902	-4.95	<0.001*	-68.381	-29.567

Table 8. Combined Nursing and Physician Health Workforce Associations with Population Health Outcomes Controlling for Disasters

Table 8. Combined Nursing and Physician Health Workforce Associations with Population Health Outcomes During Disasters							
Infant Mortality Rate n=517; 142 countries							
Variable	Coef. β	IRR	SE	Z	P value	95% CI	
Health Workforce	-0.017	0.983	0.001	-11.86	<0.001*	-0.020	-0.014
Disaster Exposure	0.020	1.020	0.004	1.36	0.173	-0.009	0.048
Gross National Income	-0.103	0.902	0.042	-2.46	0.014*	-0.185	-0.021
Year	0.001	1.001	0.004	0.17	0.864	-0.007	0.008
Constant	4.844	126.914	7.606	0.64	0.524	-10.065	19.752
Under 5 Mortality Rate n=518; 142 countries							
Health Workforce	-0.020	0.98	0.002	-12.76	<0.001*	-0.023	-0.017
Disaster Exposure	0.029	1.029	0.023	1.22	0.221	-0.017	0.074
Gross National Income	-0.117	0.890	0.053	-2.18	0.029*	-0.221	-0.012
Year	0.007	1.007	0.010	0.70	0.485	-0.013	0.027
Constant	-7.508	0.001	19.813	-0.38	0.705	-46.342	31.325
Maternal Mortality Ratio n=518; 142 countries							
Health Workforce	-0.030	0.970	0.003	-12.05	<0.001*	-0.035	-0.025
Disaster Exposure	-0.006	0.994	0.010	-0.067	0.506	-0.025	0.012
Gross National Income	-0.104	0.901	0.047	-2.20	0.028*	-0.197	-0.011
Year	0.025	1.026	0.011	2.30	0.022*	0.004	0.047
Constant	-42.262	4.42e-19	22.411	-1.89	0.059	-86.187	1.663
Aged 15-60 Mortality Rate n=435; 135 countries							
Health Workforce	-0.005	0.995	0.001	-5.60	<0.001*	-0.007	-0.004
Disaster Exposure	-0.000	0.999	0.003	-0.12	0.908	-0.007	0.006

Gross National Income	-0.080	0.923	0.020	-4.00	<0.001*	-0.119	-0.041
Year	0.027	1.028	0.005	5.57	<0.001*	0.018	0.037
Constant	-47.927	1.53e-21	9.935	-4.82	<0.001*	-67.400	-28.455

Table 9. Total Adequate Level Health Workforce Associations with Population Health Outcomes Controlling for Disasters (>49 per 10,000 population)

Table 9. Total Adequate Level Health Workforce Associations with Population Health Outcomes During Disasters (>49 per 10,000 population)							
Infant Mortality Rate n=772; 168 countries							
Variable	Coef. β	IRR	SE	Z	P value	95% CI	
Health Workforce	-0.085	0.915	0.017	-5.10	<0.001*	-0.118	-0.052
Disaster Exposure	0.012	1.012	0.007	1.78	0.074	-0.001	0.025
Gross National Income	-0.014	0.869	0.029	-4.86	<0.001*	-0.200	-0.084
Year	-0.024	0.977	0.003	-9.21	<0.001*	-0.029	-0.019
Constant	54.291	2.92e+23	4.774	11.37	<0.001*	44.934	63.648
Under 5 Mortality Rate n=776; 168 countries							
Health Workforce	-0.051	0.951	0.001	-4.56	<0.001*	-0.073	-0.029
Disaster Exposure	0.011	1.011	0.007	1.64	0.100	-0.002	0.024
Gross National Income	-0.113	0.893	0.035	-3.21	0.001*	-0.181	-0.044
Year	-0.018	0.982	0.011	-1.62	0.106	-0.040	0.004
Constant	42.483	2.47e+18	23.138	1.84	0.066	-2.866	87.833
Maternal Mortality Ratio n=776; 168 countries							
Health Workforce	-0.166	0.831	0.043	-3.90	<0.001*	-0.250	-0.083
Disaster Exposure	-0.011	0.989	0.007	-1.05	0.296	-0.033	0.010
Gross National Income	-0.172	0.844	0.037	-4.60	<0.001*	-0.246	-0.099
Year	-0.013	0.987	0.007	-1.84	0.066	-0.027	0.001
Constant	35.507	2.33e+15	13.969	2.54	0.011*	8.129	62.886
Aged 15-60 Mortality Rate n=650; 160 countries							
Health Workforce	-0.048	0.953	0.027	-1.79	0.074	-0.100	0.005
Disaster Exposure	0.002	1.002	0.002	0.83	0.408	-0.002	0.005

Gross National Income	-0.121	0.885	0.016	-7.46	<0.001*	-0.153	-0.090
Year	0.016	1.016	0.003	4.48	<0.001*	0.009	0.023
Constant	-23.607	6.18e-11	7.111	-3.31	0.001*	-37.445	-9.569

Table 10. Supplemental Table, Measures included in Lifeyears Index

Supplemental Table. Measures included in Lifeyears Index			
Variable	**Construct**	**Objective Measure**	**Data Source**
Y	Monetary damages	Damages in US Dollars	EM-DAT
M	Mortality	# of people killed in the disaster	EM-DAT
A^{exp}	Life expectancy	92	World Health Organization's *Life Tables*
A^{med}	Median age	Median age for country	World Bank's *World Development Indicators*
N^{EMDAT}	People affected	Number of people affected by the disaster	EM-DAT
E	"welfare-reduction weight" of being exposed to a disaster	0.054	WHO's weight for disability
T	Time it takes an affected person to return to normality	3 years	
$PCGDP$	Opportunity cost of spending effort on reconstruction	Per capita gross domestic product	World Bank's *World Development Indicators*
C	Discounted measure of 75% to account for the observation that time is not always spent on work-related activities	75%	

Equation 1: $Lifeyears = M(A^{exp} - A^{med}) + eTN^{EMDAT} + {}^{(1-c)Y}/_{PCGDP}$

Table 11. Supplementary Table 2. Baseline Characteristics of World Health Organization Member States 2016

Supplementary Table Baseline Characteristics of World Health Organization Member States 2016								
Country	Nurse Density (per 10,000 population)	Physician Density (per 10,000 population)	Lifeyears Index	GNI (PPP)	Infant Mortality Rate	Under 5 Mortality Rate	Maternal Mortality Ratio	Age 15-60 Mortality Rate
World	38.6	19.5	-	-	30.8	41	223	-
Afghanistan	1.51	2.84	14,652.84	-	53.04	70.2	702.2	-
Albania	36.35	12.12	894.4	40,000 M	8.36	9.4	8.47	69.67
Algeria	22.27	18.19	3,785.49	600,000 M	21.38	24.9	78.69	83.53
Andorra	44.75	40.59	-	-	3.22	3.4	9.83	-
Angola	-	-	10,157.74	220,000 M	55.43	84	235.7	255.3
Antigua and Barbuda	47.13	-	-	-	9.08	10.8	27.94	111.4
Argentina	34.08	50.24	13,910.86	1,200,000 M	10.11	11.4	39.51	115.1
Armenia	49.57	28.86	121.5	39,000 M	12.3	13.8	24.59	120.4

Australia	123.71	35.57	910.22	1,200,000 M	3.23	3.8	5.93	60.37
Austria	70.26	51.29	0	550,000 M	3	3.6	6.49	62.11
Azerbaijan	59.6	32.62	-	-	22.01	24.8	22.34	106.8
Bahamas	-	-	6.07	12,000 M	11.9	13.8	77.21	180.2
Bahrain	21.13	8.3	-	75,000 M	6.38	7.5	16.61	78.53
Bangladesh	2.59	4.89	521,346.5	960,000 M	30.1	36.8	191	123.3
Barbados	-	-	-	-	12.08	13	36.26	113.9
Belarus	108.86	43.72	-	210,000 M	2.92	3.9	1.3	161.6
Belgium	120.01	32.8	206	670,000 M	3.36	4.1	4.84	69.03
Belize	21.66	-	1,677.51	4,300 M	12.86	14.9	51.4	165.7
Benin	2.23	0.45	3,047.14	35,000 M	61.8	95.2	604.2	211.4
Bhutan	15.1	4	-	9,400 M	24.55	29.4	63.31	118.6
Bolivia (Plurinational State of)	11.03	15.69	108,903.5	99,000 M	24.66	30.4	162.1	137.4
Bosnia and Herzegovina	56.52	21.46	-	51,000 M	5.53	6.4	6.53	94.39
Botswana	39.77	3.71	-	37,000 M	38.06	47.4	72.26	326.4
Brazil	94.87	-	27,379.66	3,500,000 M	15.03	16.7	63.64	137.4
Brunei Darussalam	63.55	-	-	32,000 M	8.54	9.9	39.38	98.83
Bulgaria	48.03	41.07	-	160,000 M	6.43	7.7	6.93	138.1
Burkina Faso	6.35	0.62	9761.96	38,000 M	57.94	96.9	313	244.5
Burundi	-	-	3208.47	9,600 M	44.15	64	500.5	249.5
Cabo Verde	13.46	-	-	3,800 M	14.63	17	44.26	144.2
Cambodia	11.24	1.97	405000	75,000 M	25.86	30.1	159.2	190.3
Cameroon	-	-	5707.2	110,000 M	56.15	85.9	393.3	308.8
Canada	99.27	-	14332.72	1,900,000 M	4.63	5.3	12	67.38
Central African Republic	-	-	10530.1	1,900 M	-	126	962.5	469
Chad	2.05	0.36	-	35,000 M	74.1	125	1133	263.1
Chile	30.66	22.86	718.41	460,000 M	6.71	7.8	13.17	80.8
China	24.98	18.88	11.8 M	-	7.57	9.9	24.78	91.49
Colombia	12.86	20.88	62,128.64	780,000 M	11.41	13.3	93.68	105.1
Comoros	-	2.91	-	2,400 M	45.75	59.1	225.5	178.8
Congo	8.88	1.01	-	37,000 M	36.73	51	262.7	301.8
Costa Rica	25.92	19.55	8,692.29	100,000 M	7.55	8.8	27.03	85.61
Cote d'Ivoire	4.67	-	1,484	140,000 M	61.51	83.8	487.7	269.2
Croatia	67.92	32.65	-	130,000 M	4.13	4.9	3.72	86.58
Cuba	79.07	80.03	-	-	4.8	6.1	41.48	98.25
Cyprus	38.36	25.94	-	33,000 M	2.38	3	11.57	53.89
Czechia	83.28	-	-		2.58	3.2	3.22	81.92
Democratic People's Republic of Korea	-	36.45	-	-	16.2	20.4	71.31	165.1
Democratic Republic of the Congo	5.56	-	14,822.19	74,000 M	70.88	92.4	526.5	267.9
Denmark	115.86	39.99	-	360,000 M	3.47	4	5.17	65.87
Djibouti	-	-	-	5,200 M	52.67	63.2	204.5	246.6
Dominica	68.53	-	-	-	26.46	28	47.70	-
Dominican Republic	11.01	-	454,261.2	200,000 M	28.85	35.1	105.7	160.2
Egypt	17.89	7.63	25,937.43	1,400,000 M	19.08	22.4	22.6	153.7
El Salvador	18.49	-	-	60,000 M	12.68	14.2	43.4	178.6
Ecuador	28.5	20.6	115,337	180,000 M	12.5	15	40	104.1
Equatorial Guinea	-	-	-	24,000 M	65.78	90.3	216.3	292.9
Eritrea	15.55	0.72	-	-	33.1	44.9	394.6	297.6
Estonia	64.36	34.56	-	49,000 M	2.25	2.9	7.16	117.4
Eswatini	36.54	0.93	79,704	11,000 M	47.33	60.6	212.9	528.1
Ethiopia	-	-	95,044.52	220,000 M	41.8	59.9	364	183
Fiji	-	-	91,503.45	-	18.71	22	37.56	224.6
Finland	120.89	34.2	-	300,000 M	1.98	2.4	7.44	69.55

France	91.86	31.99	4,756.65	3,500,000 M	3.25	4.2	8.76	72.13
Gabon	24.32	3.4	1,272.6	25,000 M	34.11	48.6	214.8	261.5
Gambia	-	-	-	5,600 M	38.44	57.1	489.5	254.1
Georgia	50.61	63.51	-	55,000 M	9.09	10.2	27.94	160.3
Germany	110.92	41.66	923.89	5,200,000 M	3.28	3.9	4.44	70.12
Ghana	20.53	1.23	5,151.01	160,000 M	37.85	53	296.1	250.1
Greece	35.01	61.22	22,887.51	340,000 M	3.6	4.3	4.92	70.77
Grenada	-	-	-	-	13.46	15.1	44.04	148.4
Guatemala	10.24	-	733.36	170,000 M	22.95	27.3	110.1	174.7
Guinea-Bissau	5.69	1	-	4,300 M	58.13	88.7	616.8	339.4
Guinea	1.21	0.81	1,129.86	35,000 M	70.7	109.9	606	258.9
Guyana	7.4	-	-	-	26.58	32.1	114.1	240.3
Haiti	-	-	982,027.8	37,000 M	51.48	67.8	356.1	265.2
Honduras	7.21	5.89	73,420.06	53,000 M	16.88	19.7	54.65	165
Hungary	66.04	32.12	369.68	310,000 M	3.98	4.7	13.31	125.8
Iceland	152.92	38.72	-	-	2.07	2.6	3.11	54.6
India	14.74	7.48	733,751	9,300,000 M	34.71	41.1	120.8	173
Indonesia	11.93	-	101,453.7	2,900,000 M	22.25	26.4	181.8	159.6
Iran (Islamic Republic of)	-	-	6,312.19	1,300,000 M	12.78	14.9	21.3	89.23
Iraq	16.32	7.07	806.3	410,000 M	23.91	28.6	87.09	173.6
Ireland	115.65	31.93	-	320,000 M	3.09	3.6	4.36	60.31
Israel	54.38	34.22	9,746.64	360,000 M	3.07	3.8	3.13	55.08
Italy	58.54	39.62	20,251.24	2,900,000 M	2.92	3.4	7.7	50.11
Jamaica	16.6	4.7	20,250	-	15.97	18.6	102.1	143.4
Japan	115.72	24.32	76,503.13	5,800,000 M	1.97	2.7	4.92	52.8
Jordan	-	-	988.63	-	14.64	17	40.38	69.22
Kazakhstan	72.69	37.07	-	480,000 M	9.84	11	12.18	169.3
Kenya	10.55	-	561,770.4	220,000 M	33.61	46.3	440.9	269.6
Kiribati	-	-	-	550 M	46.07	59.6	88.1	302.5
Kuwait	70.07	21.06	-	200,000 M	7.67	9	7.78	55.64
Kyrgyzstan	47.78	18.53	-	30,000 M	18.76	21	53.16	148.6
Lao People's Democratic Republic	12.51	3.71	4,613.64	-	40.04	50.8	164.8	189.3
Latvia	48.42	32.12	-	60,000 M	4	4.7	23.27	151.9
Lebanon	16.69	21.36	-	110,000 M	11.18	13	14.81	75
Lesotho	-	-	114,858	6,900 M	63.02	77.8	517.5	606.2
Liberia	-	0.49	2,499.82	-	63.08	86	690.1	247.5
Libya	-	-	90,859.6	80,000 M	10.92	12.8	74.04	163.1
Lithuania	80.23	44.65	-	110,000 M	3.81	4.7	9.27	161.6
Luxembourg	120.77	28.84	-	49,000 M	2.24	2.7	13.38	50.99
Madagascar	-	-	187,765.5	43,000 M	45.07	65.7	469.9	241.8
Malawi	2.92	0.31	1,364.4	-	36.78	53.2	311.8	306.6
Malaysia	40.17	15.76	8,150.86	880,000 M	6.99	8.2	29.59	140.8
Maldives	25.63	13.2	1,944	9,900 M	7.73	9	40.97	70.81
Mali	3.86	1.17	2,541.3	48,000 M	68.52	112	471.7	236.7
Malta	86.02	76.57	-	19,000 M	5.66	6.5	9.59	54.26
Marshall Islands	-	-	-	290 M	28.45	34.5	183.5	-
Mauritania	-	-	-	20,000 M	36.44	47.5	456	155.4
Mauritius	32	21.44	-	-	13.03	14.7	62.4	148.2
Mexico	28.8	23.45	24,986.42	2,500,000 M	13.52	15.7	43.16	133.6
Micronesia (Federated States of)	-	-	16,200	-	24.59	29.5	172.6	271.5
Monaco	-	-	-	-	2.78	3.4	5.53	-
Mongolia	40.86	32.89	25,434	33,000 M	15.84	18.5	48.13	214.8
Montenegro	50.25	25.89	-	13,000 M	3.28	3.8	6.03	99
Morocco	-	-	121,500	290,000 M	19.1	22.3	94.25	122
Mozambique	4.89	-	413,467.8	40,000 M	57.95	79.4	169.8	395.7
Myanmar	10.65	6.38	169,731.7	-	39.11	49.4	215.2	191.4
Namibia	19.74	-	-	28,000 M	32.5	45.3	249.6	334.5
Nauru	-	-	-	-	26.67	32.2	248.4	-

