GLOBAL SOCIAL VULNERABILITY TO PANDEMICS: AN EXAMINATION OF SOCIAL DETERMINANTS OF H1N1 2009

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Abstract: This research analyzes the relationship between global determinants of health and mortality from the H1N1 2009 pandemic. Grounded in social vulnerability and social determinants of paradigms, six variables were examined in relationship with H1N1 2009 mortality. These are; health, education, communication, population, air transport, and governance variables of 193 WHO member states. Health had three indicators (Health Expenditure per capita, International Health Regulations and Health Emergency Preparedness, and Adult mortality), Education had two (Education expenditure, and adult literacy,), Communication three (Radio, and Television penetration, and cell phone subscription), Population had two (population living in urban areas and international migrant stock), a single indicator of air transport, and two indicators of governance (Corruption Perception Index and Human Development Index). I conducted a multiple regression analysis to examine the relationship between these indicators and H1N1 2009 mortality. Results indicated significant relationship between the indicators and H1N12009 mortality. In addition, for each of the group of indicators, regression identified statistically significant predictors of H1N12009 mortality. The findings suggest that social vulnerability and social determinants of health provide a robust conceptual framework by which to examine pandemic disaster mortality.

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DEFINITION OF TERMS

A(H1N1)pdm09: Official term used by World Health Organization to denote virus that caused the 2009 pandemic.

Antigenic shift: Reassortment of two or more influenza virus subtypes that causes a phenotypic change and the formation of a new subtype having a mixture of the surface antigens of the original viruses (e.g. A(H1N1) + A(H3N2) = A(H1N2).

Co-morbidity: Pre-existing chronic illness or condition that predisposes an individual to the greater risk of health complications.

Critical national infrastructure (CNI): Term used in emergency preparedness to denote national functions and assets such as healthcare, law and order, sanitation transportation food fuel and power distribution, etc.. This infrastructure is considered essential to maintain pre and post disruptive periods.

Emerging Infectious Diseases: Infectious diseases caused by formerly undetected pathogens. Emerging infectious diseases are also caused when known agents spread to new geographic locations or among new populations.

Epidemic: Sudden surge of new cases rising sharply above baseline for a given geographical location (Gordis,2009).

Epidemiology: The formal branch of science and medicine devoted to the study of the patterns of disease, health events and their determinants in human and animal populations.

Excess mortality: The number of extra deaths caused by a period of influenza activity i.e. deaths due to influenza that would not have occurred anyway due to background factors such as winter temperature, etc. Excess mortality does not on its own give any clues about the age group of persons who died; pandemics without massive excess mortality may still result in substantial years of life lost if the average age of casualties is young.

Gross National Income per capita: Divides the gross national income of a country with its population to achieve an adjusted per capita measure for purchasing power parity (PPP).

Index patient - First medically-identified person with a particular infection which triggers a line of investigation.

Infectious diseases - A clinically evident communicable disease, or one that can be transmitted from one human being to another or from animal to human by direct or indirect contact.

Influenza-like illness (ILI). A term used to describe a syndrome commonly associated with influenza infection. The syndrome is fairly non-specific and without laboratory confirmation may inadvertently capture many other acute respiratory virus infections.

Morbidity: Poor health, illness or disability falling short of death. In relation to influenza the term is frequently used to describe significant illness, complications and hospitalizations.

Mortality: Death rate.

Pandemic: When a novel influenza A subtype spreads worldwide it is termed a pandemic.

Pathogens: Living organisms that infect humans and or animal hosts.

Pathology: The science of cause and effect of typical behavior of a disease.

Public Health Emergency of International Concern (PHEIC): An extraordinary event which is determined to constitute a public health risk to other States through the international spread of disease and to potentially require a coordinated international response. (WHO 5 May 2011).

Quarantine: Applied to people exposed who may or may not be infected but are not ill. Separation or restriction of movement is then practiced or applied so that if any of these people subsequently become ill, they ill not pose a risk of infection to others.

Reassortment: Mixing of genetic material between influenza viruses.

Re-emerging Infectious Diseases - Infectious disease that has decreased in incidence in the global population and was brought under control through effective heal care and living conditions but has begun to resurge as a health problem due to changes in health status of susceptible population.

Seasonal influenza: term used to refer to Influenza that occurs during interpandemic periods.

Shift. The ability of influenza virus to evolve using acquisition through reassortment.

Social determinants of health: External conditions and processes that people find themselves in and that affect their health outcomes (Carter-Pokras & Baquet, 2002; Thomas, et al. 2013). They include income, education, transportation, access to services, social exclusion, political and environmental stressors (Marmot 2005; Johnson, 2014).

Social distancing: An imprecise term often applied to the collection of measures intended to decrease the frequency of close contact among people and so possibly reduce influenza transmission. Most experts consider it better to describe the range of specific interventions within this blanket term.

Social vulnerability: "In conceptual terms, the most vulnerable are those households with the fewest choices, those whose lives are constrained, for example, by poverty, gender oppression, ethnic discrimination, political powerlessness, physical disability, limited employment opportunities, the absence of legal rights and other forms of domination" (Cannon, 1994). Cannon (1994) further presents three categories of vulnerabilities namely; economic, health, and preparedness levels. Economic vulnerability has to do with livelihood resilience, health has to do with the robustness of individuals and the third, preparedness has to do with capacity to protect oneself.

Surveillance: The ongoing, systematic collection, interpretation, and dissemination of health data, including information on clinical diagnosis, laboratory-based diagnoses, specific syndromes, health-related behaviors, and use of products related to health (CDC 2000). Analysis of data, and the provision of information which leads to action being taken to prevent and control a disease, and also as an evaluation tool for public health programs.

CHAPTER 1

INTRODUCTION

Infectious diseases have existed for centuries and are among the leading causes of mortality worldwide (Morens, Folkers, & Fauci, 2004; Osterholm 2005; Kaufmann, 2007; Holmes, 2008). They are often caused by pathogens originating from animals that spread to and sustained among and through humans (Pike, et al. 2010). The effects of infectious diseases are extensive and wide-ranging. Causing anywhere from simple discomfort to sporadic outbreaks responsible for excessive morbidity and mortality worldwide (Kaufmann, 2007). Annually, infectious diseases cause 25% (15 million) of all deaths worldwide (Morens et al. 2004). Trends indicate an increase in infectious disease mortality exacerbated by emergent and re-emergent pathogens, globalization, urbanization, and climate change (Barrett, et al. 1998; Red Cross, 1999; Morens et al. 2004; Marmot et al. 2008; Jones et al. 2008; World Health Organization, 2016).

Infectious disease mortality is caused either by recognized re-emergent pathogens, or new emerging pathogens (Morens et al. 2004). Re-emerging infectious diseases such as malaria, West Nile virus, Ebola, Human Immune Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) and Zika, are caused by recognized pathogens. Due to the pre-existence of re-emerging infections, some populations have immunity, and professional pharmacological and non-pharmacological interventions exist.

Conversely, emerging infectious diseases (EIDs) are caused by previously inexistent or unrecognized pathogens formed by genetic reassortment and mutation to create a novel pathogen (Morens et al. 2004; Kaufmann, 2007). Examples of EIDs include Severe Acute Respiratory Syndrome (SARS), H1N1 2009, Middle East Respiratory Syndrome (MERS). Humans are extremely vulnerable to the scourge of EIDs because they have no immunity, nor do matching pharmacological and non-pharmacological protocols exist. Upon the outbreak of an EID, treatment protocols such as vaccines, and containment strategies are urgently developed to minimize risk by containing and treating the disease.

The most infamous EID, the Spanish flu of 1918 – 1920, caused death to at least 20 million (Ghendon, 1994; Kilbourne, 2006; Morens et al. 2009; Walsh, 2014). However, some estimates indicate that up to 100 million lives were lost worldwide (Taubenberger & Morens, 2006; Richard, Sugaya, Simonsen, Miller, & Viboud, 2009; Fineberg 2014). Some estimates indicate that a third of the world’s population was infected by the Spanish flu, with the young adult demographic bearing the brunt of this infection (Johnson & Mueller, 2002; Taubenberger & Morens, 2006; Walsh, 2014). Despite the outbreaks’ catastrophic impact worldwide, transmission was relatively gradual because of slower travel speed, and limited geographical mobility of that era (Mathews, Chesson, McCaw, & McVernon, 2009). The exponentially increased speed of travel and geographic mobility in contemporary society would significantly increase transmission and impact should a similar outbreak occur. Scientists estimate that a modern ‘Spanish flu' like pandemic of would result in 1.7 million deaths in the United States (U.S.) compared to the Spanish flu U.S. mortality of 675,000

(Meltzer, Cox, & Fukuda, 1999; Johnson & Mueller, 2002; WHO, 2005; Osterholm, 2005). Unfortunately, despite these calamitous projections, the historical lessons of this and other past infectious disease outbreaks have not been adequately learned by health practitioners, and policy makers (Bissel & Krish, 2013; Stern & Markel, 2004; French & Raymond, 2009; Sachs, 2014).