Nepal	-	-	20,472.45	110,000 M	29.66	36.2	213.5	156
Netherlands	107.86	35.01	5.187	1,100,000 M	3.46	4.1	5.26	58.28
New Zealand	107.83	31.15	200.17	200,000 M	4.45	5.3	7.67	66.69
Nicaragua	14.83	9.65	2,612.74	44,000 M	15.96	18.6	76.77	116.3
Niger	2.7	0.33	26,986.13	32,000 M	63.13	125.5	450.3	220.7
Nigeria	16.7	4.28	121,810	-	78.22	124.5	1155	194.1
Niue	-	-	-	-	-	-	-	-
North Macedonia	50.4	31.66	6,661.008	36,000 M	9.38	10.6	3.88	95.5
Norway	157.49	42.2	698.1	420,000 M	2.13	2.6	2.06	53.03
Occupied Palestinian territory, including east Jerusalem	-	-	-	32,000 M	15.2	17.7	22.94	88.43
Oman	45	19.64	1,278.59	150,000 M	9.55	11.1	14.49	108.9
Pakistan	4.51	8.9	49,937.44	1,000,000 M	60.48	73.8	193	188
Palau	-	-	-	320 M	21.68	21.9	79.87	-
Panama	29.92	15.73	2,395.5	120,000 M	14.71	17.1	46.57	93.03
Papua New Guinea	-	-	1,921.2	-	39.5	50	213.8	213.4
Paraguay	7.63	-	0	87,000 M	18.29	21.5	59.63	127.7
Peru	21.8	13.07	10,349.03	420,000 M	12.98	16.7	68.76	81.62
Philippines	46.18	6.31	904,282.4	1,000,000 M	22.07	27.9	97.96	195.1
Poland	57.16	23.97	1,226.39	1,200,000 M	4.08	4.8	1.86	114
Portugal	67.16	49.3	4,16.91	370,000 M	2.95	3.6	12.16	73.54
Qatar	50.6	27.51	680.64	-	6.29	7.4	5.4	73.91
Republic of Korea	69.81	22.9	5,850.55	2,300,000 M	2.93	3.4	6.07	59.65
Republic of Moldova	66.28	32.39	-	35,000 M	13.22	15.4	20.6	171.2
Romania	68.03	28.3	235.2	550,000 M	7.06	8.5	17.17	137.5
Russian Federation	92.28	39.64	17,784.75	4,600,000 M	6.07	7.5	13.75	207.5
Rwanda	10.36	1.2	13,476.06	27,000 M	33.8	46.1	278.1	206.9
Saint Kitts and Nevis	-	-	-	-	15.46	18	74.57	-
Saint Lucia	-	56.7	4,050	-	16.22	17.7	45.81	128.5
Saint Vincent and the Grenadines	86.6	-	4,110.96	-	14.22	15.5	52.05	181
Samoa	-	3.29	-	1,400 M	15.74	18.4	107.7	200.4
San Marino	-	-	-	-	1.71	1.9	7.39	-
Sao Tome and Principe	-	-	-	-	16.84	21.1	119.4	161.4
Saudi Arabia	59.89	24.66	2,488.50	1,600,000 M	7.32	8.6	7.91	89.45
Senegal	2.99	0.77	2,096.65	54,000 M	34.22	48.3	345.1	193.2
Serbia	62.89	29.26	1,453.6	130,000 M	5.22	6.1	13.17	112.2
Seychelles	70.38	18.48	40.97	2,600 M	12.59	14.6	46.99	159.2
Sierra Leone	7.59	-	-	19,000 M	89.86	125.7	632.9	254.6
Singapore	62.52	23.25	2,114.26	540,000 M	2.18	2.7	8.2	51.3
Slovakia	60.84	34.76	-	180,000 M	5.08	6.1	4.99	104.3
Slovenia	97.58	30.19	-	81,000 M	2.08	2.6	4.97	71.67
Solomon Islands	-	1.81	4,822.94	1,800 M	18.87	22.2	142.7	288.9
Somalia	-	-	49,418.73	20,000 M	80.47	128.5	754.1	365.3
South Africa	13.1	7.5	2,835.81	750,000 M	28	37	475	324.6
South Sudan	-	-	-	-	63.8	98.8	1629	290.2
Spain	56.73	38.03	930.22	2,100,000 M	2.73	3.3	3.39	57
Sri Lanka	18.69	8.56	207,073	290,000 M	7.12	8.3	21.6	103.2
Sudan	-	-	47,957.73	-	43.44	62.7	288.2	159
Suriname	18.78	10.87	-	-	17.82	20	108.6	173.1
Sweden	117.11	42.33	-	590,000 M	2.31	2.8	4.55	52.3
Switzerland	173.38	42.5	-	660,000 M	3.65	4.2	6.67	47.26

Syrian Arab Republic	14.02	11.71	-	-	23.19	34.7	22.6	324
Tajikistan	48.91	17.54	2,375.41	63,000 M	31.92	36.6	20	118.9
Thailand	26.99	4.33	138,180.1	-	8.57	10	34.15	142.4
Timor-Leste	-	-	19,440	6,100 M	49.98	59.6	286.7	163
Togo	3.03	0.44	-	19,000 M	49.44	73.4	460.1	277.9
Tonga	-	-	63.504	670 M	10.62	12.3	77.93	167.6
Trinidad and Tobago	40.88	-	-	-	16.74	18.7	50.62	161.7
Tunisia	26.06	12.58	-	150,000 M	14.67	17.1	38.92	86.84
Turkmenistan	39.02	19.58	-	-	37	42.9	5.7	192.2
Tuvalu	-	-	-	-	21.18	25.1	170.4	-
Türkiye	25.15	17.74	9,951.07	-	10.89	12.7	19.28	87.32
Uganda	16.76	-	7193.417	100,000 M	37.49	52.6	272.5	257.8
Ukraine	-	-	3,025.71	560,000 M	7.84	9.2	16.5	179.7
United Arab Emirates	57.33	24.58	-	620,000 M	5.86	7.3	3.12	43.94
United Kingdom of Great Britain and Northern Ireland	83.26	27.73	-	3,300,000 M	3.84	4.4	9.41	70.1
United Republic of Tanzania	-	-	47,892.88	160,000 M	37.72	52.4	395.5	236.3
United States of America	114.57	-	13.8 M	21,000,000 M	5.72	6.7	17.79	109.4
Uruguay	-	40.08	2,180.45	91,000 M	7.21	8.5	16.14	112
Uzbekistan	-	22.98	-	-	16.53	18.5	30.57	172.6
Vanuatu	-	1.69	56.86	850 M	17.71	20.8	107.3	256
Venezuela (Bolivarian Republic of)	-	-	-	-	21.18	24.2	162.2	161.1
Viet Nam	14.41	8.25	418,164.9	890,000 M	17.33	21.7	56.05	134
Yemen	6.33	-	-	-	37.49	47.9	133.8	190.2
Zambia	-	0.9	1,816.8	-	45.4	65.1	158.1	323.5
Zimbabwe	13.45	1.72	4,917.03	49,000 M	40.35	57.5	411.4	411.3

Chapter 5 Chapter 5 Global Nurse Leader Insights on Resilience and Readiness

5.1 Abstract

Background: Global shortages and poor working conditions continue to undermine the global nursing workforce, particularly in low- and middle-income countries and in disaster-prone settings. International policy has emphasized sustained investment in nursing as essential for building resilient and equitable health systems, yet implementation of these commitments—through funded, enforceable, and measurable workforce policies—remains limited. While a myriad of conceptual models of healthcare disaster readiness and health system resilience have been advanced, these often exclude or limit the role of nursing, or are produced without nursing involvement. Empirical work centering the perspectives of nursing leaders regarding the nursing workforce warrants further investigation. Therefore, this study aimed to identify the facilitators, barriers, and contributions of nurses in fostering health system resilience in disaster contexts.

Methods: This qualitative study used semi-structured interviews with 10 global nursing leaders from all six World Health Organization regions. Participants were recruited through professional networks and international nursing organizations using purposive and snowball sampling. Interviews were audio-recorded, transcribed verbatim, and analyzed using content analysis guided by an iterative, team-based coding process. Rigor was enhanced through double-coding and reflexive journaling.

Results: Analysis revealed three categories: 1) Nursing's positioning and public narrative; 2) Power, leadership, and system influence; and 3) Policy engagement and future-oriented change. Together, these categories characterize the barriers, facilitators, and real and potential contributions through which nursing influences population health during disasters.

Conclusion: Global nursing leaders describe how the nursing workforce is indispensable to disaster response and health system resilience, but constrained by chronic underinvestment and policy marginalization across all regions. Strengthening nursing leadership, ensuring effective training and educational supports, and embedding nurses in health and healthcare policy governance structures are critical strategies for advancing resilient and equitable health systems worldwide.

Implications for Practice and Policy: Findings support the need for national and global policies that prioritize sustained nursing workforce investment, integrate nurses into disaster management leadership roles, and target inequities in resource distribution, particularly in response to increasing hazards and sociopolitical risks.

5.2 Introduction

Strong health systems not only protect populations during ordinary times, but they are also especially critical when shocks strike, whether they be conflict and displacement, pandemics, or natural hazards. Because nurses are the largest healthcare profession globally, with nearly 30 million in number and accounting for nearly 60% of the global health workforce, their capacity and distribution are central determinants of health system functioning and continuity of care during these periods (World Health Organization, 2025f). Nurses often bear the brunt of dysfunctional health systems as frontline providers, however, as a discipline are largely excluded from the high-level policy and decision-making leading to the development of more resilient health systems. Health system resilience refers to the ability of a system to prepare for, absorb, adapt, and recover from disasters and shocks while maintaining continuity of care (OECD, 2023). Disaster readiness is an extension beyond the traditional notion of "disaster preparedness" to include both the practical and logistical aspects of preparedness (planning, resource allocation) as well as the psychological anticipation and fortitude needed to mitigate the negative effects of such events (Hugelius, 2021; Kruger et al., 2024; Su et al., 2022). Analyzing health system resilience through a nursing lens aims to prioritize the needs and valuable perspectives of nurses, which have long been overlooked (Rasmussen et al., 2022). The ability for a health system to be resilient and maintain essential functions is heavily dependent on its healthcare workforce stability (Buchan, 2010; Clarke et al., 2025). Further, health workforce retention, appropriate nurse staffing ratios, and specialty training that matches the needs of the community are all components of healthcare workforce stability (Burau et al., 2022).

Nursing remains comparatively underrepresented in many of the conceptual and empirical analyses of health care resilience (Kruger et al., 2025). Meaningful progress toward resilient health systems requires the active engagement of nurses in system design, policy development, preparedness, and recovery efforts (International Council of Nurses, 2022b; World Health Organization, 2025f). Globally, nurses and midwives in many settings constitute the primary, and sometimes sole source of healthcare within communities. Despite this central role, the nursing profession's influence in global health policy and planning has historically lagged behind its scale and societal contributions (Salvage & White, 2020). Health systems are projected to increasingly confront compounding conditions—aging populations with increased chronic health needs, worsening health disparities across geographic contexts, and intensifying hazard risks (World Bank, 2026). Successful system adaptation and mitigation efforts will depend upon embedding and empowering nurses in leadership roles to drive sustainable and resilient system transformation (International Council of Nurses, 2021b).

Globally, working conditions for nurses remain poor, reflecting longstanding underinvestment (World Health Organization, 2025f). Inadequate compensation, compounded by persistent gender pay inequities, alongside workplace violence and chronic understaffing have directly intensified the global nursing shortage (Catton, 2025). The International Council of Nurses projects this shortage will worsen by 2030, with a deficit exceeding 13 million nurses worldwide (International Council of Nurses, 2024). Most concerning, the majority of these vacancies are expected to occur in low- and middle-income countries, further entrenching existing inequities in both workplace conditions, leadership and population health outcomes (Catton, 2025).

The World Health Organization has repeatedly underscored the urgent need for sustained and strategic investment in the nursing workforce as a cornerstone of resilient health systems; yet the extent to which countries have translated this guidance into concrete policy and financing commitments has been highly uneven (World Health Organization, 2022a). Although a growing body of scholarship has examined the relationship between disasters and health system resilience, advancing conceptual frameworks, refining definitions, and proposing early efforts to operationalize resilience at the system level (Copeland et al., 2023; Foroughi et al., 2022; Kruk et al., 2015), empirical work centering the nursing workforce remains limited. To address this gap, this qualitative study sought to explore global nursing leaders' perspectives on the facilitators, barriers shaping nursing capacity during disasters, as well as the critical contributions of the nursing workforce to advancing and leading both health system resilience and health equity in disaster-affected settings.

5.3 Methods

5.3.1 Study Design

Guided by the Health System Dynamics Framework, this study used semi-structured key-informant interviews with global nursing leaders to explore the relationships between the global nursing workforce, health system resilience, and disasters (Olmen et al., 2012; Perlman et al., 2023). The interview guide was developed using the WHO's Health System Resilience Framework and the ICN Disaster Nursing Core Competencies (International Council of Nurses, 2019a; World Health Organization, 2024a) (Appendix A).. The interview guide was developed using a semi-structured format, allowing for a balance between consistency across interviews and flexibility for participants to elaborate on their experiences (DeJonckheere & Vaughn, 2019). Prior to full implementation, pilot testing was conducted with a small sample of nurse

researchers to allow for the refinement of questions, wording, and flow to minimize the potential for confusion or bias (DeJonckheere & Vaughn, 2019). The draft interview guide consists of 28 open-ended questions aimed to understand 1) the background of the nurse leader participant; 2) disaster and health system context in their specified region/context; 3) the role of nurses in health system resilience; 4) policy engagement and development; 5) broad recommendations for increased nursing participation in resilience; 6) health equity; 7) nursing leadership; and 8) future directions. Interviews were designed to last between 50 and 60 minutes. In this study, we employed a rigorous, well-established content analysis method to systematically identify and interpret key patterns within the data. (Erlingsson & Brysiewicz, 2017a) to analyze and code transcripts.

5.3.2 Recruitment & Study Population

Using purposive and snowball sampling, participants were chosen because of their expertise and leadership position as country representative nurse leaders, senior executive nurses, or senior nurse academics (Campbell et al., 2020; Oregon State University Division of Research and Innovation, 2012). We reached thematic saturation with 10 interviews (Hennink & Kaiser, 2022). We sought participants from each of the WHO Regions: African Region, Region of the Americas, South-East Asian Region, European Region, Eastern Mediterranean Region, and Western Pacific Region. Recruitment efforts included personalized electronically delivered invitations and detailed explanations of the study's purpose, emphasizing the importance of their insights. The electronically delivered invitation included study information as well as informed consent.