From a global and national perspective, infectious diseases create notable disruption in society from loss of life and livelihoods (Osterholm, 2005; Kaufmann, 2007). Infectious diseases also pose a significant challenge to public health infrastructure, global security, political, and economic development (Bruine de Bruin et al., 2006; Lee & Fidler 2007; Burns et al. 2008; Davis, Stephenson, Lohm, Waller, & Flowers, 2015). On an individual level, infectious disease outbreaks are dreaded because of their impact on health and related socio-economic effects (Brahmbhatt, 2007; Kaufmann, 2007). With EIDs the fear is compounded by the unpredictability of the outbreak, lack of immunity, and undeveloped pharmacological and non-pharmacological responses (Davis 2005).

Contemporary Infectious Diseases

Despite remarkable technological and medical advancement, infectious diseases remain an imminent invisible threat with potential for significant impact on global health and economies (Kaufmann, 2007; Jones Patel et al. 2008; Walsh, 2014). Trends indicate that infectious diseases will continue to emerge and re-emerge with increased severity, frequency, and geographic spread (Ghendon, 1994; Morens, et al. 2004; Bruine de Bruin et al. 2006; Kaufmann, 2007; Jones, et al. 2008). The Ebola Virus Disease (EVD) and Zika are examples of re-emerging infectious diseases that have done just that.

Ebola was first detected in 1976 in multiple African countries and later among some Asian countries. The most recent outbreak of 2014 originated in West Africa with Liberia, Guinea, and Sierra Leone bearing the heaviest burden of the disease through loss of lives and livelihoods, and degeneration of development and health infrastructures (WHO, 2016). The 2014 outbreak was distinct in its complexity, geographical spread to new continents, and total mortality which was more than all prior EVD outbreaks combined (WHO, 2016c). The outbreak underscored a collective global failure of public health disaster management in developed and developing countries alike. Dismal management and systemic failures by international and national organizations, local hospitals, and medical personnel were exposed.

Zika was first identified in 1947 and remained primarily in African and Asian countries. While the first Zika infection in the United States occurred in 2008, it was not until the 2014 outbreak that an explosive outbreak affected the Americas and Caribbean (Fauci & Morens 2016; WHO 2016, d). Thirteen new countries outside of the African and Asian continent were impacted (Bogoch et al. 2016; Fauci & Morens 2016).

Collectively these inadequacies of public health strategies during EVD and Zika triggered additional transmissions, economic downturns, insecurity, and apprehension among various publics (Burns, van der Mensbrugghe, & Timmer, 2008; Tomori, 2015). Demand to critically review and remedy public health emergency planning worldwide was palpable among responding professionals, policy makers, and the general public. Both outbreaks were declared a Public Health Emergency of International Concern (PHEIC), which under International Health Regulations (IHR) 2005 implies an extraordinary international public health threat (WHO 2015). Declaration of a PHEIC also delineates the event as a step below a pandemic but still having potential for high and tragic mortality worldwide. The two contemporary outbreaks, EVD and Zika, while less grave in scope to pandemics, were instrumental in calling into question pandemic preparedness strategies worldwide.

Influenza Pandemic Disasters

According to Dynes (1974) disasters are triggered by a physical agent, cause physical consequences, create impacts which can be evaluated, and result in social disruption and change. Additionally, disasters occur within a specific time and space framework with direct primary impact on people, and secondary impacts on the essential functions of society and critical infrastructure (Fritz, 1961; Erickson 1976; Quarantelli, 2005; Bissell & Kirsch 2013). Influenza pandemics are by their very nature, quintessential disasters.

Influenza (flu), the physical agent, is a severe respiratory infection that causes illness in humans (WHO, 2014). While the phenomenon creates collective stress that interferes with societies normal functions, the event begins with affecting individuals (Barton 1969). Its predominant symptoms range from fever, unproductive cough, body aches, runny nose, and overall lethargy for an average five days (Lee & Fidler, 2007; Van-Tam & Sellwood, 2010; WHO, 2014). While these symptoms are common with other illnesses too, it is only through confirmatory laboratory testing that influenza-like illnesses (ILIs) are diagnosed. Of three flu variants, A, B and C, Type A viruses are most effective in co-infecting animals and humans, mutating or re-assorting which is the nexus for pandemic a pandemic event (Lee & Fidler, 2007; WHO, 2014). Flu, a common occurrence in human populations, is categorized into two. Seasonal outbreaks which are commonplace and off-season which are less common, unexpected and have potential for pandemic onset.

Seasonal flu outbreaks are relatively consistent in their timing, symptoms, and mortality rates unlike the relatively rare yet related off-season flu pandemic outbreaks (Brahmbhatt, 2007; Van-Tam & Sellwood, 2010; Vittecoq et al. 2015). Worldwide, seasonal influenza causes between 250,000 – 500,000 deaths annually (WHO, 2014; Vittecoq, et al. 2015). However, non-seasonal influenza outbreaks are unique in their unpredictability, novel virus origination, and significantly higher mortality in multiple countries (See Table 1) (Belshe, 2005; Kaufmann, 2007; Molinari et al. 2007; Mathews, et al. 2009; WHO, 2009; Van-Tam & Sellwood, 2010). While, people with some pre-existing health conditions and susceptible age groups - the young and the elderly - tend to fare worse when infected by the flu, each pandemic attacks a unique demographic unlike seasonal flu (Lee & Fidler, 2007; Richard, et al. 2009; Van-Tam & Sellwood, 2010). Table 1 delineates influenza pandemics in the past 97 years, their site of origin, mortality worldwide and demographic most affected.

Table 1

H1N1 epidemics and pandemics in the last 97 years.

Pandemic date and common name	Site of origin	Influenza A virus subtype	Estimated mortality worldwide	Age groups most affected
*1918-1919 "Spanish Flu"	Kansas, USA	H1N1	20 – 50 million	Young adults
*1957-1958 "Asian Flu"	Southern China	H2N2	1-4 million	Children
*1968-1969 "Hong-Kong Flu"	Southern China	H3N2	1-4 million	All age groups
**1976 Jan. – Feb. "Swine Flu"	Fort Dix, USA	A (Hsw1N1)	1	Military
**1977 - 1978 "Russian Flu"	Russia	A(H1N1)		Military recruits and school populations
**1997-1999 Avian Flu	Hong Kong	H5N1	6	Young adults
***2009-2010 "Swine Flu"	Mexico	A(H1N1) 2009	18,449–575,400 thousand	Young people 5-60 years

*Officially declared influenza pandemics in the 20th century

**Pandemic Flu threats

***First officially declared influenza pandemic in the 21st century

Disasters are defined as extreme situations that deviate from normal patterns, occur in space and time, and cause adverse social, economic, environmental, and political impacts on vulnerable people and systems (Killian, 1954; Fritz, 1961; Oliver-Smith, 1998; Smith, 2005; Quarantelli, 2005; Thomas, et al. 2013). Pandemics fit this definition because they are unpredictable, low probability high impact extreme public health events (Bruine de Bruin, Fischoff, Brilliant & Caruso 2006; Kilbourne 2006). As indicated in Table 1, between 1918 and 2010, there were four officially declared pandemics and three pandemic flu threats. The incidence of pandemics while not very high is unpredictable and results in higher than normal flu season mortality. In some instances such as the Spanish, Asian and Hong-Kong pandemics, mortality was in the millions. Additionally, different demographics were affected ranging from young adults with the Spanish flu, children with the Asian flu, and all age groups in the Hong Kong flu. During the H1N1 2009 pandemic young people between the ages of 5-6- were most affected. This indicates to the variance in the total number of people affected by each flu outbreak, as well as different age groups affected.