Table 12. Inclusion and Exclusion Criteria of Study Participants

Table 13. Inclusion and Exclusion Criteria of Study Participants	
Inclusion Criteria	*Exclusion Criteria*
Global nurse leader	Not professionally registered nurse

Currently employed or holding a recognized volunteer position at a national, regional, or global nursing leadership position	Fewer than 10 years of nursing experience
English speaking, although this does not need to be their primary language	
Experience in global leadership and disaster leadership	

5.3.3 Data Collection

Interviews were conducted via Zoom for Healthcare, recorded and transcribed with artificial intelligence (AI) transcription within the application with participant's verbal consent. The interviews occurred with two trained interviewers on the videocall, in an effort to minimize interviewer bias as well as confirmation and inconsistency bias (Kviz, 2019). The AI transcription was then deidentified and manually verified by the primary researcher through repeated review of the original video recordings to ensure accuracy and completeness. Additionally, all electronic data/notes from study personnel conducting interviews were stored on a password-protected and HIPPAA compliant server. Immediately after each interview, the two interviewers met to debrief, as well as practice reflexive analysis to minimize researcher bias.

5.3.4 Researchers' positionality

The two interviewers both have experience as clinical nurses in emergency and disaster management, while one of the coders is an early career researcher and nurse without significant emergency and disaster experience. The primary investigator (KEK) had professional working relationships with two of the participants prior to the study, while the second interviewer (SAB) had professional relationships with five of the participants (Tong et al., 2007).

5.3.5 Data Analysis

Data analysis occurred inductively using content analysis (Erlingsson & Brysiewicz, 2017a). The transcripts were coded systematically by two researchers trained in content analysis (KEK & TNL), with recurring codes and categories identified; a third coder (SAB) conducted an independent review of the coding to ensure consistency and analytic rigor. Interview notes were also collected and used in data analysis to triangulate results. We used Dedoose (Dedoose, 2021), a qualitative coding software, to organize codes into a coding framework. The transcripts were first divided into meaning units and condensing meaning units (Erlingsson & Brysiewicz, 2017b). Thereafter, we iteratively conducted theme development, ensuring these accurately reflect the data and capture the depth of participant responses (Naeem et al., 2023). Using the underlying Health System Dynamics Framework (Olmen et al., 2012), the study team explored the relationships between the concepts and identified categories to explain the facilitators, barriers, and key contributions of the nursing workforce during disasters.

5.3.6 Ethical Considerations

This study was approved by the University of Michigan Institutional Review Board (HUM00274342). Written Informed Consent was obtained from participants prior to beginning interviews. No study incentives were provided.

5.4 Results

5.4.1 Descriptive Statistics

A total of 10 nurse leaders participated in this study. Table 2 summarizes participant demographics. Participants represented each of the World Health Organization's six regions, with two each from the African Region, the Americas, South-East Asia, and the Europe Regions. The Western Pacific and the Eastern Mediterranean region had one nurse leader participant each.

All the participants identified as female, while 6/10 (60%) identified as White or Caucasian, 1/10 (10%) identified as Black and Middle Eastern, respectively, and 2/10 (20%) identified as Asian.

Table 13. Participant Demographics

Participant Demographics	***n* (%)**
Gender	
Female	9 (90%)
Male	1 (10%)
Race	
Asian	2
Black	1
Middle Eastern	1
White/Caucasian	6
World Health Organization Region	
Africa	2
Americas	2
Eastern Mediterranean	1
Europe	2
South-East Asia	2
Western Pacific	1
Highest Degree Achieved	
PhD	8
DNP	1
Masters	1
Additional Certifications	
Emergency	5
Disaster Management	3
Mental Health	1
Nursing and/or Hospital Management	1
Public Health Nursing	1
Current Primary Job Setting	
Academic	3
Government	3
Health System/Non-Governmental Organization	4
Years in Nursing	
Mean	31
Range	15-51

The study team identified three categories to describe the facilitators, barriers, and contributions of the nursing workforce during disaster contexts: 1) Nursing's positioning and public narrative; 2) Power, leadership, and system influence; and 3) Policy and future-oriented change.

5.4.2 Category 1: Nursing's positioning and public narrative

Participants described how nursing is framed in the public narrative as both a facilitator and barrier to the status and realized authority of the profession. Nurse leaders discussed the invisibility of the profession, both in terms of how nursing is undervalued and underrecognized, while also contrasting that with the public perception of high public trust, and under-recognized effectiveness. Participants consistently described the quiet leadership without clear recognition or credit, emphasizing this as both a facilitator for health, but a barrier for being included in leadership roles:

"The silence, in many ways, of nursing leadership the, the quiet nursing leadership that occurs, that is invisible, but binds from, sort of, like, within the organization to get things done, which doesn't raise its head as, you know, like shouting, here we are, here we are. We just get on and do what needs to be done, efficiently. And effectively, often." (Participant 9)

"You know, there's not enough organizations in the country that, as I said, that value nurses, and they need to understand that nurses do have a valuable role, do have a strong voice, do understand what the needs of the people are. For the most part, without an agenda. Nurses are one of the few professions in healthcare that don't always have a monetary position to take." (Participant 5)

One participant emphasized a key barrier being that nurses may not be seen as effective or valuable outside of bedside roles by other healthcare providers:

"It's hard because nurses are not seen and viewed, outside their sphere as decision makers. They're nice people, they help with healthcare, they help me know what to do with my kids when they're sick, but they're not viewed as decision makers." (Participant 5)

Some participants agreed that barriers to leadership participation go beyond the public perception, and included how nurses view themselves:

"Nursing is very good about complaining how nobody involves them, and so it doesn't involve them in the disaster committees, and just does stuff without them, but then the nurses are very good at just scattering and not, you know, not wanting to put themselves forward to be on the disaster committee, being part of the disaster planning, you know, etc. And I think if you want to be leading in those things, you have to be willing to be." (Participant 1)

Several participants discussed the barriers related to health system structure as well as broader societal expectations related to traditional power and gender structures:

"It's because of the hierarchical structure with the health system…physicians are often positioned at the top in the combined, broader gender norm in male-dominant society. So, nurses are more female-dominant. So…even though nursing has, strong, contributions, their voices are not, easily taken up…the nurses' voice are frequently not fully integrate[d] into decision-making process, policy development, or system design related to disaster preparedness or strengthen health system resilience. But it's not due to the lack of the competency or experience among nurses. This is larger structure or cultural factor that's, limited their… Participation, leadership, and the policy spaces." (Participant 4)

Nine (90%) of the participants discussed the need for nurses to actively work to reshape the public and profession image and messaging:

"So just having nurses in the room. Who are capable and able to represent nursing and to explain and to…put into words what nurses contribute and what the value of nursing is to the, to the health systems." (Participant 7)

"Your seat at the table, yes, is important, but also the influence occurs outside often of those meetings. We talk about that, you know, we have a seat at the table, but actually, the influence can occur beyond that in other forums, which is then brought into those… those meetings." (Participant 9)

Five (50%) participants encouraged nurses to take a more proactive role to gain influence and decision-making authority:

"I said, but…why didn't you just inject yourself in the conversation? I said, you don't need… you don't wait to be invited, because you're already there. It's sort of like you're waiting for something that is unnecessary, and if you wait for that, you're not… it's not gonna come. You just inject yourself." (Participant 9)

And reiterated by this participant:

"It's about as much us realizing our value, and standing our ground. And actually staying there till we're listened to. Rather than expecting to be invited in." (Participant 9)

5.4.3 Category 2: Power, leadership, and system influence

Participants discussed the decision-making capacity, authority, and system influence by nurses who operationalize disaster expertise to build resilience within organizations and networks:

"Without nurses, we don't really have any resilient system… in a health system where, there's an emphasis on resilience in… in the nursing workforce. But what we're saying is that it's not the nurses who are resilient, it's the health system that needs to be resilient, right? (Participant 7)

One participant highlighted the decision-making qualities that nurses bring to disaster contexts, that facilitate improved system outcomes:

"Disaster requires a rapid judgment or action, often with limited information." (Participant 4)

"A lot of, organizations that are, to this day, resilient, and it has been because of nurses, but they don't always get the, the credit. (Participant 5)

Participants recognized the potential for power and system influence through leadership, facilitation and strength in numbers:

"And in places where we have nurses who, you know, we might have one or two nurses that are very involved, and they're very involved in the higher levels, so involved in the committees, very actively involved in the campaigns and whatever else is happening. Those are very powerful nurses. And… and make a huge contribution, but we… we often have very few and far between." (Participant 1)

"Nurses need to…acknowledge…our potential, or our, expertise or capacity for leading." (Participant 4)

"If you need to change the way that the healthcare system works, then you need to have the nurses who will push things forward." (Participant 10)

Other participants acknowledged the limited number of nurses who reach high-level positions, at times due to pressures from within the nursing profession as potential barriers:

"Here on this continent, we often talk about the tall puppy syndrome, where you… you mustn't stand out above the others, because then you make all the others look bad." (Participant 1)

"One of the challenges…is nurses are not getting involved in this higher level…I can tell you in any of the disaster response task forces, I didn't see a single nurse." (Participant 6)

One participant highlighted the incongruity of non-nurses filling nursing leadership roles at national levels, and how these politically driven decisions limit leadership opportunities for nurses:

"Or even you may see Chief Nursing Officers' administerial levels in some countries not being a nurse. So, how can you… how can you be a chief nursing officer if you're not a nurse?" (Participant 10)

Participants described engagement beyond traditional nursing roles as a strategy for cultivating leadership skills, particularly in the context of limited leadership opportunities within nursing:

"And then on the other side of the street, there should be organizations that, have the view of nurses being very… a very valued commodity for their own decision-making, for their own work that they do." (Participant 5)

Further explaining:

"There are a lot of organizations that need healthcare voices, like in transportation departments or organizations that have to do with food or housing. So there's a lot of ways that nurses can get involved in many different organizations to have a voice, to have a health voice. Okay? So, that's one side of the street, encouraging nurses to, you know, expand their own view of what leadership is for them, and it's not just being the manager of the unit." (Participant 5)

Participants described nursing's capacity and expertise in disaster as stemming not just through clinical competence, but system-level knowledge and navigation skills to facilitate continuity of care:

"Disaster readiness is closely linked to everyday nursing practice...nurses play an important role in educating patients and the general public about how to respond and act during disasters.., thereby enhancing preparedness before emergencies occur.." (Participant 4)

"Their knowledge and their preparedness…because… the health system depends on…the people, who are making timely decisions, or coordinating across sectors and adaptive care…those strengths and, capacity is very much, important and also effective." (Participant 4)

Consistently, participants highlighted the need for nurses to engage with their nursing organizations to increase their own power and influence:

"How are they positioning themselves? It is a small number, joining, their associations. Those organizations are certainly helping to prepare nurses to more adequately represent themselves, more adequately represent their patients, and…be part of decision-making." (Participant 5)

Three participants discussed the need to consciously engage, and ally with physicians, administrators and other health professions:

"Being able to leverage for change is very effective by joining up with other health professionals. Nurses are often in a very…weak bargaining position. So if you want to strengthen your position, you've got to drag in all the others as well…the same works for some of the doctors…they often say, it's very useful for us to get the nurses on board, because you can bring the numbers." (Participant 1)

Six (60%) participants emphasized the need for nurse leaders to intentionally mentor younger nurses into the profession and leadership opportunities:

"We have to be extremely intentional, very… it really is up to us. We can't just do our job. We have to reach back and reach, you know, help young people, the next generation, move along. We have to inspire them." (Participant 5)

"I think we need empowered, students, we need, we need to welcome them into our profession, we need to be good examples for them, and we need to welcome them, to…use their capacity and develop their competence." (Participant 7)

5.4.4 Category 3: Policy and future-oriented change

Across the board, every participant described the necessity and utility for nurses to engage in policy development, and discussed their perspectives on the future of nursing:

"Policy is everybody's problem, and everybody has to be involved in it" (Participant 1)

"Nurses have long played [an] essential role in maintaining continued care…and adapting care during disaster. So, the next step is…planning and the policy decision by doing so, nurses can more effectively lead." (Participant 4)

Several participants highlighted the need to think broadly about policy engagement as a lever for change and influence, and the importance of emphasizing policy training and exposure in basic nursing education:

"There is a huge gap. Nursing education currently, especially the undergraduate study. Lots of jobs, a lot of, lots of, gaps. In terms of, you know, making a nurse, to be capable enough." (Participant 6)

"There is a really, huge move to develop a policy and training for nurses…still, that was not accepted by the decision makers, policy makers, the curriculum is already developed, but decision makers are not accepting that." (Participant 6)

Several participants emphasized that change is dependent on the availability of role models:

"Unless you have…a good rapport with your department and with other nurse leaders that you want to emulate….nothing is gonna change." (Participant 2)

"One of the things I'm thinking is to get those champions, those few champions. Should advocate on that you know, on the, you know, importance of nursing leadership in health system resilience. That is, we need a champion…to be voiced at the higher level." (Participant 6)

"But not in clinical practice, like, for example, if I am a nurse working for 15 years, having a mentor to be able to help me to getting a leadership role. We don't have that." (Participant 10)

Finally, five (50%) participants echoed concerns about attraction to and attrition from the profession:

"Considering the loss of nurses around the world, and the lack of attractiveness of the nursing profession….means that a lot of nurses are leaving the profession. And how can you really reverse that, development and we need the leadership at the national level, really, to point out how to position nursing leadership in the hospitals, in the communities, etc., so that nursing really is able to take hold… because how can we survive without nurses?" (Participant 7)

"The system is not attractive for the nurse to pursue." (Participant 6)

All participants discussed the future of nursing education needing focused exposure to policy literacy and leadership and systems thinking skills to prepare a workforce ready to engage with policy development, and lead at all levels:

"One of the major gaps I see current nursing education is, like, a limited focus on prepared nursing to function at the system and the leadership level, and particularly in the context of disaster and just emergency." (Participant 4)

"So how else do we talk nurses into it? I think it certainly starts…with their basic education, I think that's the best place to start." (Participant 5)

"If you see the curricula of nursing, both postgraduate and undergraduate level, the leadership component is very, very slight, or light, lightly placed." (Participant 6)

"We have very little leadership…it's very difficult. We've actually…have developed a course for student nurses in policy…and in leadership… but it should be incorporated as part of as part of the nursing program." (Participant 7)

One participant emphasized that nurses should be encouraged to use their clinical experience as well as pursue political or leadership options to help move the profession forward:

"Even though there are two different pathways, We should, as nurses. Be able to follow both of them. In order to, showcase that nurses are crucial, and they are important. For politicians to listen to them." (Participant 10)

Finally, most participants described both optimism and resolve that nurses make good leaders:

"I want nurses to run the world, yes, of course. Yeah, I think if nurses ran the world, we'd be in a much better shape than we are today." (Participant 5)

5.5 Discussion

This qualitative study highlights perspectives about nursing leadership, health system resilience, and disasters from nurse leaders across the world, representing all six WHO regions Through semi-structured interviews, we isolated three interrelated categories that explored the facilitators, barriers, and contributions of nurses in supporting resilient health systems during disaster contexts: 1) nursing's positioning and public narrative, 2) power, leadership, and system influence, and 3) policy and future-oriented change. The findings from this study align with recommendations from ICN and WHO for increased nursing leadership and policy engagement at all organizational levels, while adding to the growing body of research highlighting the importance of the nursing workforce in disasters. Further, we suggest that the future roles of nursing in health system resilience depend on accurately reflected professional meaning as well

as realized governance and decision-making power (International Council of Nurses, 2022b; World Health Organization, 2025f).

Across interviews, participants consistently described nursing as a stabilizing presence when routine service delivery is disrupted. This echoes ICN's and WHO's emphasis on nurses as central to service delivery and universal health coverage. Yet participants' descriptions also indicated that presence, continuity, and trust are not synonymous with power or influence. This disconnect matters, because global workforce strategies, including those laid out in the *State of the World's Nursing 2025*, emphasize retention, fair working conditions, and workforce sustainability; all goals which will require nursing power and influence to realize.

A second central focus in the interviews concerned nursing leadership and where it is situated in decision-making during disasters. Participants frequently described a gap in visibility vs. authority in which nurses were responsible for maintaining continuity of care and navigating across sectors and systems but had uneven access and influence on the formal levers that shape health systems and response operations. Where nurses reported being embedded in operational governance, such as command structures and task forces, participants reported more coherent continuity of essential services, smoother problem solving, and more favorable outcomes. In situations where they were not, participants described reliance on impromptu crisis navigation through informal workarounds and their role in absorbing the friction created by unclear or unrealistic plans. These accounts further support global calls for increased nursing leadership by specifying what leadership means in practice: role clarity, decision authority, and resourcing, not simply individual capability or interest. More concretely, these interviews suggest that leadership development efforts will have limited effect unless paired with governance designs that structurally embed nursing in preparedness, response, and recovery planning.

Finally, participants located the profession's future within policy and system choices that either expand or constrain nursing work during disasters. This policy forward discourse again resonates with ICN's and WHO's emphasis on nursing workforce sustainability through education, regulation, and investment (International Council of Nurses, 2025; World Health Organization, 2025f). Interviewees repeatedly looked to the future of nursing in disasters with both optimism and caution. They described global workforce realities, and the need for nurses to utilize professional networks, join their professional organizations and insist those organizations advocate for their members (e.g. Chief Nursing Officer positions to be filled by nurses), interdisciplinary collaboration, and their own strategic positioning to elevate nursing's voice and influence. These accounts suggest that disaster nursing be treated as a universal workforce and policy concern, and not an ad hoc expectation placed on individual nurses. Across the board, participants recommended nursing education include the importance of policy and leadership, including basic policy literacy skills, in order to support advocacy and action by future nurse leaders.

Taken together, this study's findings complement global frameworks by showing how global workforce realities are interpreted at the level of lived experience and organizational practice in disaster and resilience contexts. The interviews suggest that strengthening nursing's contribution and authority in crises requires attention to three linked agendas: 1) public, institutional, and profession narratives that accurately represent nursing expertise; 2) governance arrangements that translate nursing's frontline responsibility into formal power and resources; and 3) policy support that align education, workforce conditions, leadership pathways, and service delivery design with the realities of operating under disruption.

5.5.1 Limitations

Although this study was drawn from global nurse leaders representing all WHO regions, it is still somewhat limited in its generalizability given the variability within WHO regions and smaller sample size. As it is qualitative in nature, and utilized purposive and snowball sampling, the study cannot fully describe the entirety of global nurse leaders' perspectives. Further, although attempts were made to recruit more male participants, the majority were female, and as such, may have influenced some responses surrounding gender norms in the nursing profession. The researchers recognize the potential for social desirability and recall bias among participants. Additionally, given the researchers' professional experiences and identities in disaster nursing, particular attention was made to address the potential for reflexivity among the researchers through regular debriefings and reflexive journaling. Nevertheless, as one of the few studies examining global nursing perspectives about disasters and health system resilience, these findings offer important insights for future studies.

5.5.2 Implications for Policy

This study complements growing research and policy recommendations to strengthen and support the nursing workforce as well as protect population health in the face of increasing disasters around the world. Three concrete recommendations are to align public messaging with role accuracy; embed nurses in disaster governance with clear decision rights; and treat preparedness as a workforce issue encompassing education, improved workplace conditions, and retention supports.

In practice this may look like public-facing messaging that explicitly describes the breadth of nurses' clinical and scientific expertise (e.g. the complex management of critical care patients, infectious disease contact tracing, and rapid triage and stabilization in mass-casualty events), going beyond the standard tropes that nursing is a soft science, with nurses positioned in

a “servile status” (Teresa-Morales *et al.*, 2022; James, Kelly and Bennett, 2024, para. 11). The traditional notion of nursing, as purely angelic caregivers, no longer reflects the extent of the, responsibility, competence, and capacity of the nursing profession (James et al., 2024).

To support and elevate nurses in disaster governance, disaster protocols must expressly define the leadership role, and delineate clear decision-making authority for nurses (Köhler et al., 2026). Achieving this will require nurses to prepare to step into these roles, as well necessitate organizational and national policymakers to agree on and systematize these roles in formal policy. Further, comprehensive redesigns in nursing education are needed to ensure nurses at the pre-service level are reaching disaster readiness and policy fluency (Kim, 2025; Nikitara et al., 2025).

Recognizing the looming threat of a worsening global nursing shortage, compounded by increasing global hazards and shocks, preparedness efforts must incorporate nursing workforce attrition and retention strategies (International Council of Nurses, 2022b; Kiptulon et al., 2025; Yamamoto et al., 2024). This will require dedicated policy efforts to increasing nursing education opportunities, including systemic education supports to increase nursing faculty; recognizing the reality of unattractive and dangerous workplaces, and then investing in sustainable solutions improving these conditions for nurses (Ahmed, 2025; International Council of Nurses, 2022a).

5.6 Conclusions

This qualitative study explores global nurse leaders’ perspectives about the facilitators, barriers, and contributions of the nursing workforce in health system resilience during disasters. Future research should build on these qualitative insights by examining how narrative framing,

governance inclusion, and policy implementation relate to measurable system performance and population health outcomes in disaster contexts.

Chapter 6 Chapter 6 Conclusion

This dissertation examined the role of the global nursing workforce within the contexts of disaster exposure using a sequential mixed-methods design that integrated large-scale global datasets, multi-country quantitative analyses, and qualitative interviews with global nursing leaders. Across three complementary studies, the findings demonstrate that nursing workforce capacity functions as a central component of health system resilience during disasters.

6.1 Summary of Problem and Study Aims

Disasters and other global shocks increasingly disrupt the delivery of essential health services and threaten population health. At the same time, the capacity of health systems to protect the negative effects of these events depends heavily on the health workforce. Nurses comprise the largest segment of the global health workforce, yet their contributions are underrecognized and under-measured. To address these gaps, this dissertation pursued three aims: 1) to create a novel, global longitudinal dataset linking nursing workforce capacity with disaster exposure and population health outcomes, enabling cross-national nursing and disaster-related health impacts; 2) use the dataset to explore the associations between nursing capacity, disaster exposure, and population level health outcomes; and 3) conduct qualitative interviews with global nurse leaders to explore and identify facilitators, barriers, and contributions of nurses to health system resilience during disasters.

6.2 Summary of Key Findings by Aim

The Chapter 3 advances a novel approach to harmonizing publicly available global datasets on disaster exposure, population level health outcomes, economic indicators, and health

workforce density across countries and years. Through extensive data cleaning, harmonization, and sensitivity analyses, this work established a reproducible process for studying workforce, disaster, and health relationships at a global scale, while highlighting the feasibility and limitations of leveraging existing global data for resilience research.

Chapter 4 employed a multivariate statistical approach using Generalized Estimating Equation (GEE) regression to assess associations between nursing and midwifery density, combined clinical workforce density, disaster exposure, and population health outcomes; including infant, under-five, maternal, and adult mortality. Results consistently demonstrated that higher nursing density was associated with improved population health outcomes while controlling for disaster exposure. However, models incorporating combined health workforce density yielded stronger associations and revealed that disaster exposure and national income were significantly related to mortality only when system-level workforce capacity was considered. Threshold analyses suggested that achieving minimum workforce density levels may be particularly consequential, with markedly larger protective effects observed once countries surpassed specified adequacy benchmarks.

Chapter 5 drew on interviews with global nursing leaders to contextualize these quantitative findings. Participants described how nurses function not only as clinical and educational resources, but contribute to broader system level resilience through quiet leadership and expertise in system navigation. Analysis revealed three primary categories: nursing's positioning and public narratives of the profession; power, leadership and system influence; and policy and future-oriented change. Across all interviews, participants emphasized the essential contributions of the nursing workforce during disaster contexts, and identified facilitators to

strengthen nurses' decision-making power, leadership roles, and policy voice, while also acknowledging the barriers that limit their influence.

6.3 Integrated Interpretation Across Aims

This sequential explanatory mixed methods study used integration (connecting and merging) to further explore and explain the quantitative findings through the qualitative results. The global quantitative analyses identified that higher nursing density was associated with lower infant, under-five, and maternal mortality when accounting for disaster burden. This finding suggests that nursing capacity functions as a key component of health system resilience, and supports the assertion that nurses are essential to achieving universal health coverage, which prioritizes health promotion and primary health care and is associated with improved child and maternal outcomes (Hone et al., 2024; World Health Organization, 2025g). Using Fetters and Creswell's approach, I then connected these quantitative findings to qualitative strands by prioritizing the specific findings (improved mortality) and relationships (nursing capacity) requiring explanation, and by shaping interview questions around potential mechanisms and contextual factors that cannot be observed in the quantitative models alone (Fetters et al., 2013).

Integration occurred through merging of the quantitative and qualitative findings. Specifically, I compared statistical patterns with interview-derived themes in a joint display (Table 15) where the qualitative findings were used to explain how additional nursing capacity may translate to survival gains (preserving continuity of care, system navigation, skill mix, decision authority in disaster response). This merged interpretation yields an integrated conclusion: nursing density appears to operate as a resilience-supporting resource in disaster contexts, but the mortality benefits depend on organizational and system conditions that determine whether nursing capacity is effectively utilized and supported when disasters occur.

Table 14. Joint display of study findings

Quantitative Pattern	Qualitative Explanation	Integrated Meta-Inference	Policy/implementation Implication
Nursing density decreases child mortality	Embedded in community, early detection, family and community support	Nursing density improves survival through continuity, surveillance, particularly when systems are stressed	Prioritize preventative care nursing services in pediatric care; include disaster training for community health nurses; continue efforts to promote UHC
Nursing density decreases maternal mortality	Continuity of care, across systems and time	Nursing density increases capacity for early response and referral	Invest in supporting maternal nurses and midwives in training and education; continue efforts to promote UHC
Combined health workforce density decreases mortality with stronger associations	Interprofessional collaboration, task-shifting, system support, coordination	Nurses and physicians working collaboratively in sufficient numbers indicates and enables a more resilient health system	Support joint disaster training and shared leadership and governance roles
Effect varies by country/context	Governance, leadership patterns & opportunities, nursing training and scope of practice	Density is necessary, but not sufficient	Pair staffing investments with nursing leadership roles that carry real decision-making authority

6.4 Significance and Contributions to the Field

Collectively, this dissertation contributes to global health, nursing science, and disaster readiness scholarship in several important ways. First, it advances workforce-centered models of health system resilience by empirically demonstrating that workforce capacity may condition the population-level health effects of disasters. While prior research has established links between disasters and adverse health outcomes, this work extends existing literature by identifying workforce density, as a key factor shaping those relationships (Frankenberg et al., 2020; MacKenzie et al., 2020).

Conceptually, this dissertation begins to explore the nursing workforce as an important driver of health system functioning. While previous research has routinely consolidated the "healthcare workforce" or even "human resources," this work begins to disentangle the potential unique contributions of nurses from the rest of the healthcare workforce, and questions the need for new conceptual models which highlight this workforce independently.

This dissertation further breaks data utilization ground by providing a transparent and reproducible approach to integrating previously unused heterogenous global datasets for longitudinal disaster research. Chapter 3 contributes to emerging calls for open science and data harmonization in global health systems research, offering a blueprint for future researchers seeking to study complex system-level phenomena using publicly available sources (BaHammam & Chee, 2022; Cheng et al., 2024).

By pairing quantitative analyses with qualitative insights from global nursing leaders, this work deepens understanding of how macro-level workforce metrics correspond to operational realities on the ground. The interviews suggest that continuity of care, community engagement, and nursing leadership (both formal and informal) are central mechanisms through which health systems absorb shocks, maintain service delivery, and recover following crises. This mixed-method integration strengthens interpretation of the quantitative results and situates nursing within broader system dynamics rather than an isolated group.

From a practice and policy perspective, these findings have direct implications health system resilience policy globally. They suggest that investments in nursing must be embedded within coordinated, multilateral workforce strategies. The identification of threshold effects further highlights the potential value of establishing minimum workforce density benchmarks as part of global resilience agendas and universal health coverage initiatives. Additionally, the

threshold effects suggest that focusing investment on nursing working training and education can yield significant cost-effective and time-saving benefits.

6.5 Strengths and Limitations

This work leverages large, longitudinal, cross-country global datasets spanning seven years, enabling examination of relationships that are difficult to capture otherwise. This approach allows for some increased generalizability to the findings. The integration of sensitivity analyses, alternative specifications, and threshold models strengthens confidence in the robustness of the quantitative findings. The sequential mixed-methods design allows for triangulation across data sources and analytic approaches, while the qualitative component adds explanatory depth and policy relevance.

At the same time, important limitations warrant consideration. Global workforce and disaster datasets remain incomplete, inconsistently reported, and are subject to measurement error, particularly in low- and middle-income countries. Workforce densities also do not measure skill mix, national distribution, deployment during emergencies, or quality of care. Disaster exposure indicators similarly vary in precision and may obscure subnational heterogeneity. Although longitudinal models account for time-invariant confounding, causal inference remains limited by the observational nature of the data.

The qualitative interviews, while rich and geographically diverse, reflect perspectives of senior nursing leaders and may not fully represent frontline experiences. Finally, the integration of qualitative and quantitative findings, though analytically purposeful, cannot definitively link specific mechanisms to observed statistical associations.

6.6 Equity and Ethical Considerations

Because this dissertation evaluates nursing capacity as a protective factor during disaster contexts, it is essential to consider that nursing resources are not distributed equitably, and whether benefits accrued disproportionately affect the advantaged. Nursing density at the national level can mask maldistribution between urban and rural areas, resulting in a differential protection across countries. Further, the global datasets used underrepresent low-income countries due to missingness and inconsistent reporting, thereby potentially skewing results and interpretability to higher income (data-rich) countries.

Importantly, framing nurses as a key solution to mitigating disaster impacts can unintentionally normalize poor working conditions and chronic underinvestment in nursing workforce stability. Indeed, disaster scenarios have consistently asked nurses to do more with less (Bourgault, 2022). These findings should be interpreted with caution alongside a call for supportive frameworks and sustainable change; that although the nursing workforce appears to offer protective effects during disaster exposure, those effects may be diminished with the continued shortages facing the nursing workforce globally.

6.7 Directions for Future Research

Future research should prioritize improving the availability, granularity, reliability, and comparability of global health workforce data, including measures of distribution, scopes of practices, and specialties during crises. Subnational analyses and geospatial approaches could elucidate within-country disparities and identify communities most vulnerable to workforce shortages during disasters. Further, using more granular analysis of disaster and hazard types, could identify higher-risk communities that warrant targeted investments. By making the dataset

and process transparent and readily available, future researchers can advance research and policy around health system resilience and related questions.

Additional research is also needed to examine the impacts of workforce investments on broader system performance indicators, including service continuity, primary care access, and recovery trajectories. Implementation-focused studies translating quantitative thresholds into operational staffing benchmarks could support national preparedness planning and global policy initiatives. Future implementation work should also consider the objectives suggested in this research. Recommendations such as 1) aligning public messaging with role accuracy should occur across global health organizations, nursing organizations, and ministries of health; 2) embed nursing leadership roles within emergency governance structures at the national, subnational, and institutional level; and 3) merging preparedness and workforce stability as interconnected needs. This may mean implementing a shared set of nursing messaging focusing on nursing expertise, competence, and scientific skill in disaster response, as well as concerted efforts to replace "angelic" and "hero" narratives with capability-based language. At all health organizational levels nursing leadership roles should be established, supported with decision-making rights, and with outcomes measurements. Finally, efforts to improve disaster preparedness should include not just increased disaster response training and capacity for nurses, but measured outcomes associated with workforce investment policy implementation.

Future research will also need to account for health workforce migration as a contributor to resilience within and across health systems. Future studies should extend this work by examining how disaster exposure interacts with health workforce migration and mobility across national and regional contexts. Disasters may accelerate outward migration of nurses and physicians from affected areas, disrupt training pipelines, and reshape health system capacities

within countries and across high hazard regions. Better understanding of these patterns may help inform global ethical migration policies and interventions to incentivize workforce retention in source and high disaster exposure countries. Similarly, the ethical dimensions of international nurse migration warrant closer investigation within disaster-prone and climate-vulnerable regions. As high-income countries increasingly rely on internationally educated nurses to address domestic shortages, disaster affected lower resourced countries may experience compounded strain through workforce outflows. Future studies should explicitly integrate frameworks such as the WHO Global Code of Practice on the International Recruitment of Health Personnel (World Health Organization, 2010b) to assess whether post-disaster recruitment patterns align with principles of equity, reciprocity, and sustainability.