Between 2010 to date, infectious diseases that have emerged or re-emerged include polio, Ebola, Lassa, Zika, and MERS. Pandemics cause a high burden of disease through illness, direct loss of lives and livelihoods, and by negatively impacting the social and economic fabric of society on a global scale. Pandemics not only exert substantial direct losses on global economies through human impact but also inadvertently through containment measures. These measures include avian and animal culling, agricultural losses, import embargos, air travel bans, and workplace absenteeism (Mayer, 2000; Brahmbhatt, 2007; Burns et al. 2008; McLafferty, 2010). Additional secondary effects on supply chain logistics, tourism, and business from fear of travel also exert economic stress (Brahmbhatt, 2007; Burns et al. 2008; Abubakar et al. 2012). All pandemics are characteristically different, but their explosive impact portends disastrous global outcomes particularly on vulnerable populations (Osterholm, 2005; Stohr 2005; Relman et al. 2010; Kilbourne, 2006) (See Table 1).

Influenza pandemic H1N1 2009

In March 2009, a 10-year-old California patient presented with ILI symptoms followed in April when a 54-year-old Kansas resident reported similar symptoms (Neatherlin, et al. 2013). Before their illness, both patients had separately traveled from or to Mexico. By mid-April, these two cases identified as a reassorted H1N1 virus traced to an index patient in Mexico. The Centers for Disease Control (CDC) U.S. confirmed the virus as being a variant of A (H1N1) swine lineage (Garten et al. 2009; Zimmer & Burke, 2009; Van-Tam & Sellwood, 2010). They also warned that the explosive outbreak, now spreading to more people, could no longer be contained in the U.S. (CDC, 2009; ECDC, 2009). As is typical with pandemics, this outbreak was also at the time, exhibiting multiple intense peaks of non-seasonal transmission (CDC, 2009; ECDC, 2009). Within two months, the WHO declared the outbreak an official influenza pandemic. The rationale for the declaration was that WHO established that the virus as a novel strain was rapidly spreading through multiple countries, and having potential for a higher than normal seasonal influenza mortality (Liu & Kim, 2011). Eight months after the first cases were diagnosed in the U.S., half a million cases were reported in more than 200 countries, with higher than 6,000 laboratory confirmed deaths (WHO, 2009).

The WHO estimate for laboratory-confirmed 2009 H1N1 mortality 14 months after the official declaration was 18,449 deaths in 214 countries (WHO, 2010; Roos, 2012). Notably, WHO's official mortality rate was 6% (18,499) that of the CDC's estimate (284,400) (WHO, 2010; Dawood, et al., 2012). The average age of death for the H1N1 2009 pandemic was relatively young compared to average death during regular flu season (Roos, 2012). While 85% of the laboratory-confirmed deaths occurred among people under the age of 60, the mean age of death was 37 years (Miller, et al. 2010; Roos, 2012). Inconsistent reporting protocols precipitated the discrepancy of estimated mortality in the H1N1 2009 pandemic, a phenomenon not unique to this pandemic (Johnson & Muller 2002; Dawood, et al. 2012).

The first official pandemic of the 21st Century (H1N1 2009) was ultimately dubbed a mild pandemic (Miller, et al., 2010; Davis et al. 2015, a). Some researchers and practitioners reference the mild designation of the H1N1 2009 outbreak as "… insufficient and possibly inappropriate because it reflects a single measure outcome", which was mortality (Miller et al. 2010, p. 5.) The H1N1 2009 pandemic brought to the forefront the need for global review and improvement in healthcare infrastructure, risk communication, epidemiologic surveillance, strategic stockpile, health promotion research and development (Cordova-Villalobos, et al. 2009; Hutchins, Truman, Merlin, & Redd, 2009; Fauci & Morens, 2016). Morens, Taubenberger, and Fauci, (2009, p. 225) aptly stipulated a need by public health stakeholders to "… understand in greater depth, and continue to explore, the determinants and dynamics of the pandemic era in which we live". Despite the lessons available from the H1N1 2009 outbreak, the 2014 Ebola outbreak demonstrated an enduring lack of a globally coherent strategic approach to 'pandemic era in which we live.'

Social Vulnerability Perspective and Pandemics

Succinctly put, pandemics do not affect the ‘haves' and ‘have not's' alike (Carter-Pokras & Baquet 2002; Lawrence 2006; Thomas, Davis, & Clive, 2010). External historical conditions beyond the control of individuals, societies and entire countries affect their physical, mental, and social health disparately. This phenomenon is explained in the social vulnerability perspective. Despite there not being a common conceptualization of social vulnerability, for purposes of this study I apply the conceptualization of Cannon 1994 but also draw from other experts. Humans exist in an environment where hazards are natural, and they learn to navigate these hazards with minimal destabilization of their environment (Cannon 1994). However, when an imbalance between the built, physical, and human environment occurs that a hazard becomes a disaster (Cannon 1994; Mileti 1999). Social vulnerability theorizes that societal inequalities exist based on class, race, ethnicity, gender, age, health, national origin, abilities, (Blaikie et al., 1994; Cannon 1994; Cutter 1996; Morrow & Enarson, 1996). The most vulnerable people, according to Cannon (1994), are those with fewest choices and live constrained lives from poverty, gender oppression, ethnic discrimination, political powerlessness, physical disability, limited employment opportunities, the absence of legal rights and other forms of domination. Vulnerable people are exposed to what Cannon (1994) categorizes as livelihood, self-protection and social protection vulnerabilities, which all lead to a lack of resilience. Under his theory, livelihood vulnerability includes economic and health components which are directly related to some of the study variables. Economic resilience reflects a measure of economic strength and responsiveness to hazards, health resilience is a factor of robustness and preparedness that has to do with protection capability. These historical processes are dynamic and create vulnerability to hazards. Which in turn exposes people to disparate life threatening impact when extreme events occur (Cutter 1996; Phillips 2009; Thomas et al., 2013). Consequently, a disaster management approach cognizant not only of the disaster agent but also about minimizing vulnerability presents a comprehensive and more sustainable approach to minimizing loss of life and livelihoods.

Analyzing in-depth the impact of external processes and the degree to which they cause vulnerability during public health emergencies is critical to saving lives and livelihoods (Osterholm 2005; Stohr 2005: Bruine de Bruin et al., 2006; Jones et al. 2008; Hannigan 2012). Social determinants of health are external conditions and processes, that people find themselves in and that affect their health outcomes (Carter-Pokras & Baquet, 2002; Thomas, et al. 2013). They include income, education, transportation, access to services, social exclusion, political and environmental stressors (Marmot 2005; Johnson, 2014). Social determinants of health condition through which social vulnerability can be assessed. Robust social determinants of health imply mitigated vulnerability to health emergencies. In contrast, if social determinants are compromised then resulting vulnerability to health emergencies is exacerbated.

In the public health arena, the study of social determinants of health is relatively new, having been preceded by research and practice more emphatic on a medical, single stream approach (Marmot 2005; Osterholm 2005; Stohr 2005; Dingwall, Hoffman, & Staniland, 2013).

Social vulnerability and determinants of health data indicate that marginalized populations, indigenous populations, people living in developing countries, and those living in poverty are disparately exposed to pandemics (Cannon 1994; Marmot 2005; La Ruche, Tarantola et al. 2009; Mathews et al. 2009; WHO 2011; WEC 2015). Predetermined social stratification disparately determines exposure to disasters, capacity to respond, and recovery potential by interfering with social empowerment processes, access to information and infrastructure (Fritz, 1961; Couch & Kroll-Smith, 1985; Phillips, 1993; Watts & Bohle 1993; Morrow, 1997; Wisner et al. 2004; Fothergill & Peek 2004; Fordham, Lovekamp, Thomas, & Phillips, 2013). Vulnerability during pandemics is further exacerbated by a failure to include the most vulnerable populations in the pandemic preparedness discourse (Garrett 2000; Carter-Pokras & Baquet 2002; Koop, Pearson, & Shwartz, 2002; Barnett &Whiteside, 2006; Kaufmann 2007; Lee & Fidler 2007; WHO, 2011). The confluence of these factors results in further complicating systems of accesses to socio-political capital, perpetuating closed complex systems, top-down communication, and unrelenting vulnerability (Fordham et al. 2013).