Finally, further research is also needed to evaluate policy interventions aimed at stabilizing and rebuilding the health workforce before and after disasters. This dissertation aligns with the International Council of Nurses (ICN) Strategic Health Workforce Policy Guide (2025) as well as the ICN Charter for Change (2023), calling for increased investment in the global nursing workforce to retain established workforces, as well as build workforce stability. Together, these findings position the nursing workforce not only as a facilitator and contributor of disaster resilience, but also a potential barrier, without realized investments in the stability of the workforce.

6.8 Conclusion

Together, these studies advance understanding of the health workforce as an important pillar of disaster resilience and global health system performance. By integrating large-scale empirical analysis with grounded expert perspectives, this dissertation positions the nursing

workforce as a central component to mitigating the negative health impacts of disasters, and stabilizing health systems.

This dissertation generates actionable outputs that can be directly used by policymakers and health system leaders, including a publicly available global dataset for continued evaluation of health workforce and disaster exposure phenomena, evidence-informed preparedness guidance, and clear recommendations for integrating nursing leadership and policy participation within health systems. In doing so, this dissertation not only contributes new empirical evidence to the literature, but also demonstrates how publicly available data and nursing leadership perspectives can be mobilized to inform global strategies for disaster readiness and equitable health system strengthening.

Appendix A: Informed Consent Template

HEALTH SCIENCES & BEHAVIORAL SCIENCES IRB
UNIVERSITY OF MICHIGAN

General Informed Consent Template

CONSENT TO BE PART OF A RESEARCH STUDY

1. KEY INFORMATION ABOUT THE RESEARCHERS AND THIS STUDY

Study title: How nurses contribute to global health system resilience in disaster contexts
Principal Investigator: Katherine Kruger, MSN, University of Michigan
Faculty Advisor: Dr. Sue Anne Bell, PhD, University of Michigan]
Study Sponsor: Funded in part by Predoctoral Fellowship Training Grant (T32 NR016914. Program Director: McCullagh) Complexity: Innovations in Promoting Health and Safety through Team Science. 9/22/2022 – 6/30/2027.

You are invited to take part in a research study. This form contains information that will help you decide whether to join the study.

1.1 Key Information

Things you should know:

- The purpose of this study is to explore the perspectives and experiences of global nursing leaders on how nurses can be more effectively engaged in mitigating the negative health effects of disasters and leading efforts to strengthen health system resilience. Insights from this study will help identify strategies to empower nurses and improve global health outcomes.
- If you choose to participate, you will be asked to take part in a semi-structured interview. The interview will last approximately 60 minutes and will be conducted virtually/in-person/over the phone, depending on your preference.
- Risks or discomforts from this research are anticipated to be minimal, by may include discomfort/anxiety recalling prior experiences with disaster events.
- There are likely no direct benefits from your participation in this study.

Taking part in this research project is voluntary. You do not have to participate, and you can stop at any time. Please take time to read this entire form and ask questions before deciding whether to take part in this research project.

2. PURPOSE OF THIS STUDY

The purpose of this study is to explore the perspectives and experiences of global nursing leaders on how nurses can be more effectively engaged in mitigating the negative health effects of disasters and leading efforts to strengthen health system resilience. Insights from this study will help identify strategies to empower nurses and improve global health outcomes.

3. WHO CAN PARTICIPATE IN THE STUDY

3.1 Who can take part in this study? Nurses who have experience and expertise in nursing leadership and health systems as well as disaster readiness.
3.2 How many people are expected to take part in this study? We anticipate enrolling approximately 10-12 global nursing leaders in this study.

4. INFORMATION ABOUT STUDY PARTICIPATION

4.1 What will happen to me in this study?

- The study will be conducted virtually.
- Participation will include 45-60 minute semi-structured interviews with a single interviewer. The interviews will be recorded for later transcription.
- It is not anticipated that the interviews will collect sensitive or upsetting information.

4.2 How much of my time will be needed to take part in this study? Each interview is anticipated to take 45-60 minutes and will be conducted in a single session.

5. INFORMATION ABOUT STUDY RISKS AND BENEFITS

5.1 What risks will I face by taking part in the study? What will the researchers do to protect me against these risks?
Potential risks are anticipated to be minimal. Psychological risks related to recalling traumatic events may occur, and should that occur, the researchers will provide resources to participants.

You do not have to answer any questions you do not want to answer.

Because this study collects information about you, one of the risks of this research is a loss of confidentiality. See Section 8 of this document for more information on how the study team will protect your confidentiality and privacy.
5.2 How could I benefit if I take part in this study? How could others benefit?
You may not receive any personal benefits from being in this study. However, others may benefit from the knowledge gained from this study.

6. ENDING THE STUDY

6.1 If I want to stop participating in the study, what should I do?

You are free to leave the study at any time. If you leave the study before it is finished, there will be no penalty to you. If you decide to leave the study before it is finished, please tell one of the persons listed in Section 9. “Contact Information”. If you choose to tell the researchers why you are leaving the study, your reasons may be kept as part of the study record. The researchers will keep the information collected about you for the research unless you ask us to delete it from our records. If the researchers have already used your information in a research analysis it will not be possible to remove your information.

7. FINANCIAL INFORMATION

7.1 Will I be paid or given anything for taking part in this study? No, participants in this study will not receive any direct compensation.

8. PROTECTING AND SHARING RESEARCH INFORMATION

8.1 How will the researchers protect my information?
Data collected will be stored de-identified, with identifiers stored separately on HIPAA compliant storage devices at the University of Michigan.
8.2 Who will have access to my research records? The primary researcher, and IRB approved research team will have access to the de-identified records. The primary researcher and her mentor are the only two who will have access to the identifiable records.
There are reasons why information about you may be used or seen by the researchers or others during or after this study. Examples include:

- University, government officials, study sponsors or funders, auditors, and/or the Institutional Review Board (IRB) may need the information to make sure that the study is done in a safe and proper manner.

8.3 What will happen to the information collected in this study?

We will keep the information we collect about you during the research for 5 years in compliance with NIH guidelines. Your name and other information that can directly identify you will be stored securely and separately from the research information we collected from you.

We will not keep your name or other information that can identify you directly.

The results of this study could be published in an article or presentation but will not include any information that would let others know who you are.
8.4 Will my information be used for future research or shared with others?
We may use or share your research information for future research studies. If we share your information with other researchers, it will be de-identified, which means that it will not contain your name or other information that can directly identify you. This research may be similar to this study or completely different. We will not ask for your additional informed consent for these studies.
We would like to share your identifiable information with other researchers for future research. We will ask for your consent to do so at the end of this form. You can be a

part of this current research project without agreeing to this future use of your identifiable information.
We will put the information we collect from you into a repository. The repository contains information about many people. Your information will be de-identified –or- labeled with a code, instead of your name or other information that could be used to directly identify you.

9. CONTACT INFORMATION

Who can I contact about this study?

Please contact the researchers listed below to:

- Obtain more information about the study
- Ask a question about the study procedures
- Report an illness, injury, or other problem (you may also need to tell your regular doctors)
- Leave the study before it is finished
- Express a concern about the study

Principal Investigator: Katherine Kruger
Email: katkru@umich.edu
Phone: +1 (734) 546-9981

Faculty Advisor: Dr. Sue Anne Bell
Email: sabell@umich.edu
Phone: +1 (734) 647-0341

If you have questions about your rights as a research participant, or wish to obtain information, ask questions or discuss any concerns about this study with someone other than the researcher(s), please contact the following:

University of Michigan
Health Sciences and Behavioral Sciences Institutional Review Board (IRB-HSBS)
2800 Plymouth Road
Building 520, Room 1169Ann Arbor, MI 48109-2800
Telephone: +1 734-936-0933 or toll free (866) 936-0933
Fax: +1 734-936-1852

You can also contact the University of Michigan Compliance Hotline at 1-866-990-0111.

10. YOUR CONSENT

Consent/Assent to Participate in the Research Study
By signing this document, you are agreeing to be in this study. Make sure you understand what the study is about before you sign. I/We will give you a copy of this document for your records and I/we will keep a copy with the study records. If you have

any questions about the study after you sign this document, you can contact the study team using the information in Section 9 provided above.

I understand what the study is about and my questions so far have been answered. I agree to take part in this study.

Print Legal Name: _____

Signature: _____

Date of Signature (mm/dd/yy): _____

11. OPTIONAL CONSENT

Consent to be Contacted for Participation in Future Research
Researchers may wish to keep your contact information to invite you to be in future research projects that may be similar to or completely different from this research project.

_____ Yes, I agree for the researchers to contact me for future research projects.

_____ No, I do not agree for the researchers to contact me for future research projects.

Appendix B: Invitation Letter to Global Nursing Leaders to Participate in Interviews

Invitation to Participate in a Research Study on Global Nursing Leadership, Disasters, and Health System Resilience

Dear [Participant's Name],

My name is Katherine Kruger, and I am an Emergency Nurse Practitioner and PhD candidate at the University of Michigan in Ann Arbor, Michigan, United States. I am conducting a research study exploring how nurses can and do contribute to mitigating the negative health impacts of disasters and strengthening health system resilience globally.

As a respected nurse leader with significant expertise in global health and systems evaluation, I believe your insights would be invaluable to this study. This research aims to inform global strategies for disaster readiness and health system resilience, highlighting the critical role of nursing leadership.

What participation involves:

- A 45-60 minute virtual interview conducted via Zoom
- Discussions will focus on your experiences and perspectives on disaster readiness and nursing leadership
- Your participation is entirely voluntary, and all information shared will remain confidential

Why participate?

- By sharing your expertise, you will help advance knowledge about disaster response and health system strengthening globally. Findings from this study may contribute to global health policies and nursing education frameworks.

Next Steps:

- If you are interested in participating or have questions about the study, please reply to this email or contact me directly at katkru@umich.edu by August 1, 2025. I will provide additional details and schedule the interview at a time convenient for you.

Thank you for considering this opportunity. I look forward to the possibility of learning from your valuable experiences.

Respectfully,

Katherine Kruger, MSN, ENP, FNP, ACNP, CEN

PhD Candidate

University of Michigan, School of Nursing, United States

Dr. Sue Anne Bell, PhD, FNP-BC, FAAN

Associate Professor

University of Michigan, School of Nursing, United States

Appendix C: Semi-Structured Interview Guide Draft

Semi-Structured Interview Guide- Global Nursing Leaders

i. Background

Can you describe your current role and your experience in global nursing leadership?

How have you been involved in disaster readiness efforts?

How have you been involved in initiatives or policymaking related to health system resilience?

ii. Disaster & Health System Context in Your Region

What types of disasters have the greatest impact on health in your region? Can you tell me more about these health impacts? (Probe at the individual level and the systems level)

iii. Addressing the Role of Nurses

Utilization of Nurses

What are the most effective ways nurses can contribute to fostering resilient health systems? What gaps exist that prevent this?

Are there specific skills or roles where you see nurses being underutilized within disaster contexts? I am especially interested in nursing leadership and advocacy efforts.

What opportunities exist for greater nursing involvement in this area? How about nursing leadership?

Barriers

What barriers do you see that limit the potential contributions of nurses into disaster readiness and resilience efforts?

What barriers have you encountered as a nurse leader in these contexts?

What kind of challenges affect the ability of nurses to participate in developing resilient health systems? I am particularly thinking about cultural, systemic, policy, or institutional challenges. Can you give me any examples of these challenges?

Training and Education

What additional training or education do you think nurses need to enhance their effectiveness in disaster situations?

What skills or competencies are most critical for nurses to lead efforts in health system resilience?

Are there existing gaps in nursing education or training that need to be addressed?

iv. Policy and Systems

How can policies be adapted or developed to better leverage nursing expertise in disaster scenarios?

How can nurses influence policy to promote health system resilience?

How can capacity-building programs better prepare nurses to engage in resilience-focused roles?

Can you share any examples of successful nursing-led initiatives during disasters?

v. Global Nursing Workforce

How can the global nursing workforce be better prepared and supported to improve its ability to lead the development of resilient health systems?

What role do international collaborations or organizations play in enhancing nursing capacity in disaster settings?

vi. Health Equity

Are there gaps in the current approaches to providing equitable disaster response that nurses could help bridge?

Are there regional differences or challenges that require tailored approaches?

What specific strategies can nurses employ to advocate for underserved or vulnerable populations in resilience planning?

vii. Nursing Leadership

How can nurses be empowered to take on leadership roles in health system resilience initiatives?

Are there examples where nursing leadership has significantly contributed to a more resilient health system?

How can interdisciplinary approaches enhance nursing leadership in resilience efforts?

viii. Future Directions

In your view, what is the most critical step to enhance the role of nurses in facilitating resilient health systems in the face of increasing climate-induced disasters?

What is your vision for how nurses can lead global health systems toward greater resilience?

Are there any additional thoughts or insights you'd like to share?

Bibliography

1960—1989. (n.d.). Retrieved January 16, 2025, from https://www.nursing.upenn.edu/nhhc/nursing-through-time/1960-1989/

Ahmat, A., Asamani, J. A., Abdou Illou, M. M., Millogo, J. J. S., Okoroafor, S. C., Nabyonga-Orem, J., Karamagi, H. C., & Nyoni, J. (2022). Estimating the threshold of health workforce densities towards universal health coverage in Africa. *BMJ Global Health*, *7*(Suppl 1), e008310. https://doi.org/10.1136/bmjgh-2021-008310

Ahmed, S. K. (2025). Global Nursing Shortages: A Call for Policy Over Promise. *SAGE Open Nursing*, *11*, 23779608251408230. https://doi.org/10.1177/23779608251408230

Aiken, L. H., Sloane, D. M., Bruyneel, L., Heede, K. V. den, Griffiths, P., Busse, R., Diomidous, M., Kinnunen, J., Kózka, M., Lesaffre, E., McHugh, M. D., Moreno-Casbas, M. T., Rafferty, A. M., Schwendimann, R., Scott, P. A., Tishelman, C., Achterberg, T. van, & Sermeus, W. (2014). Nurse staffing and education and hospital mortality in nine European countries: A retrospective observational study. *The Lancet*, *383*(9931), 1824–1830. https://doi.org/10.1016/S0140-6736(13)62631-8

All-Party Parliamentary Group on Global Health. (2017). *Triple Impact: How developing nursing will improve health, promote gender equality, and support economic growth*.

American Nurses Association. (2017, October 14). *Workforce*. ANA. https://www.nursingworld.org/practice-policy/workforce/

Amin, K., Wager, E., Levinson, Z., Cubanski, J., & Cox, C. (2024). Health Cost and Affordability Policy Issues and Trends to Watch in 2024. *Peterson-KFF Health System Tracker*. https://www.healthsystemtracker.org/brief/policy-issues-and-trends-2024/

Amiri, A., & Solankallio-Vahteri, T. (2019). Nurse staffing and life expectancy at birth and at 65 years old: Evidence from 35 OECD countries. *International Journal of Nursing Sciences*, *6*(4), 362–370. https://doi.org/10.1016/j.ijnss.2019.07.001

Anand, S., & Bärnighausen, T. (2004). Human resources and health outcomes: Cross-country econometric study. *The Lancet*, *364*(9445), 1603–1609. https://doi.org/10.1016/S0140-6736(04)17313-3

Arya, A. N., & Allison, J. (2018). Standardising medical education's approach to global healthAre we moving forward? In *Global Health Experiential Education*. Routledge.