Disaster research is unique because "it subsumes multiple disciplines, theories, and substantive topics." (Kreps 1989). However, a literature search reveals a limited investigation into pandemics as disasters as they are predominantly investigated under medical and public health disciplines, political and legal domains (Cannon 1994; Quarantelli 1995; Marmot 2005; Garoon & Duggan, 2008; Schartung, Moulder, Bruer & Simpson, 2010). There are different perspectives as to why pandemics have not been a stronger component in disaster research. The first perspective posits a historically limited integration between the two disciplines Logue (1996). Second, conceptualization of pandemics under disaster taxonomy is challenging. Pandemics are a diffuse event. They do not fit the typical quick or slow onset disaster framework, nor do they explicitly fit into the natural, man-made or technological disaster distinction (Bates & Pelanda 1995). Green III and McGinnis (2002) in discussing higher-order taxonomy of disasters suggest three distinguishing classes of disasters; natural, human systems failure and conflict based disasters. Under this taxonomy, pandemics closely fit the human systems failure category distinguished as "… a disaster with significant human failure in any portion …" Green III & McGinnis (2002).

Despite a lack of consensus on pandemic taxonomy and nominal investigation within disaster discourse, this study will address a pandemic as its extreme event. I will also apply an integrated approach to disaster management and public health theory in analyzing social determinants and their relationship to the H1N1 2009 pandemic.

Problem Statement

Emerging and re-emerging diseases continue as invisible threats worldwide. This notwithstanding research and development of antibiotics, vaccines, and medical technologies necessary to safeguard public health from diseases. Antibiotic resistant bacteria and reassorted pathogens not only debunk views on having conquered infectious diseases but remain an imminent threat to public health (Morens et al., 2004; Walsh 2014). Additionally, trends project an increase and expansion of infectious disease mortality facilitated by globalization, urbanization, and climate change (Barrett, et al. 1998; Morens et al. 2004; Marmot et al. 2008; Jones et al. 2008).

While a concerted effort by international organizations to implement integrated pandemic preparedness planning is ongoing, adoption of the necessary global strategies has not kept pace. Geo-political, social, and resource shortcomings continue to affect implementation of IHR policies at member state level affecting public health outcomes during pandemics (Johnson & Mueller, 2002; Dawood, et al. 2012; 2016). Unfortunately, partial pandemic preparedness does not bode well for what is otherwise a global threat whose transmission transcends geo-political boundaries.

Finally, the challenge of this area of study is that extant literature on the topic is predominantly medical

Purpose of the Study

The principal purpose of this study is to capture the multi-dimensional nature of social vulnerability and its relationship to pandemic mortality. The secondary purpose is to contribute to a multi-disciplinary approach. study is grounded on social vulnerability and social determinants of health paradigms. This study examines six variables, health, education, communication, population, air transport and governance. With the exception of air transport each of these variables is measured by multiple indicators with data drawn from multiple sources.

Research Questions

The following fundamental questions are addressed in this study:

- What is the relationship between health indicators and H1N12009 pandemic mortality?
- What is the relationship between education indicators and H1N1 2009 pandemic mortality?
- What is the relationship between communication indicators and H1N12009 pandemic mortality?

- What is the relationship between population indicators and H1N1 2009 pandemic mortality?
- What is the relationship between air transport indicators and H1N12009 pandemic mortality?
- What is the relationship between governance indicators and H1N1 2009 pandemic mortality?

Theoretical Framework

The medical cause of pandemics is attributable to transmission of pathogenic agents from animals to humans, and from humans to humans (WHO 2009; Hughes et al. 2010). While the existence of disease-causing microorganisms has existed as long as humans have, most have not caused infectious diseases (Kaufmann, 2007). However, non-pathogenic determinants of health such as socio-economic, environmental and political dynamics have contributed an increase in infectious disease outbreaks (Kaufmann 2007; Lee & Fidler 2007; Hutchins, et al. 2009; McLafferty 2010; Thomas et al. 2013). Despite accumulation of knowledge and data on social vulnerability, nominal progress has been made in minimizing disaster impacts (Mileti, Darlington, Passerini, Forrest, & Myers 1995; Lee & Fidler 2007; & Oliver-Smith 2012). For example, public health and disaster management professionals agree on the salient role of socio-economic, environmental and political dynamics in minimizing pandemic impacts (Baker & Fidler 2008; King 2009; Jones et al. 2008). This notwithstanding, there is limited integration between the two disciplines in research and practice (Johnson & Mueller, 2002).

Historically, public health institutions, medical researchers, and practitioners have almost exclusively led the charge in research and management tied to pandemics (Schartung et al. 2010). Most of this research is based on a traditional health theory an approach similar to the dominant paradigm in disaster research (Drabek 1986; Fischoff 1995; Powell & Leiss 1997). Traditional health theory and practice are based on the individual as its unit of focus. It applies a top-down method of communicating facts to different publics by medical experts and relies on the assumption of a single rational decision maker (Fischoff 1995; Powell & Leiss 1997). The dominant paradigm is similar in its conceptualization of top-down communication, and a focus on hazards only instead of a more ecological method (Gebbie, Rosenstock, & Hernández, 2005; Fordham et al. 2013). While both theories achieved some successes, they are not sustainable in adequately mitigating health disasters, or addressing the complexities of contemporary disasters.

Increasingly a shift toward orienting disaster and public health research, policy, and practice towards a social vulnerability paradigm and ecological model of health respectively, is taking root (Hernandez et al. 2003). The ecological model of health encompasses relevant non-medical practices and disciplines as integral to population health (McMichael 2006). It takes into account global perspectives on communication, participatory research, health infrastructure and policies that affect public health outcomes (Hernandez et al. 2003). The social vulnerability approach takes into account physical agents of disasters as well as the socio-economic and political processes that create conditions in which some are disparately exposed to disasters than others (Fordham et al. 2013).

This study is grounded in social determinants of health and social vulnerability paradigms to examine social determinants of health and their relationship with pandemic mortality during the H1N1 2009 outbreak. Figure 1 presents the model of the study. I developed the model study based upon the Pressure Release Model for the progression of vulnerability Wisner et al. 2004) and social determinants of health conceptual framework by WHO (2010). These conceptual frameworks provide a spectrum of measures which also align with the Whole-of-Society pandemic preparedness model applied by WHO and WHO member states. In the next section, I introduce the independent variables. I analyzed data from 193 World Health Organization member states. The six data variables selected for this study are health, education, communication, population, air transport, and governance. Each variable is measured by specific quantitative indicators that encapsulate factors included in the frameworks. The factors are directly mentioned or implied in the conceptual frameworks for social vulnerability and social determinants of health.