BaHammam, A. S., & Chee, M. W. L. (2022). Publicly Available Health Research Datasets: Opportunities and Responsibilities. *Nature and Science of Sleep*, *14*, 1709–1712. https://doi.org/10.2147/NSS.S390292

Baker, C., Cary, A. H., & da Conceicao Bento, M. (2021). Global standards for professional nursing education: The time is now. *Journal of Professional Nursing: Official Journal of the American Association of Colleges of Nursing*, *37*(1), 86–92. https://doi.org/10.1016/j.profnurs.2020.10.001

Banco, E., Furlong, A., & Pfahler, L. (2022, September 14). *How Bill Gates and partners used their clout to control the global Covid response—With little oversight*. POLITICO. https://www.politico.com/news/2022/09/14/global-covid-pandemic-response-bill-gates-partners-00053969

Banks, J., Brugiavini, A., & Pasini, G. (2020). The Powerful Combination of Cross-country Comparisons and Life-History Data. *Journal of the Economics of Ageing*, *16*, 100206. https://doi.org/10.1016/j.jeoa.2019.100206

Bermudez, G. F., & Prah, J. J. (2022). *Examining power dynamics in global health governance using topic modeling and network analysis of Twitter data*. https://doi.org/10.1136/bmjopen-2021-054470

Bieber, F. (2020). Global Nationalism in Times of the COVID-19 Pandemic. *Nationalities Papers*, 1–13. https://doi.org/10.1017/nps.2020.35

Bigbee, J. L., Evans, S., Lind, B., Perez, S., Jacobo, L., & Geraghty, E. M. (2014). RN-to-Population Ratio and Population Health: A Multifactorial Study. *Journal of Nursing Regulation*, *5*(1), 11–17. https://doi.org/10.1016/S2155-8256(15)30094-6

Boniol, M., McCarthy, C., Lawani, D., Guillot, G., McIsaac, M., & Diallo, K. (2022a). Inequal distribution of nursing personnel: A subnational analysis of the distribution of nurses across 58 countries. *Human Resources for Health*, *20*(1), 22. https://doi.org/10.1186/s12960-022-00720-5

Boniol, M., McCarthy, C., Lawani, D., Guillot, G., McIsaac, M., & Diallo, K. (2022b). Inequal distribution of nursing personnel: A subnational analysis of the distribution of nurses across 58 countries. *Human Resources for Health*, *20*(1), 22. https://doi.org/10.1186/s12960-022-00720-5

Borghi, J., & Brown, G. W. (2022). Taking Systems Thinking to the Global Level: Using the WHO Building Blocks to Describe and Appraise the Global Health System in Relation to COVID-19. *Global Policy*, *13*(2), 193–207. https://doi.org/10.1111/1758-5899.13081

Botzen, W. J. W., Deschenes, O., & Sanders, M. (2019). The Economic Impacts of Natural Disasters: A Review of Models and Empirical Studies. *Review of Environmental Economics and Policy*, *13*(2), 167–188. https://doi.org/10.1093/reep/rez004

Bourgault, A. M. (2022). The Nursing Shortage and Work Expectations Are in Critical Condition: Is Anyone Listening? *Critical Care Nurse*, *42*(2), 8–11. https://doi.org/10.4037/ccn2022909

Boz, C., & Kurnaz, F. S. (2025). Economic and demographic influences on health expenditures: Robust approaches for income and aging effects. *Health Economics Review*, *15*, 95. https://doi.org/10.1186/s13561-025-00631-w

Bransby, D. P., Mayo, A. T., Cronin, M. A., Park, K., & Yuan, C. T. (2023). A systematic review of respect between acute care nurses and physicians. *Health Care Management Review*, *48*(3), 237–248. https://doi.org/10.1097/HMR.0000000000000370

Buchan, J. (2010). Reviewing The Benefits of Health Workforce Stability. *Human Resources for Health*, *8*(1), 29. https://doi.org/10.1186/1478-4491-8-29

Burau, V., Mejsner, S. B., Falkenbach, M., Fehsenfeld, M., Kotherová, Z., Neri, S., Wallenburg, I., & Kuhlmann, E. (2024). Post-COVID health policy responses to healthcare workforce capacities: A comparative analysis of health system resilience in six European countries. *Health Policy (Amsterdam, Netherlands)*, *139*, 104962. https://doi.org/10.1016/j.healthpol.2023.104962

Burki, T. (2020). Global shortage of personal protective equipment. *The Lancet. Infectious Diseases*, *20*(7), 785–786. https://doi.org/10.1016/S1473-3099(20)30501-6

Caldera, H. J., & Wirasinghe, S. C. (2022). A universal severity classification for natural disasters. *Natural Hazards (Dordrecht, Netherlands)*, *111*(2), 1533–1573. https://doi.org/10.1007/s11069-021-05106-9

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: Complex or simple? Research case examples. *Journal of Research in Nursing: JRN*, *25*(8), 652–661. https://doi.org/10.1177/1744987120927206

Catton, H. (2025). *Addressing the global nursing shortage to boost health and economies*. World Economic Forum. https://www.weforum.org/videos/global-nursing-shortage-demand/

Charani, E., Abimbola, S., Pai, M., Adeyi, O., Mendelson, M., Laxminarayan, R., & Rasheed, M. A. (2022). Funders: The missing link in equitable global health research? *PLOS Global Public Health*, *2*(6), e0000583. https://doi.org/10.1371/journal.pgph.0000583

Cheng, C., Messerschmidt, L., Bravo, I., Waldbauer, M., Bhavikatti, R., Schenk, C., Grujic, V., Model, T., Kubinec, R., & Barceló, J. (2024). A General Primer for Data Harmonization. *Scientific Data*, *11*, 152. https://doi.org/10.1038/s41597-024-02956-3

Christian Aid. (2024). *Counting the Cost 2024: A year of climate breakdown - World | ReliefWeb*. https://reliefweb.int/report/world/counting-cost-2024-year-climate-breakdown

Clarke, J., Blom, I. M., Campbell-Lendrum, D., & Kerry, V. (2025). Health workforce as a climate and health priority in nationally determined contributions. *The Lancet Planetary Health*, *9*(8), 101288. https://doi.org/10.1016/j.lanplh.2025.101288

Congressional Research Service. (2025). *US Agency for International Development*.

Copeland, S., Hinrichs-Krapels, S., Fecondo, F., Santizo, E. R., Bal, R., & Comes, T. (2023). A resilience view on health system resilience: A scoping review of empirical studies and

reviews. *BMC Health Services Research*, *23*(1), 1297. https://doi.org/10.1186/s12913-023-10022-8

Correia, T., Kuhlmann, E., Lotta, G., Beja, A., Morais, R., Zapata, T., & Campbell, J. (2025). Turning the global health and care workforce crisis into action: The pathway to effective evidence-based policy and implementation. *The International Journal of Health Planning and Management*, *40*(1), 224–233. https://doi.org/10.1002/hpm.3860

CRED. (2024). *EM-DAT - The international disaster database*. https://www.emdat.be/

da Silva, R. N., & Ferreira, M. de A. (2021). Nursing and society: Evolution of Nursing and of capitalism in the 200 years of Florence Nightingale. *Revista Latino-Americana de Enfermagem*, *29*, e3425. https://doi.org/10.1590/1518-8345.4482.3425

Daly, J., Jackson, D., Anders, R., & Davidson, P. M. (2020). Who speaks for nursing? COVID-19 highlighting gaps in leadership. *Journal of Clinical Nursing*, *29*(15–16), 2751–2752. https://doi.org/10.1111/jocn.15305

Dedoose. (2021). *Appendix Userguide | Dedoose*. https://www.dedoose.com/userguide/appendix

DeJonckheere, M., & Vaughn, L. M. (2019). Semistructured interviewing in primary care research: A balance of relationship and rigour. *Family Medicine and Community Health*, *7*(2), e000057. https://doi.org/10.1136/fmch-2018-000057

Ditlopo, P., Blaauw, D., Penn-Kekana, L., & Rispel, L. C. (2014). Contestations and complexities of nurses' participation in policy-making in South Africa. *Global Health Action*, *7*, 10.3402/gha.v7.25327. https://doi.org/10.3402/gha.v7.25327

Doan, V. N., & Noy, I. (2021). A Comprehensive Measure of Lifeyears Lost due to COVID-19 in 2020: A Comparison across Countries and with Past Disasters. *Global Policy*, *12*(4), 553–561. https://doi.org/10.1111/1758-5899.12957

Dooley, K. J. (1997). A Complex Adaptive Systems Model of Organization Change. *Nonlinear Dynamics, Psychology, and Life Sciences*, *1*(1), 69–97. https://doi.org/10.1023/A:1022375910940

Dunton, N., Byron, G., McElroy, S., & Belinda, P. (2007). The Relationship of Nursing Workforce Characteristics to Patient Outcomes. *Online Journal of Issues in Nursing*, *12*. https://doi.org/10.3912/OJIN.Vol12No03Man03

Ebi, K. L., Balbus, J., Luber, G., Bole, A., Crimmins, A. R., Glass, G. E., Saha, S., Shimamoto, M. M., Trtanj, J. M., & White-Newsome, J. L. (2018). *Chapter 14: Human Health. Impacts, Risks, and Adaptation in the United States: The Fourth National Climate Assessment, Volume II*. U.S. Global Change Research Program. https://doi.org/10.7930/NCA4.2018.CH14

EM-DAT. (2023, April 13). *Entry Criteria*. EM-DAT Documentation. https://doc.emdat.be/docs/protocols/entry-criteria/

EM-DAT. (2024). *Public EM-DAT platform*. https://public.emdat.be/

Environment, U. N. (2023, November 16). *Climate Change and Water-Related Disasters | UNEP - UN Environment Programme*. https://www.unep.org/topics/fresh-water/disasters-and-climate-change/climate-change-and-water-related-disasters

Erlingsson, C., & Brysiewicz, P. (2017a). A hands-on guide to doing content analysis. *African Journal of Emergency Medicine*, *7*(3), 93–99. https://doi.org/10.1016/j.afjem.2017.08.001

Erlingsson, C., & Brysiewicz, P. (2017b). A hands-on guide to doing content analysis. *African Journal of Emergency Medicine: Revue Africaine De La Medecine D'urgence*, *7*(3), 93–99. https://doi.org/10.1016/j.afjem.2017.08.001

Etowa, J., Adele Vukic, Aston, M., Iduye, D., Mckibbon, S., George, A., Nkwocha, C., Thapa, B., Abrha, G., & Dol, J. (2022). Experiences of nurses and midwives in policy development in low- and middle-income countries: Qualitative systematic review. *International Journal of Nursing Studies Advances*, *5*, 100116. https://doi.org/10.1016/j.ijnsa.2022.100116

Farmer, P., Kim, J., Kleinman, A., & Basilico, M. (2013). *Reimagining Global Health*. University of California Press.

Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving Integration in Mixed Methods Designs—Principles and Practices. *Health Services Research*, *48*(6 Pt 2), 2134–2156. https://doi.org/10.1111/1475-6773.12117

Fields, L., Perkiss, S., Dean, B. A., & Moroney, T. (2021). Nursing and the Sustainable Development Goals: A Scoping Review. *Journal of Nursing Scholarship: An Official Publication of Sigma Theta Tau International Honor Society of Nursing*, *53*(5), 568–577. https://doi.org/10.1111/jnu.12675

Firouzkouhi, M., Kako, M., Abdollahimohammad, A., Balouchi, A., & Farzi, J. (2021). Nurses' Roles in Nursing Disaster Model: A Systematic Scoping Review. *Iranian Journal of Public Health*, *50*(5), 879–887. https://doi.org/10.18502/ijph.v50i5.6105

Fletcher, K. A., Reddin, K., & Tait, D. (2022). The history of disaster nursing: From Nightingale to nursing in the 21st century. *Journal of Research in Nursing*, *27*(3), 257. https://doi.org/10.1177/17449871211058854

Foroughi, Z., Ebrahimi, P., Aryankhesal, A., Maleki, M., & Yazdani, S. (2022). Toward a theory-led meta-framework for implementing health system resilience analysis studies: A

systematic review and critical interpretive synthesis. *BMC Public Health*, *22*(1), 287. https://doi.org/10.1186/s12889-022-12496-3

Forsgren, L., Tediosi, F., Blanchet, K., & Saulnier, D. D. (2022). Health systems resilience in practice: A scoping review to identify strategies for building resilience. *BMC Health Services Research*, *22*(1), 1173. https://doi.org/10.1186/s12913-022-08544-8

Frankenberg, E., Sumantri, C., & Thomas, D. (2020). Effects of a natural disaster on mortality risks over the longer term. *Nature Sustainability*, *3*(8), 614–619. https://doi.org/10.1038/s41893-020-0536-3

Gan, C. C. R., Oktari, R. S., Nguyen, H. X., Yuan, L., Yu, X., Kc, A., Hanh, T. T. T., Phung, D. T., Dwirahmadi, F., Liu, T., Musumari, P. M., Kayano, R., & Chu, C. (2021). A scoping review of climate-related disasters in China, Indonesia and Vietnam: Disasters, health impacts, vulnerable populations and adaptation measures. *International Journal of Disaster Risk Reduction*, *66*, 102608. https://doi.org/10.1016/j.ijdrr.2021.102608

Gaynor, T. S., & Wilson, M. E. (2020). Social Vulnerability and Equity: The Disproportionate Impact of COVID-19. *Public Administration Review*, *80*(5), 832–838. https://doi.org/10.1111/puar.13264

Gimbel, S., Kohler, P., Mitchell, P., & Emami, A. (2017). Creating academic structures to promote nursing's role in global health policy. *International Nursing Review*, *64*(1), 117–125. https://doi.org/10.1111/inr.12338

Gómez, E. J., Singh, P., Shiffman, J., & Barberia, L. (2022). Political science and global health policy. *Lancet (London, England)*, *399*(10341), 2080–2082. https://doi.org/10.1016/S0140-6736(22)00923-0

Governo Do Brasil. (2025). *Belem Health Action Plan*. https://cdn.who.int/media/docs/default-source/climate-change/en---belem-action-plan.pdf

Guzmán, C. A. F. (2022). Complexity in Global Health– Bridging Theory and Practice. *Annals of Global Health*, *88*(1). https://doi.org/10.5334/aogh.3758

Haakenstad, A., Irvine, C. M. S., Knight, M., Bintz, C., Aravkin, A. Y., Zheng, P., Gupta, V., Abrigo, M. R. M., Abushouk, A. I., Adebayo, O. M., Agarwal, G., Alahdab, F., Al-Aly, Z., Alam, K., Alanzi, T. M., Alcalde-Rabanal, J. E., Alipour, V., Alvis-Guzman, N., Amit, A. M. L., … Lozano, R. (2022). Measuring the availability of human resources for health and its relationship to universal health coverage for 204 countries and territories from 1990 to 2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, *399*(10341), 2129–2154. https://doi.org/10.1016/S0140-6736(22)00532-3

Halabicky, O. M., Scott, P. W., Carpio, J., & Porat-Dahlerbruch, J. (2024). Examining observed and forecasted nursing PhD enrollment and graduation trends in the United States: Implications for the profession. *Journal of Professional Nursing*, *55*, 81–89. https://doi.org/10.1016/j.profnurs.2024.09.006

Han, N. K., & Kim, G. S. (2024). The Barriers and Facilitators Influencing Nurses' Political Participation or Healthcare Policy Intervention: A Systematic Review and Qualitative Meta-Synthesis. *Journal of Nursing Management*, *2024*(1), 2606855. https://doi.org/10.1155/2024/2606855

Hanley, J. A., Negassa, A., Edwardes, M. D. deB, & Forrester, J. E. (2003). Statistical analysis of correlated data using generalized estimating equations: An orientation. *American Journal of Epidemiology*, *157*(4), 364–375. https://doi.org/10.1093/aje/kwf215

Hennink, M., & Kaiser, B. N. (2022). Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Social Science & Medicine*, *292*, 114523. https://doi.org/10.1016/j.socscimed.2021.114523

Hoffman, S. J., & Cole, C. B. (2018). Defining the global health system and systematically mapping its network of actors. *Globalization and Health*, *14*(1), 38. https://doi.org/10.1186/s12992-018-0340-2

Holmér, S., Nedlund, A.-C., Thomas, K., & Krevers, B. (2023). How health care professionals handle limited resources in primary care – an interview study. *BMC Health Services Research*, *23*(1), 6. https://doi.org/10.1186/s12913-022-08996-y

Holst, J. (2020). Global Health – emergence, hegemonic trends and biomedical reductionism. *Globalization and Health*, *16*(1), 42. https://doi.org/10.1186/s12992-020-00573-4

Hone, T., Gonçalves, J., Seferidi, P., Moreno-Serra, R., Rocha, R., Gupta, I., Bhardwaj, V., Hidayat, T., Cai, C., Suhrcke, M., & Millett, C. (2024). Progress towards universal health coverage and inequalities in infant mortality: An analysis of 4·1 million births from 60 low-income and middle-income countries between 2000 and 2019. *The Lancet Global Health*, *12*(5), e744–e755. https://doi.org/10.1016/S2214-109X(24)00040-8

Hovis, K. (2024, April 1). *Panel explores rise of nationalism across the globe*. https://as.cornell.edu/news/panel-explores-rise-nationalism-across-globe

Hugelius, K. (2021). Disaster nursing research: A scoping review of the nature, content, and trends of studies published during 2011–2020. *International Emergency Nursing*, *59*, 101107. https://doi.org/10.1016/j.ienj.2021.101107

ICAP. (2025). *Leadership*. https://icap.columbia.edu/who-we-are/leadership/

Institute of Medicine (US) Committee on the Robert Wood Johnson Foundation Initiative on the Future of Nursing, at the Institute of Medicine. (2011). *The Future of Nursing: Leading Change, Advancing Health*. National Academies Press (US). http://www.ncbi.nlm.nih.gov/books/NBK209880/

Intergovernmental Panel on Climate Change. (2016). *Chapter 4: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities — Special Report on the Ocean and Cryosphere in a Changing Climate*. https://www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/

Intergovernmental Panel On Climate Change (Ipcc). (2023). *Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781009325844

International Council of Nurses. (2019a). *Core Competencies in Disaster Nursing 2.0*. https://www.icn.ch/sites/default/files/inline-files/ICN_Disaster-Comp-Report_WEB.pdf

International Council of Nurses. (2019b). *International Council of Nurses: Why nurses are so important for UHC*. https://www.uhc2030.org/news-and-events/news/partner-insights/international-council-of-nurses-why-nurses-are-so-important-for-uhc-555297/

International Council of Nurses. (2021a). *ICN says 115,000 healthcare worker deaths from COVID-19 exposes collective failure of leaders to protect global workforce*. ICN - International Council of Nurses. https://www.icn.ch/news/icn-says-115000-healthcare-worker-deaths-covid-19-exposes-collective-failure-leaders-protect

International Council of Nurses. (2021b). *Nurses: A Voice to Lead*.