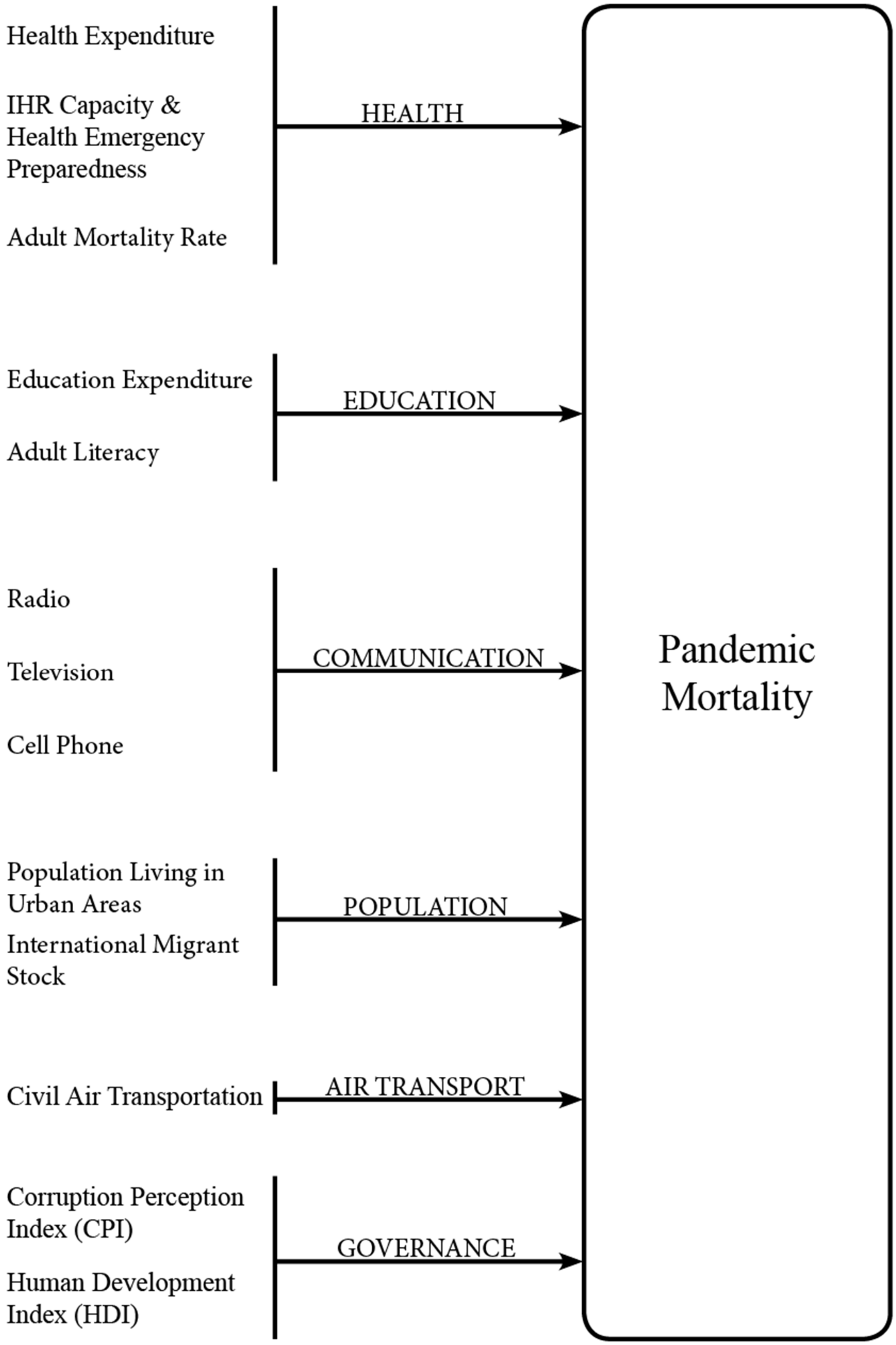

Figure 1: Model of Study

Significance of the study

According to the Global Burden of Disease (GBD) report, which calculates the number of years lost due to disability and premature mortality, infectious disease GBD has steadily increased. The GBD of infectious diseases including pandemics is currently estimated at 15 of 57 million deaths annually, or approximately 26% deaths annually (WHO, 2011). Of particular concern is the exponential surge of influenza mortality when unseasonal outbreaks occur (WHO, 2011). During the H1N1 2009 influenza pandemic, the global burden of infectious disease grew exponentially due to markedly increased mortality, and morbidity. While proactive research on emergent and re-emergent pathogens continues in an attempt to curtail future influenza outbreaks, it is not expected that all outbreaks are preventable. Succinctly put we live in a ‘pandemic era' (Morens, Taubenberger, & Fauci, 2005). The threat of pandemics and their global burden of disease are salient, particularly in an increasingly globalized world.

The timing of this study aligns with a time when the world faces increasing public health concerns. Recent officially declared Public Health Emergencies of International Concern (PHEIC’s) such as Polio, EVD, and Zika have resulted in heightened awareness among various publics. The mishandling of Ebola and Ebola victims during the 2013/2014 outbreak resulted in intense criticism of medical professionals, politicians, and international organizations (Hofman & Au, 2017). While Ebola was finally contained after an initial sluggish response internationally, the world is yet to experience another PHEIC or pandemic, so policy and practice lessons from H1N1 2009, and Ebola remain untested. However, what is evident is that the world is changing. Globalization, geo-political shifts, climate change, and urbanization are impacting people’s lives and livelihoods worldwide.

Modifications among human, animal, avian, and environmental interactions are attendant outcomes of globalization, and they have exponentially increased the probability of influenza outbreaks (McMichaels 2006; Taubenberger & Morens, 2006; McLafferty 2010; Shaman & Lipsitch, 2011; Heffernan 2015). Enhanced human interconnectedness through population shifts and increased global travel have also significantly accelerated human contact, compressed time, and inadvertently escalated pandemic transmission (Fidler, 2001; Smith 2005; Brahmbhatt 2007; Stern & Markel, 2004; Hughes et al. 2010; Fauci & Morens 2016). This collective human system failure has fostered medical, socio-economic and political conditions conducive to the creation of novel pathogens and explosive transmission of infectious diseases (Kaufmann, 2007). As the medical community continues research on emerging and re-emerging diseases, the need for integrated research on social determinants of health increases. Understanding more than just the clinical aspects of disease is necessary for an ecological approach to prevention and containment of pandemics. This study highlights the relationship between traditional social determinants of health, but also incorporates some non-traditional determinants that increase vulnerability to pandemics. Additionally, embedding the study in two disciplines, public health and disaster management will contribute to much-needed literature and research in the field, as well as identify areas of deliberation in policy and practice.

Overview of Upcoming Chapters

Chapter two address extant literature related to the dependent and independent variables. An in-depth review of pandemics beginning with a historical background, conceptualization of the extreme event, H1N1 2009, and the operationalization and management of pandemics is presented. The second section of this chapter focuses on the six independent variables and their indicators. Literature on pertinent global social determinants of health, namely health, education, communication, population air transport and governance are discussed. Chapter three presents the research design of the study. In this chapter more information on the population, unit of analysis, data sources, and study variables are also provided. The research questions are also presented in this chapter as well as the statistical analysis procedures. In chapter four findings from data analysis are presented systematically. Chapter five provides an interpretation of study findings, limitations of the study and implications for policy practice and research.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this study is to examine the relationship between health, education, communication, population, air transport, and governance variables and H1N1 2009 mortality. The first section of this chapter presents a review of extant literature on the H1N1 2009 pandemic. I also review the historical context, epidemiology, and impact of the extreme event. The second section of the chapter will introduce the independent variables, their conceptualization, and relevance. The final section delves into the theoretical framework of the study as relates to the independent variables.

Dependent Variable – Pandemic Mortality

Emerging, and re-emerging infectious disease outbreaks remain among the leading causes of mortality worldwide (Morens et al., 2004; Kaufmann, 2007; Holmes, 2008). Infectious diseases sometimes develop into public health emergencies of international concern (PHEIC), and on occasion progress into full-blown pandemics. Overall, the past two decades have experienced an increase in infectious diseases outbreaks worldwide (Brower & Chalk, 2003; Stern & Markel, 2004: Waarbeek et al. 2011). A handful of the outbreaks were officially designated PHEICs but the H1N1 2009 outbreak surpassed PHEIC classification to become an official pandemic.

Infectious disease outbreaks cause anxiety among individuals and communities at large because of fear of infection and associated socio-economic effects, and concern for health infrastructure response robustness (Tang, & Wong 2003; Rubin, Amlot, Page & Wessely 2005; Pike et al. 2010; Dawood et al., 2012). Most recently in March 2014, the WHO was informed about a re-emergent Ebola Virus Disease outbreak in Guinea and declared it a PHEIC in August the same year (WHO 2014; Hofman & Au, 2017). By March 2016 EVD had spread to six countries with a total confirmed mortality of 11, 323 (WHO, 2016). Ebola mortality was highest in West Africa, but the global impact of the disease resonated worldwide because exposed incomprehensibly deficient public health preparedness and response (Hofman & Au, 2017). The two outbreaks, H1NI 2009, and EVD have both created a window of opportunity for investigation and investment into globally integrated infectious disease preparedness strategies. This study is organized around the first pandemic of the 21st century the H1N1 2009 Influenza pandemic.

Defining Influenza Pandemics

Influenza is an acute viral infection that typically originates from an animal or avian host then is spread to humans who in turn transmit it to others through contact (Pike et al. 2010; WHO 2011). There are two categories of influenza, seasonal and non-seasonal. Seasonal influenza outbreaks occur in the winter months in temperate regions worldwide while in tropical regions outbreaks could occur up to two times a year (WHO 2011). In a typical year, annual mortality from influenza in the United States is 30-50,000 people and up to 30 times higher in the rest of the world (Osterholm 2005; WHO 2014; Vitecoq 2015). From a medical perspective, the pathology of seasonal influenza outbreaks is understood. Annual outbreaks are anticipated therefore mitigating pharmacological and non-pharmacological strategies exist. The same is not true of non-seasonal influenza outbreaks. Non-seasonal influenza outbreaks are unpredictable, have the potential for becoming pandemics, and affect a distinctly different demographic (Kaufmann 2007; Van-Tam & Sellwood, 2013). It is not possible to accurately determine effective pharmacological strategies such as vaccines and stockpiling of vaccines before non-seasonal outbreaks. Additionally, non-pharmacological strategies such as social distancing cannot be activated without knowledge of the outbreaks' pathology.