International Council of Nurses. (2022a). *Policy Brief: Nurse Shortage and Retention*.

International Council of Nurses. (2022b). *"The return on investment in nursing for global health is priceless" – ICN calls for nurse-led models of care*. ICN - International Council of Nurses. https://www.icn.ch/news/return-investment-nursing-global-health-priceless-icn-calls-nurse-led-models-care

International Council of Nurses. (2024). *ICN Hot News: The Nursing Shortage is a Global Health Emergency | Welcome to our blog*. https://dynamichealthstaff.com/blog/icn-hot-news-the-nursing-shortage-is-a-global-health-emergency/

International Council of Nurses. (2025). *Strategic Health Workforce Planning Policy Guide*. https://www.icn.ch/sites/default/files/2025-02/ICN_StrategicHealthWorkforcePlanning_PolicyGuide_EN_FINAL.pdf

James, A. H., Kelly, D., & Bennett, C. L. (2024). Nursing tropes in turbulent times: Time to rethink nurse leadership? *Journal of Advanced Nursing*, *80*(1), 8–10. https://doi.org/10.1111/jan.15766

Janes, C. R., & Corbett, K. K. (2009). Anthropology and Global Health. *Annual Review of Anthropology*, *38*(Volume 38, 2009), 167–183. https://doi.org/10.1146/annurev-anthro-091908-164314

Janlov, N., Blume, S., Glenngard, A. H., Hanspers, K., Anell, A., & Merkur, S. (2023). *Sweden: Health system review 2023*. https://eurohealthobservatory.who.int/publications/i/sweden-health-system-review-2023

Jordan, K., Marten, R., Gureje, O., Daelmans, B., & Kruk, M. E. (2018). Where is quality in health systems policy? An analysis of global policy documents. *The Lancet Global Health*, *6*(11), e1158–e1161. https://doi.org/10.1016/S2214-109X(18)30375-9

Kahn, L. H., Kaplan, B., Monath, T., Woodall, J., & Conti, L. (2014). A manifesto for planetary health. *Lancet (London, England)*, *383*(9927), 1459. https://doi.org/10.1016/S0140-6736(14)60709-1

Kanbara, S., Pandey, A., & Mashino, S. (2023). *The Nurse's Role in Achieving Health Equity in Disasters and Public Health Emergencies in Asia* (pp. 117–130). https://doi.org/10.1007/978-3-031-29746-5_9

Karimi, H., & Masoudi Alavi, N. (2015). Florence Nightingale: The Mother of Nursing. *Nursing and Midwifery Studies*, *4*(2), e29475. https://doi.org/10.17795/nmsjournal29475

Kasza, J., Wolfe, R., & Schuster, T. (2017). Assessing the impact of unmeasured confounding for binary outcomes using confounding functions. *International Journal of Epidemiology*, *46*(4), 1303–1311. https://doi.org/10.1093/ije/dyx023

Kayona, R., Clarke, M., Murray, V., Chan, E., Abrahams, J., & O'Sullivan, T. (2023). WHO Guidance on Research Methods for Health Emergency and Disaster Risk Management. *Prehospital and Disaster Medicine*, *38*(S1), s25–s25. https://doi.org/10.1017/S1049023X23001061

Kerry, V., & Murthi, M. (2024). *The climate crisis is driving a global public health emergency*. World Bank Blogs. https://blogs.worldbank.org/en/investinpeople/climate-crisis-driving-global-public-health-emergency

Khan, Y., O'Sullivan, T., Brown, A., Tracey, S., Gibson, J., Généreux, M., Henry, B., & Schwartz, B. (2018). Public health emergency preparedness: A framework to promote resilience. *BMC Public Health*, *18*(1), 1344. https://doi.org/10.1186/s12889-018-6250-7

Kharazmi, E., Bordbar, N., & Bordbar, S. (2023). Distribution of nursing workforce in the world using Gini coefficient. *BMC Nursing*, *22*, 151. https://doi.org/10.1186/s12912-023-01313-w

Kim, H. S. (2025). Effectiveness of Disaster Nursing Education Programs: A Meta-Analysis Focused on Knowledge, Attitude, and Skill Domains. *Disaster Medicine and Public Health Preparedness*, *19*, e275. https://doi.org/10.1017/dmp.2025.10209

Kiptulon, E. K., Elmadani, M., Szőllősi, A., Zrínyi, M., & Siket, A. U. (2025). The race to retain nursing workforce in healthcare: An umbrella review of effectiveness of retention interventions and strategies. *BMC Health Services Research*, *25*, 1344. https://doi.org/10.1186/s12913-025-13365-6

Klomp, J. G., & Valckx, K. (2014). Natural disasters and economic growth: A meta-analysis. *Global Environmental Change : Human and Policy Dimensions*, *26*, 183–195. https://doi.org/10.1016/j.gloenvcha.2014.02.006

Köhler, M., Ballmann, J., Glorius, L., & Ewers, M. (2026). The Role and Mandate of Nurses in Disasters: A Delphi Study in German-Speaking Countries. *International Nursing Review*, *73*(1), e70167. https://doi.org/10.1111/inr.70167

Koplan, J. P., Bond, T. C., Merson, M. H., Reddy, K. S., Rodriguez, M. H., Sewankambo, N. K., Wasserheit, J. N., & Consortium of Universities for Global Health Executive Board. (2009). Towards a common definition of global health. *Lancet (London, England)*, *373*(9679), 1993–1995. https://doi.org/10.1016/S0140-6736(09)60332-9

Kruger, K., & Bell, S. A. (2024). *How Nurses Contribute to Global Health System Resilience: A Scoping Review Protocol*. https://doi.org/10.7302/23388

Kruger, K., Brysiewicz, P., Lori, J., & Bell, S. A. (2025). The role of the nursing workforce in health system resilience during disasters: A scoping review of empirical studies. *International Journal of Nursing Studies Advances*, *9*, 100361. https://doi.org/10.1016/j.ijnsa.2025.100361

Kruger, K., Rettell, Z., Chang, T., & Bell, S. A. (2024). Youth perspectives about readiness for disaster events. *Traumatology*, No Pagination Specified-No Pagination Specified. https://doi.org/10.1037/trm0000515

Kruk, M. E., Myers, M., Varpilah, S. T., & Dahn, B. T. (2015). What is a resilient health system? Lessons from Ebola. *The Lancet*, *385*(9980), 1910–1912. https://doi.org/10.1016/S0140-6736(15)60755-3

Kviz, F. J. (2019). *Conducting Health Research: Principles, Process, and Methods*. SAGE Publications.

Lawler, J. J., Spencer, B., Olden, J. D., Kim, S.-H., Lowe, C., Bolton, S., Beamon, B. M., Thompson, L., & Voss, J. G. (2013). Mitigation and Adaptation Strategies to Reduce Climate Vulnerabilities and Maintain Ecosystem Services. *Climate Vulnerability*, 315–335. https://doi.org/10.1016/B978-0-12-384703-4.00436-6

Le Page, M. (2024). *Trump's exit from World Health Organization could backfire on the US*. New Scientist. https://www.newscientist.com/article/2465111-trumps-exit-from-world-health-organization-could-backfire-on-the-us/

Lee, H., Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P. W., Trisos, C., Romero, J., Aldunce, P., Barrett, K., Blanco, G., Cheung, W. W. L., Connors, S., Denton, F., Diongue-Niang, A., Dodman, D., Garschagen, M., Geden, O., Hayward, B., … Péan, C. (2023). *IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working*

Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland. (First). Intergovernmental Panel on Climate Change (IPCC). https://doi.org/10.59327/IPCC/AR6-9789291691647

Lencucha, R. (2024). Transforming global health: Decoloniality and the human condition. *BMJ Global Health*, *9*(8), e015420. https://doi.org/10.1136/bmjgh-2024-015420

Liu, J., & Eggleston, K. (2022). The Association between Health Workforce and Health Outcomes: A Cross-Country Econometric Study. *Social Indicators Research*, *163*(2), 609–632. https://doi.org/10.1007/s11205-022-02910-z

Lusk, B. (2023). *The Relevance of Nursing History and Why It Matters Today*. Springer Publishing Company. https://connect.springerpub.com/content/book/978-0-8261-3139-3/part/part01/chapter/ch01

Lynaugh, J. E., & Brush, B. L. (1999). The ICN Story – 1899-1999. *International Nursing Review*, *46*(1), 3–8. https://doi.org/10.1046/j.1466-7657.46.no.1issue343.2.x

MacKenzie, E. J., Wollek, S. H., Yost, O. C., & Cork, D. L. (Eds.) (with Committee on Best Practices for Assessing Mortality and Significant Morbidity Following Large-Scale Disasters, Board on Health Sciences Policy, Health and Medicine Division, & National Academies of Sciences, Engineering, and Medicine). (2020). *A Framework for Assessing Mortality and Morbidity After Large-Scale Disasters*. National Academies Press. https://doi.org/10.17226/25863

Maier, C. B., & Aiken, L. H. (2016). Expanding clinical roles for nurses to realign the global health workforce with population needs: A commentary. *Israel Journal of Health Policy Research*, *5*(1), 21. https://doi.org/10.1186/s13584-016-0079-2

Masters, J. (2026, January 26). *Earth was hit by 55 billion-dollar weather disasters in 2025 » Yale Climate Connections*. https://yaleclimateconnections.org/2026/01/earth-was-hit-by-55-billion-dollar-weather-disasters-in-2025/

Mayo, A. T., Myers, C. G., & Sutcliffe, K. M. (2021). Organizational Science and Health Care. *Academy of Management Annals*, *15*(2), 537–576. https://doi.org/10.5465/annals.2019.0115

Mazdiyasni, O., & AghaKouchak, A. (2020). Natural Disasters Are Prejudiced Against Disadvantaged and Vulnerable Populations: The Lack of Publicly Available Health-Related Data Hinders Research at the Cusp of the Global Climate Crisis. *GeoHealth*, *4*(1), e2019GH000219. https://doi.org/10.1029/2019GH000219

McKee, M. (2010). The World Health Report 2000: 10 years on. *Health Policy and Planning*, *25*(5), 346–348. https://doi.org/10.1093/heapol/czq032

Méndez, M., Flores-Haro, G., & Zucker, L. (2020). The (in)visible victims of disaster: Understanding the vulnerability of undocumented Latino/a and indigenous immigrants. *Geoforum*, *116*, 50–62. https://doi.org/10.1016/j.geoforum.2020.07.007

Molassiotis, A., Guo, C., Abu-Odah, H., West, C., & Loke, A. Y. (2021). Evolution of disaster nursing research in the past 30 years (1990–2019): A bibliometric and mapping analysis. *International Journal of Disaster Risk Reduction*, *58*, 102230. https://doi.org/10.1016/j.ijdrr.2021.102230

Moody, J. (2021). History of Nursing Timeline: How Nursing Education Has Evolved. *Post University*. https://post.edu/blog/history-of-nursing-education-timeline/

Naeem, M., Ozuem, W., Howell, K., & Ranfagni, S. (2023). *A Step-by-Step Process of Thematic Analysis to Develop a Conceptual Model in Qualitative Research* -. https://journals-sagepub-com.proxy.lib.umich.edu/doi/10.1177/16094069231205789

National Academies of Sciences, E., Medicine, N. A. of, Nursing 2020–2030, C. on the F. of, Flaubert, J. L., Menestrel, S. L., Williams, D. R., & Wakefield, M. K. (2021a). The Role of Nurses in Improving Health Care Access and Quality. In *The Future of Nursing 2020-2030: Charting a Path to Achieve Health Equity*. National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK573910/

National Academies of Sciences, E., Medicine, N. A. of, Nursing 2020–2030, C. on the F. of, Flaubert, J. L., Menestrel, S. L., Williams, D. R., & Wakefield, M. K. (2021b). The Role of Nurses in Improving Health Care Access and Quality. In *The Future of Nursing 2020-2030: Charting a Path to Achieve Health Equity*. National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK573910/

National Council of State Boards of Nursing. (2020). A Global Profile of Nursing Regulation, Education, and Practice. *Journal of Nursing Regulation*, *10*(4), 1–116. https://doi.org/10.1016/S2155-8256(20)30039-9

Newman, C., Stilwell, B., Rick, S., & Peterson, K. (2019). Investing in the power of nurse leadership: What will it take? *IntraHealth International, Nursing Now, Johnson & Johnson*.

Ngcamu, B. S. (2023). Climate change effects on vulnerable populations in the Global South: A systematic review. *Natural Hazards*, *118*(2), 977–991. https://doi.org/10.1007/s11069-023-06070-2

Nikitara, M., Kalu, A., Latzourakis, E., Constantinou, C. S., & Velonaki, V. S. (2025). Training Nurses for Disasters: A Systematic Review on Self-Efficacy and Preparedness. *Healthcare*, *13*(24), 3323. https://doi.org/10.3390/healthcare13243323

OECD. (2023). *Health Systems Resilience—OECD*. https://www.oecd.org/health/health-systems-resilience.htm

Olmen, J. van, Criel, B., Bhojani, U., Marchal, B., Belle, S. van, Chenge, M. F., Hoerée, T., Pirard, M., Damme, W. V., & Kegels, G. (2012). The Health System Dynamics Framework: The introduction of an analytical model for health system analysis and its application to two case-studies. *Health, Culture and Society*, *2*(1), Article 1. https://doi.org/10.5195/hcs.2012.71

Oregon State University Division of Research and Innovation. (2012). *Snowball Sampling*. Division of Research and Innovation. https://research.oregonstate.edu/irb/policies-and-guidance-investigators/guidance/snowball-sampling

Organization for Economic Cooperation and Development. (2024). *Purchasing power parities (PPP)*. OECD. https://www.oecd.org/en/data/indicators/purchasing-power-parities-ppp.html

Organization for Economic Cooperation and Development. (2025). *Gross national income*. OECD. https://www.oecd.org/en/data/indicators/gross-national-income.html

Pan American Health Organization. (2024). *Climate Change and Health*. https://www.paho.org/en/topics/climate-change-and-health

Perlman, S., Shamian, J., Catton, H., & Ellen, M. (2023). Assessing the country-level involvement of nurses in COVID-19 vaccination campaigns: A qualitative study.