A true influenza pandemic, according to Kaufmann (2007) is defined as an infectious disease outbreak, which rapidly spreads through human-to-human interaction. Pandemic viruses have high virulence and are simultaneously transnational (Kaufmann 2007; Pike et al. 2010). Compared to epidemics and regular seasonal flu outbreaks, pandemics are distinguishable by widespread human infection in multiple countries, and excess mortality rates (ECDC 2009). Additional signature characteristics that further distinguish pandemics from epidemics include the following; tendency for pandemic affected age groups to shift with each outbreak, a protracted occurrence of the outbreak, and multiple recurrent outbreaks of the same pathogen over an unpredictable time (See Table 1) (EMBO, 2007; Richard et al. 2009; Pike et al. 2010). The World Health Organization WHO (2003) offers defining guidelines rather than an exact definition of pandemics (Morens et al. 2009; WHO, 2009; Doshi, 2011). Influenza pandemic guidelines were first developed in 1999 and revised in 2003. They define pandemics as a novel influenza virus caused by genetic reassortment or gradual adaptive mutation, appearing among a human population that has no immunity (WHO 2003; Stohr 2005;

WHO 2005). The guidelines further state that pandemics cause enormous mortality and morbidity, and displays extensive geographical movement across countries (WHO, 2003; WHO, 2005). The WHO uses a six-phase pre, during and post-pandemic surveillance system as part of its declaration determination process. At phase 6 an official pandemic declaration by WHO occurs.

Historical background

Understanding diseases, their evolution, and patterns of spread has intrigued societies and scientists for generations across all continents (Barton 1969; Omran 1971; Barrett et al. 1998; Kaufmann, 2007; Morens et al. 2008). Historical archives reveal that infectious diseases have "… decimated entire populations triggered mass migrations, and decided the outcome of wars" (Kaufman, 2007, p.1). One such infection was the infamous Spanish flu of 1918-1920. Before 1918, the H1N1 virus was unknown (See Table 1). This changed after herds of swine became infected by a respiratory illness that closely resembled one that affected people in Kansas, United States (Relman et al. 2010; Zimmer & Burke, 2009; Holmes, 2010). The human strain of influenza A (H1N1) was identified, and it developed as the "Spanish Flu." The estimated mortality from this pandemic was between 20 – 100 million people, an estimated 20% – 40% people worldwide (Ghendon, 1994; Johnson, & Mueller, 2002; Taubenberger & Morens, 2006; Zimmer & Burke, 2009; Relman et al. 2010; ECDC 2012). The "Spanish Flu" virus mainly affected young adults. This had to do with the reality of war as they were the predominant demographic enlisted during the ongoing World War I. Military related travel among this age group from around the world facilitated near global transmission (Ghendon, 1994; Osterholm, 2005).

The next H1N1 virus outbreak post "Spanish Flu" was in 1957 (See Table 2). The original H1N1 Spanish Flu virus manifested as a new re-assortment - A (H2N2) - adding an avian segment to the pre-existing swine and human segments (Zimmer & Burke, 2009). Nineteen years a respiratory disease outbreak among soldiers returning to Fort Dix, New Jersey was identified as a novel H1N1 virus named the A (Hsw1N1) New Jersey virus (Gaydos et al. 2006; Zimmer & Burke, 2009) (See Table 2). In response to the 1976 New Jersey outbreak, a mass vaccination of 40 million Americans was authorized by then President Ford. The outbreak was successfully contained within the base (Laver & Garman, 2001; Zimmer & Burke, 2009). In 1977, a relatively mild A (H1N1) human, avian, and swine adapted virus emerged in China, Hong-Kong, and the former Soviet Union (Zimmer & Burke, 2009). The 'Avian Flu' of 1997 to 1999 was a unique H1N1 reassortment which went directly from infected poultry to humans without swine as an intermediary host (Flu.gov 2015). The avian virus had a mortality of six people but decimated the poultry industry across multiple continents.

Since 1918 when the first known H1N1 virus emerged, H1N1 outbreaks and their impacts have varied in transmission patterns, geographical expanse, and socio-economic impact. Morens et al. (2009 b) succinctly caution that a useful way of conceptualizing influenza A events of the past 91 years is to recognize that we are living in a 'pandemic era' that began with the 1918 Spanish Flu.

Table 2

Mortality from influenza pandemics and select seasonal epidemics 1918-2009

Mortality Associated with Influenza Pandemics and Selected Seasonal Epidemic Events 1918-2009		
Years	Circulating Virus (Genetic Mechanism)	Excess Deaths from any cause. No. per 100,000 persons/yr.
1918-1919	H1N1 (viral introduction) pandemic	598.0
1928-1929	H1N1 (drift)	96.7
1934-1936	H1N1(drift)	52.0
1947-1948	H1N1 A' (intrasubtypic reassortment)	8.9
1951-1953	H1N1 (intrasubtypic reassortment)	34.1
1957-1958	H2N(antigenic shift), pandemic	40.6
1968-1969	H3N2 (antigenic shift), pandemic	16.9
1972-1973	H3N2 A Port Chalmers (drift)	11.8
1975-1976	H3N2 (drift) and H1N1 ("swine flu" outbreak)	12.4
1977-1978	H3N2 (drift and H1N1 (viral return)	21.0
1997-1999	H3N2 A Sydney (intrasubtypic reassortment) and H1N1 (drift)	49.5
2003-2004	H3N2 A Fujian (intrasubtypic reassortment) and H1N1 (drift)	17.1
2009	H3N2 and H1N1 (drift) and swine-origin H1N1 (viral introduction), pandemic	

Morens, Taubenberger, & Fauci (2009 a)

The 2009 H1N1 Pandemic

In April 2009, two cases of a reassorted H1N1 virus were reported and confirmed by the CDC as being of the A (H1N1) swine virus 1918 lineage (Garten et al. 2009; Zimmer & Burke, 2009; Relman et al. 2010; Pike et al. 2010). It was retrospectively confirmed that the novel virus had originated in Mexico the previous month. Soon after that, the CDC determined that containment of the virus in the United States was no longer feasible, implying that transmission was not isolated and could not be controlled (CDC, 2009; ECDC, 2009). The CDC also announced that the outbreak was exhibiting multiple intense peaks of transmission yet another typical pandemic characteristic (CDC, 2009; ECDC, 2009). On April 25, 2009, after an Emergency WHO committee meeting, the first PHEIC was declared stepping up monitoring, surveillance and resource allocation for the H1N1 outbreak (CDC, 2009; WHO 2011).

By June 2009, WHO declared the outbreak an official influenza pandemic because of its novel virus strain, rapid spread, and the potential for a higher than normal flu season mortality (Liu & Kim, 2011). Pandemic mortality is the official number of laboratory-confirmed deaths. In the absence of laboratory confirmation, an alternative is used. Through calculation of excess death by comparing pre-existing non-pandemic period data to pandemic period data, results are extrapolated to arrive at an estimate (See table 2). Laboratory confirmed A(H1N1) 2009 mortality data provides a valuable formal death count. Table 3 presents data on actual laboratory confirmed H1N1 2009 mortality from WHO by region. However, this data is a misrepresentation of actual pandemic mortality because it does not include co-morbidity excess death data which is also presented in Table 3 (WHO 2011; Dawood et al. 2012; Roos 2012).

Eight months after the first the confirmation of A (H1N1) cases in U.S., 500,000 cases were reported in more than 200 countries but only 6,250 were laboratory confirmed (WHO, 2009). The WHO estimate for laboratory-confirmed H1N1 2009 flu mortality fourteen months after the official declaration (August 2010) was 18,449, in 214 countries (WHO, 2010). The H1N1 2009 mortality data is notably deficient of ILI non-laboratory confirmed deaths, which was not unique to this pandemic. Co-morbidities are yet another factor that distorts pandemic mortality data. While transmission of pandemic influenza is predominantly through respiratory infections, cardiovascular infections also contribute towards overall pandemic mortality (See Table 3) (Brower & Chalk 2003; Belshe, 2005; Mathews et al. 2009; Dawood et al. 2012). Consequently, in a CDC estimate of H1N1 2009 pandemic deaths caused by respiratory and cardiovascular complications, 284,400 lives were lost, in comparison to the WHO 18,449 official number (WHO, 2010; Dawood, et al. 2012; CIDRAP, 2012; Roos, 2012)

Underreporting of pandemic mortality data is not unique to the H1N1 2009 outbreak. Limitations that affect morbidity and mortality data include; the epidemiology of the disease by region, inadequate or lacking health infrastructure support, social, cultural norms, defective record keeping, and socio-political influences (Johnson & Mueller, 2002; Dawood, et al. 2012; 2016). Collectively, these factors often result in underreporting or over reporting of data which in turn affects public health policy and practice.

Table 3

Reported and estimated respiratory and cardiovascular H1N1 2009 pandemic influenza deaths for period up to August 2010

Region	Laboratory Confirmed WHO Deaths*	**Respiratory and cardiovascular estimated H1N1 deaths 2012 ***n(range)
WHO Regional Office for Africa (AFRO)	168	65,600(34,600-125,900)
WHO Regional Office for the Americas (AMRO)	At least 8533	29,700(16,200-61,500)
WHO Regional Office for the Eastern Mediterranean (EMRO)	1019	23,600(12,300-47,100)
WHO Regional Office for Europe (EURO)	At least 4979	31,300(17,200-67,600)
WHO Regional Office for South-East Asia (SEARO)	1992	78,600(40,900-158,900)
WHO Regional Office for the Western Pacific (WPRO)	1858	55,700(30,600-114,500)
Total	At least 18449	284,400

*The reported number of fatal cases is an underrepresentation of the numbers as many deaths are never tested or recognized as influenza related.

**Influenza deaths result from respiratory or cardiovascular complications. Researchers calculated excess

***Estimated range was calculated by summing the 25^{th} and 75^{th} percentiles of estimates in each age group above 17years per country (Kosovo, Niue, and Vatican City not included).

Operationalization of pandemics

Role definition, competence, and possible role conflict are, according to Barton (1969) relevant for facilitating decision making and response behavior at a personal and organizational level during disasters. Influenza pandemics, unlike seasonal influenza, require distinctly heightened awareness and differentiated management (Relman et al. 2010; Doshi, 2011; WHO 2011). On a personal and community level, being able to synthesize information, and make self-saving decisions is key to saving lives and minimizing pandemic impact. Decisions such as social distancing, adhering to quarantines and reporting illness are critically important for containing pandemics. On the organization level, governments, medical institutions, public health providers, and non-governmental organizations play a pivotal role in the surveillance, monitoring, and reporting of pandemic/like activity. Once WHO officially declares an official pandemic, heightened surveillance, monitoring, and resource allocation worldwide is activated (WHO, 2011). Sovereign states are responsible for the health of their population through the use of "… government vested… coercive powers." (Lee & Fidler, 2007). However, pandemics rapidly overwhelm national resources of a country and require the involvement of non-state actors such as international and non-governmental organizations. To this extent, the United Nations (UN) system, in particular, WHO is currently the preeminent global health governance body for pandemic outbreak management (Lee & Fidler, 2007).

The United Nations (UN)

Fifty-one member states founded the United Nations (UN) after the Second World War with the stated goals of maintaining worldwide peace, developing friendly relations among nations, improving the overall standard of living, and harmonizing member nation activities towards achieving these goals (United Nations, 2014). The UN has been unequivocal in attempts to minimize and or eliminate disaster and health emergency mortality improving health standards. In 1990, the adverse effects of disasters worldwide prompted the UN to declare the International Decade for Natural Disaster Reduction (IDNDR). The proposition of this declaration was to focus efforts and resources towards minimizing disaster impacts worldwide. According to Noji (1997), this offered the public health community an opportunity to "… pull together the wealth of technical expertise and experience … to prevent much of the death, injury and economic disruption caused by disasters." (p. xv). Millennium Development Goals (MDGs) is yet another way that the UN and its constituent bodies have addressed public health and disasters. To address the overarching challenges of poverty and its impact on health worldwide, the UN unanimously adopted the MDG's in 2000 (Sachs 2005). With 180 member countries in attendance, this UN Millennium assembly established that alleviating extreme poverty worldwide by 2015 would have direct impact on overall health and human development (Morrow & Enarson, 1996; Sachs 2004; Stern & Markel, 2004; Marmot 2005). United Nations member states acknowledged that unless extreme poverty was alleviated human, socio-economic, and environmental development would be stifled (Brundtland 1987: Kaufmann, 2007). Eight MDGs were delineated and adopted during this meeting, among them the critical need to combat diseases (UN, 2000). Notably, three of the eight MDG's are directly related to health, highlighting the prominence of health as a critical component of improved overall human development (Sachs, 2004; Marmot 2005).

World Health Organization (WHO)

The World Health Organization was established with the explicit goal of attaining 'health for all' and is the UN constituent agency charged with international public health (WHO, 1977). It plays a pivotal role in situating the global pandemic threat, its strategic policies, surveillance, monitoring, policy, and operations. World Health Organization consists of sovereign member states responsible for collaboratively developing and implementing global health plans (Folkers & Fauci, 2004; Lee & Fidler, 2007; Nicoll, 2010; WHO, 2013). From its foundation, the WHO focuses on achieving health for all through biomedical techniques and advances that eradicate infectious diseases, and improve basic health worldwide (Stern & Markel, 2004).

From Traditional Health Theory to an Ecological Model

Upon inception WHO spearheaded singular disease-specific awareness and eradication projects such as smallpox eradication in 1979 (Stern & Markel, 2004). The singular emergency approach focused on a geographically focused short-term goal to rid the world of one disease at a time (WHO, 2011). This pioneering method of WHO operations aligns itself with the traditional health theory. A theoretical framework that focuses on individual health, communication of facts by experts, and assumes a rational decision maker moving along a linear progression (Fischoff 1995; Powell & Leiss 1997). The model proved over time, not effective in dealing with the complexities that affect the health of people and communities. In the late 70's WHO made a shift towards a global, sustained, long-term operation cognizant of social determinants of health. The social determinants of health model was adopted as a means of establishing a sustainable approach to alleviating disparate health outcomes (WHO 2011). To actualize this approach WHO and its member states agreed to address socio-economic, political, and cultural processes as critical for attaining global health (WHO, 2009). Specifically, the 'whole of society approach' toward pandemic preparedness was specifically adopted to address social determinants of health (WHO, 2009) (See Figure 2).

Whole of Society Pandemic Preparedness

The Whole-of-Society pandemic preparedness approach (See Figure 3) is a derivative of the ecological model of health (WHO 2009; WEC, 2015). The model advocates a multi-sectorial partnership involving government, NGO's, private institutions, communities, and individuals for addressing health challenges (Marmot et al. 2008; WHO 2009; Nichol, 2010; PREVENT, 2010).