International Journal of Nursing Studies, *146*, 104569. https://doi.org/10.1016/j.ijnurstu.2023.104569

Pourvakhshoori, N., Norouzi, K., Ahmadi, F., Hosseini, M., & Khankeh, H. (2017). Nursing in disasters: A review of existing models. *International Emergency Nursing*, *31*, 58–63. https://doi.org/10.1016/j.ienj.2016.06.004

Prater, R. M., Ayesha Tandon, Kerry Cleaver, Tom Pearson, Tom. (2024, November 18). *Mapped: How climate change affects extreme weather around the world*. Carbon Brief. https://interactive.carbonbrief.org/attribution-studies/

Rasheed, S. P., Younas, A., & Mehdi, F. (2020). Challenges, Extent of Involvement, and the Impact of Nurses' Involvement in Politics and Policy Making in in Last Two Decades: An Integrative Review. *Journal of Nursing Scholarship*, *52*(4), 446–455. https://doi.org/10.1111/jnu.12567

Rasmussen, B., Holton, S., Wynter, K., Phillips, D. J., David, J. L., Rothmann, M. J., Skjoeth, M. M., Wijk, H., Frederiksen, K., Ahlstrom, L., Anderson, J. E., Harris, R., Conolly, A., Kent, B., & Maben, J. (2022). We're on mute! Exclusion of nurses' voices in national decisions and responses to COVID-19: An international perspective. *Journal of Advanced Nursing*, *78*(7), e87–e90. https://doi.org/10.1111/jan.15236

Reidpath, D., & Allotey, P. (2003). Infant mortality rate as an indicator of population health. *Journal of Epidemiology and Community Health*, *57*(5), 344–346. https://doi.org/10.1136/jech.57.5.344

Rieder, S. (2016). Interrogating the global health and development nexus: Critical viewpoints of neoliberalization and health in transnational spaces. *World Development Perspectives*, *2*, 55–61. https://doi.org/10.1016/j.wdp.2016.10.004

Romanello, M., Walawender, M., Hsu, S.-C., Moskeland, A., Palmeiro-Silva, Y., Scamman, D., Smallcombe, J. W., Abdullah, S., Ades, M., Al-Maruf, A., Ameli, N., Angelova, D., Ayeb-Karlsson, S., Ballester, J., Basagaña, X., Bechara, H., Beggs, P. J., Cai, W., Campbell-Lendrum, D., … Costello, A. (2025). The 2025 report of the *Lancet* Countdown on health and climate change. *The Lancet*. https://doi.org/10.1016/S0140-6736(25)01919-1

Rosa, W. E., & Iro, E. (2019). The future of nursing and the advancement of the United Nations Sustainable Development Goals. *Nursing Outlook*, *67*(6), 623–625. https://doi.org/10.1016/j.outlook.2019.05.009

Rosen, M. (2025). *Trump's breakup with WHO, explained*. https://www.sciencenews.org/article/trump-who-withdraw-public-health

Salvage, J., & White, J. (2020). Our future is global: Nursing leadership and global health. *Revista Latino-Americana de Enfermagem*, *28*, e3339. https://doi.org/10.1590/1518-8345.4542.3339

Scheffran, J. (2020). Chapter 16—Climate extremes and conflict dynamics. In J. Sillmann, S. Sippel, & S. Russo (Eds.), *Climate Extremes and Their Implications for Impact and Risk Assessment* (pp. 293–315). Elsevier. https://doi.org/10.1016/B978-0-12-814895-2.00016-1

Schlak, A. E., Rosa, W. E., Cynda H. Rushton, Poghosyan, L., Root, M. C., & McHugh, M. D. (2022). An expanded institutional- and national-level blueprint to address nurse burnout and moral suffering amid the evolving pandemic. *Nursing Management*, *53*(1), 16–27. https://doi.org/10.1097/01.NUMA.0000805032.15402.b3

So, A. D., & Woo, J. (2020). Reserving coronavirus disease 2019 vaccines for global access: Cross sectional analysis. *The BMJ*, *371*, m4750. https://doi.org/10.1136/bmj.m4750

Solecki, W., Leichenko, R., & O'Brien, K. (2011). Climate change adaptation strategies and disaster risk reduction in cities: Connections, contentions, and synergies. *Current Opinion in Environmental Sustainability*, *3*(3), 135–141. https://doi.org/10.1016/j.cosust.2011.03.001

Stata 18e. (2024). *Stata Software*. https://www.stata.com/support/faqs/resources/citing-software-documentation-faqs/

State Department, United States. (n.d.). The United States President's Emergency Plan for AIDS Relief—United States Department of State %. *United States Department of State*. Retrieved February 24, 2025, from https://www.state.gov/pepfar/

Stillwell, B. (2025). *Global Health and Nursing: A New Narrative for the 21st Century*. Elsevier.

Stuart-Shor, E. M., Cunningham, E., Foradori, L., Hutchinson, E., Makwero, M., Smith, J., Kasozi, J., Johnston, E. M., Khaki, A., Vandervort, E., Moshi, F., & Kerry, V. B. (2017). The Global Health Service Partnership: An Academic–Clinical Partnership to Build Nursing and Medical Capacity in Africa. *Frontiers in Public Health*, *5*. https://doi.org/10.3389/fpubh.2017.00174

Su, Z., McDonnell, D., & Ahmad, J. (2022). The need for a disaster readiness mindset: A key lesson from the coronavirus disease 2019 (COVID-19) pandemic. *Infection Control & Hospital Epidemiology*, *43*(4), 538–539. https://doi.org/10.1017/ice.2021.26

Telford, A. (2023). Where to draw the line? Climate change-conflict-migration-terrorism causal relations and a contested politics of implication. *Environmental Science & Policy*, *141*, 138–145. https://doi.org/10.1016/j.envsci.2023.01.001

Teresa-Morales, C., Rodríguez-Pérez, M., Araujo-Hernández, M., & Feria-Ramírez, C. (2022). Current Stereotypes Associated with Nursing and Nursing Professionals: An Integrative Review. *International Journal of Environmental Research and Public Health*, *19*(13), 7640. https://doi.org/10.3390/ijerph19137640

The Guardian. (2025). *How will Trump and Musk's freeze on USAid affect millions around the world? | Global development | The Guardian*. https://www.theguardian.com/global-development/2025/feb/20/how-will-trump-and-musk-freeze-on-usaid-affect-millions-around-world

The Lancet. (2020). The status of nursing and midwifery in the world. *The Lancet*, *395*(10231), 1167. https://doi.org/10.1016/S0140-6736(20)30821-7

Tong, A., Sainsbury, P., & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care: Journal of the International Society for Quality in Health Care*, *19*(6), 349–357. https://doi.org/10.1093/intqhc/mzm042

UN Climate Change. (2024). *COP29 UN Climate Conference Agrees to Triple Finance to Developing Countries, Protecting Lives and Livelihoods | UNFCCC*. https://unfccc.int/news/cop29-un-climate-conference-agrees-to-triple-finance-to-developing-countries-protecting-lives-and

UNICEF. (2025). *Maternal mortality rates and statistics*. UNICEF DATA. https://data.unicef.org/topic/maternal-health/maternal-mortality/

United Nations. (2015a). The Sustainable Development Agenda. *United Nations Sustainable Development*. https://www.un.org/sustainabledevelopment/development-agenda/

United Nations. (2015b). UN Sustainable Development Goals. *United Nations Sustainable Development*. https://www.un.org/sustainabledevelopment/health/

United Nations. (2019). *Impact of Natural Disasters Increasingly Affecting Those Most Vulnerable, Speakers Say as Commission for Social Development Continues Session | Meetings Coverage and Press Releases*. https://press.un.org/en/2019/soc4876.doc.htm

United Nations. (2025). *Global compact for safe, orderly and regular migration*. International Organization for Migration. https://www.iom.int/global-compact-migration

United Nations Climate Change Conference. (2015). *The Paris Agreement | UNFCCC*. https://unfccc.int/process-and-meetings/the-paris-agreement

United Nations Office of Disaster Risk Reduction. (2007a). *Disaster*. http://www.undrr.org/terminology/disaster

United Nations Office of Disaster Risk Reduction. (2007b, August 30). *Disaster risk reduction | UNDRR*. https://www.undrr.org/terminology/disaster-risk-reduction

United Nations Office of Disaster Risk Reduction. (2020, July 31). *Climate action and disaster risk reduction | UNDRR*. https://www.undrr.org/implementing-sendai-framework/drr-focus-areas/climate-action-and-disaster-risk-reduction

United Nations Office of Disaster Risk Reduction. (2021, June 14). *Hyogo Framework of action*. https://www.preventionweb.net/sendai-framework/Hyogo-Framework-for-Action

United Nations Office of Disaster Risk Reduction. (2023). *Uncounted costs—Data gaps hide the true human impacts of disasters in 2023 | UNDRR*. https://www.undrr.org/explainer/uncounted-costs-of-disasters-2023

US Withdrawal from the Paris Agreement: Impact and Next Steps | White & Case LLP. (2025, January 21). https://www.whitecase.com/insight-alert/us-withdrawal-paris-agreement-impact-and-next-steps

Veenema, Deruggiero, K., Losinski, S., & Barnett, D. (2017). Hospital Administration and Nursing Leadership in Disasters: An Exploratory Study Using Concept Mapping. *Nurs Adm Q*, *41*(2), 151–163. https://doi.org/10.1097/naq.0000000000000224

Veenema, T. (2018). *Disaster Nursing and Emergency Preparedness*. Springer Publishing.

Veenema, T., Griffin, A., Gable, A. R., MacIntyre, L., Simons, R. N., Couig, M. P., Walsh Jr., J. J., Lavin, R. P., Dobalian, A., & Larson, E. (2016). Nurses as Leaders in Disaster Preparedness and Response—A Call to Action. *Journal of Nursing Scholarship*, *48*(2), 187–200. https://doi.org/10.1111/jnu.12198

Viergever, R. F., & Hendriks, T. C. C. (2016). The 10 largest public and philanthropic funders of health research in the world: What they fund and how they distribute their funds. *Health Research Policy and Systems*, *14*(1), 12. https://doi.org/10.1186/s12961-015-0074-z

Wendling, M. (2025, February 14). *What is Project 2025? Wish list for Trump second term, explained*. https://www.bbc.com/news/articles/c977njnvq2do

World Bank. (2024a). *Mortality Rate under 5*. World Bank Open Data. https://data.worldbank.org

World Bank. (2024b). *World Development Indicators | DataBank*. https://databank.worldbank.org/source/world-development-indicators

World Bank. (2025). *GNI per capita, PPP*. World Bank Open Data. https://data.worldbank.org

World Bank. (2026). *The big squeeze on health care—How shifting demographics and geographical divide are reshaping policy* [Text/HTML]. World Bank.

https://www.worldbank.org/en/programs/multi-donor-trust-fund-for-integrating-externally-financed-health-programs/brief/the-big-squeeze-on-health-care-how-shifting-demographics-and-geographical-divide-are-reshaping-policy

World Health Organization. (2007). *Everybody's business -- strengthening health systems to improve health outcomes: WHO's framework for action*. 44. https://iris.who.int/handle/10665/43918

World Health Organization. (2010a). *Monitoring the building blocks of health systems: A handbook of indicators and their measurement strategies*. World Health Organization. https://iris.who.int/handle/10665/258734

World Health Organization. (2010b). *WHO Global Code of Practice on the International Recruitment of Health Personnel*. https://www.who.int/publications/i/item/wha68.32

World Health Organization. (2020a). *State of the world's nursing 2020: Investing in education, jobs and leadership*. https://www.who.int/publications-detail-redirect/9789240003279

World Health Organization. (2020b). *WHO Director-General's opening remarks at the media briefing on COVID-19—11 March 2020*. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

World Health Organization. (2020c). *WHO Global Strategy on Health, Environment and Climate Change: The transformation needed to improve lives and well-being sustainably through healthy environments*.

World Health Organization. (2021). *Countries commit to develop climate-smart health care at COP26 UN climate conference*. https://www.who.int/news/item/09-11-2021-countries-commit-to-develop-climate-smart-health-care-at-cop26-un-climate-conference

World Health Organization. (2022a). *Change Cannot Wait: Building Resilient Health Systems in the Shadow of COVID-19*. World Bank. https://www.worldbank.org/en/topic/health/publication/change-cannot-wait-building-resilient-health-systems-in-the-shadow-of-covid-19

World Health Organization. (2022b). *Nursing and midwifery*. https://www.who.int/news-room/fact-sheets/detail/nursing-and-midwifery

World Health Organization. (2023a). *Operational Framework for Building Climate Resilient and Low Carbon Health Systems*. https://iris.who.int/bitstream/handle/10665/373837/9789240081888-eng.pdf?sequence=1

World Health Organization. (2023b). *Universal health coverage (UHC)*. https://www.who.int/news-room/fact-sheets/detail/universal-health-coverage-(uhc)

World Health Organization. (2024a). *Building health system resilience to public health challenges; guidance for implementation in countries*. https://www.who.int/publications/i/item/9789240094321

World Health Organization. (2024b). *Child mortality and causes of death*. https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/child-mortality-and-causes-of-death

World Health Organization. (2024c). *Density of nurses and midwives*. https://www.who.int/data/nutrition/nlis/info/density-of-nurses-and-midwives

World Health Organization. (2024d). *Global Health Workforce statistics database*. https://www.who.int/data/gho/data/themes/topics/health-workforce

World Health Organization. (2024e). *Health Systems Resilience*. https://www.who.int/teams/primary-health-care/health-systems-resilience

World Health Organization. (2024f). *Mortality Database*. Mortality DB. https://platform.who.int/mortality/themes/theme-details/MDB/all-causes

World Health Organization. (2024g). *NHWA Web portal*. https://apps.who.int/nhwaportal/

World Health Organization. (2024h). *Strengthening the nursing and midwifery agenda globally*. https://www.who.int/activities/strengthening-the-nursing-and-midwifery-agenda-globally

World Health Organization. (2024i). *WHO health workforce support and safeguards list*. https://www.who.int/news-room/questions-and-answers/item/who-health-workforce-support-and-safeguards-list

World Health Organization. (2025a). *Global nutrition monitoring framework: Operational guidance for tracking progress in meeting targets for 2025*. https://www.who.int/publications/i/item/9789241513609

World Health Organization. (2025b). *Infant mortality rate (between birth and 11 months per 1000 live births)*. https://www.who.int/data/gho/data/indicators/indicator-details/GHO/infant-mortality-rate-(probability-of-dying-between-birth-and-age-1-per-1000-live-births)

World Health Organization. (2025c). *Life expectancy at birth (years)*. https://www.who.int/data/gho/data/indicators/indicator-details/GHO/life-expectancy-at-birth-(years)

World Health Organization. (2025d). *Maternal mortality*. https://www.who.int/news-room/fact-sheets/detail/maternal-mortality

World Health Organization. (2025e). *Social determinants of health*. https://www.who.int/health-topics/social-determinants-of-health

World Health Organization. (2025f). *State of the World's Nursing 2025: Investing in Education, Jobs, Leadership and Service Delivery* (1st ed). World Health Organization.

World Health Organization. (2025g). *UHC Service Coverage Index (SDG 3.8.1)*. https://www.who.int/data/gho/data/indicators/indicator-details/GHO/uhc-index-of-service-coverage

World Health Organization. (2025h). *Universal Health Coverage*. https://www.who.int/health-topics/universal-health-coverage

Yamamoto, K., Nasu, K., Nakayoshi, Y., & Takase, M. (2024). Sustaining the nursing workforce - exploring enabling and motivating factors for the retention of returning nurses: A qualitative descriptive design. *BMC Nursing*, *23*, 248. https://doi.org/10.1186/s12912-024-01900-5

Zeger, S. L., Liang, K. Y., & Albert, P. S. (1988). Models for longitudinal data: A generalized estimating equation approach. *Biometrics*, *44*(4), 1049–1060.