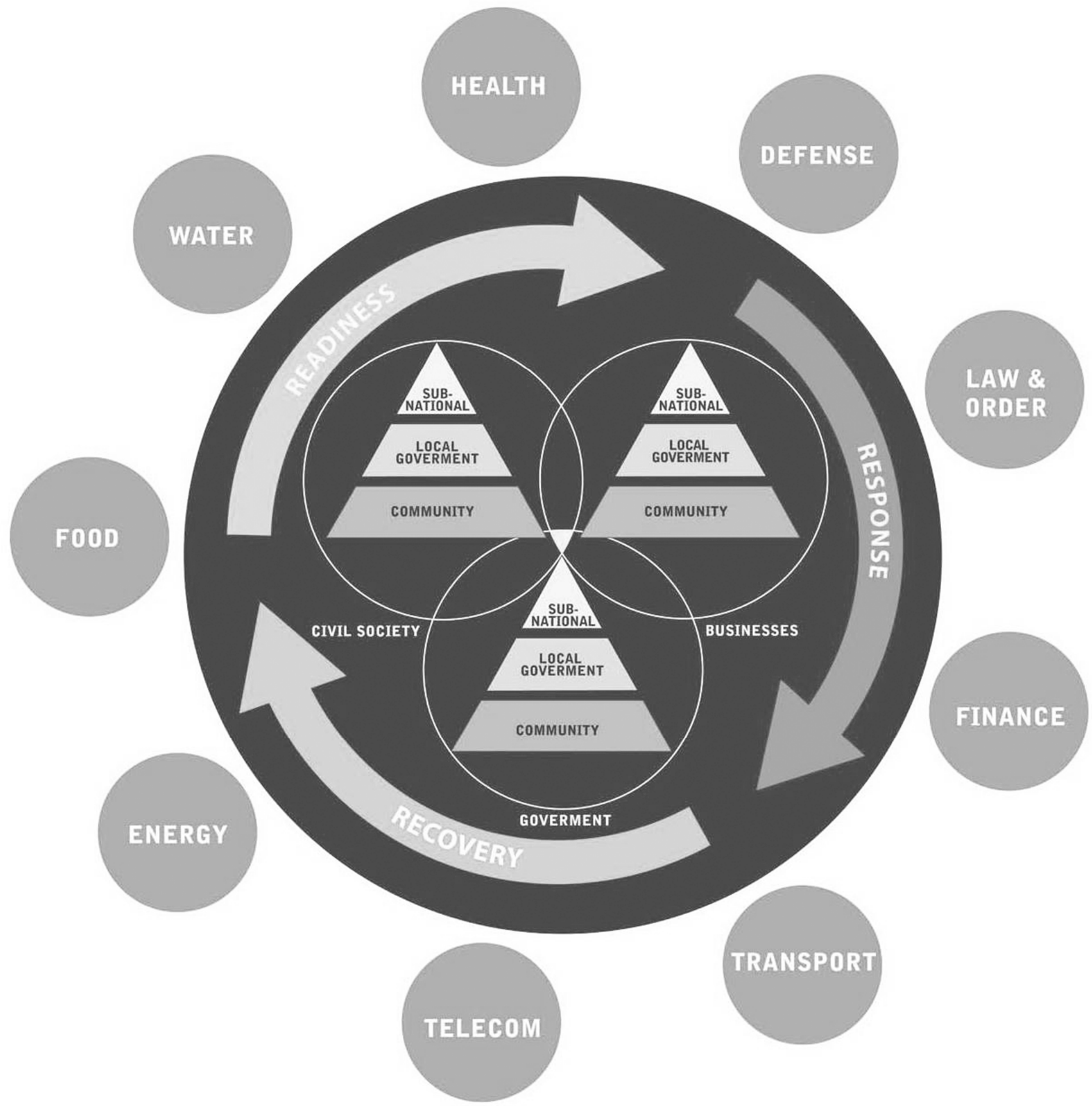

Figure 2 The Whole-Of-Society Pandemic Preparedness Model

International Health Regulations

In 2005 194 member states of UN adopted the International Health Regulations (IHR). The IHR is a global and legally binding pandemic framework between member nations and the WHO. The framework aims to support development and implementation of core local and national pandemic prevention and control capacities (WHO, 2009; WHO, 2011; Fineberg 2014). Incorporated in the IHR mandate are seven directives that;

support national legislation, policy, and financing, coordinate national focal point communications, surveillance response, preparedness, risk

communication, human resources, and laboratory capacity-building (WHO, 2013). The IHR stipulates obligatory surveillance, monitoring, and communication procedures from member states upon detection of a potential pandemic outbreak (WHO, 2009).

The WHO plays the preeminent operational role of setting leadership priorities for member states on pandemic surveillance, monitoring, and protocol (Nicoll, 2010; WHO, 2013). Despite tremendous achievements, WHO has experienced numerous challenges. They range from a lack of political will and support, cultural missteps, bureaucratic red tape, warfare, worsening tensions between countries, and inadequate funding (Garrett, 2000; Koop, et al. 2002; Barnett &Whiteside, 2006; Lee & Fidler 2007; King 2009; WHO, 2011). The 2014-2015 WHO budget reflects significant financial cuts for pandemic preparedness, surveillance, and response. Cuts which according to Sachs (2014) are debilitating because of the subsequent constraints directly affecting pandemic planning worldwide.

National Level Pandemic Governance

National governments are responsible for adopting and implementing coherent strategic pandemic plans with the support of WHO. Regional level actors, who are a collective of multiple nations, are also active in directing relevant health strategies. In particular, pandemics require strong regional actors because outbreaks do not respect geo political boundaries. Pandemics in one area inadvertently affect other locations regardless of national or continental divides. As an example, the African Union (AU) countries adopted the Abuja declaration in 2000 (WHO, 2011). The declaration acknowledges the role of poverty, poor nutrition, and underdevelopment in increasing vulnerability. Operationally, the Abuja declaration stipulates that 15% of the national budget among African member states be invested in improving the health sector through a multi-sectoral approach (OAU, 2001; Brahmbhatt 2007: Wiwanitkit, et al. 2015).

World Health Organization incentivizes member states to achieve various health development goals through direct technical and personnel support. At a national level, signatories to the WHO pandemic policy guidelines (2009) are encouraged to apply the Whole of Society Approach (See Figure 2) for pandemic preparedness. Multisectoral planning is a pragmatic approach because public health departments and national government cannot adequately cope with the overwhelming challenges inherent to pandemic outbreaks (Brahmbhatt 2007; WHO, 2009; WEC 2015). An example of the overwhelming challenges of pandemics is workforce absenteeism. National workforce absenteeism predicted by pandemic forecast models introduces complex challenges to national governments because of role conflicts, illness, and social distancing (Barton, 1969; Osterholm, 2005). Across the board, national workforce absenteeism due to illness is estimated at 20% during pandemics which would have a ripple effect on the functioning of critical national infrastructures (Nicoll, 2010; Bissell & Kirsch, 2013). Mitigating this and other forecasted pandemic effects is imperative on a national level through strategies such as cross-training. Another key area of national-level personnel needs is for implementation of non-pharmacological containment measures. Non-pharmacological measures include contact tracing and social distancing, which require implementation support by public health staff, civic and community organizations, and in extreme cases law enforcement (Bruine de Bruin, et al. 2006; Nicoll, 2010). Animal and avian culling, and movement restrictions are also non-pharmacological strategies that require collaboration among veterinarians and animal owners(Lee & Fidler, 2007). Clearly, the need for the multi-sectoral planning recommended through the Whole of Society Approach before, during and after pandemics cannot is paramount.

Overall, WHO member states have made limited progress in the implementation phase of the Whole of Society pandemic preparedness (PREVENT 2011). Despite efforts by various organizations, the implementation of pandemic preparedness strategies remains inadequate and underfunded (Brower & Chalk, 2003; WHO, 2003; Stern & Markel, 2004: Waarbeek et al. 2011). The inadequacy is attributed to factors including but not limited to a lack of political will, misdirected priorities, economic disparities, and geo-political tensions (Garrett 2000; Carter-Pokras & Baquet, 2002; Barnett &Whiteside, 2006; King 2009; WHO, 2011).

INDEPENDENT VARIABLES

Influenza pandemic outbreaks cannot be predicted with exact specificity. However, if history and science are any guides, pandemics are an imminent global threat (Stern & Markel, 2004; EMBO, 2007; WHO, 2005; Kaufmann, 2007; WHO 2011). The H1N1 2009 pandemic was deemed a ‘predictable surprise’ by some in public health because the H1N1 virus is known to cause influenza pandemics and is most likely to mutate into a novel virus (Relman et al. 2010). The timing of the outbreak, and the origin of the H1N1 2009 outbreak in the Americas, rather than Asia was however unexpected (Relman et al. 2010).

Of concern among public health and medical professionals is that despite medical advancement and multiple near misses, global pandemic preparedness is still woefully inadequate (Baker & Koplan, 2002; Osterholm 2005; Bruine de Bruin et al. 2006; Shortridge, 2006; EMBO, 2007 2009; Relman et al. 2010). The H1N1 2009 outbreak report by WHO reiterated a concern for global mitigation and preparedness stressing that, "… the need for a multi-sectoral approach, strengthened health care delivery systems, economic development in low and middle-income countries, and improved health status" (WHO, 2011, p.12). This situation report, alongside literature review on social vulnerability and determinants of health form the foundation on which the independent variables of this study were identified.

Specifically, this study integrates a disaster management and public health approach to investigating social vulnerability and the social determinants of health that contribute to it. Using the Cannon (1994) conceptualization of vulnerability, I use variables proximate to his populations with fewest choices, and whose lives are constrained by poverty, gender oppression, ethnic discrimination, political powerlessness, physical disability, limited employment opportunities, the absence of legal rights and other forms of domination. The theoretical framework that explains the progression of vulnerability Pressure and Release (PAR) model by Wisner et al. (2004) encapsulates pertinent social vulnerabilities. Pressure and Release (PAR) model (See Figure 6), and the Social Determinants of Health Conceptual Framework (SDHC) (WHO 2010 a) (See Figure 7). Both models expound on socially constructed factors that predispose some people more to the impact of disasters. Specifically, this study investigates the relationship between indicators of health, education, communication, population, air transport, and governance, with mortality from the H1N1 2009 pandemic.

I applied multiple methods to generate the independent variables for this study. First, I directly matched variables stipulated in the PAR and SDHC models with available national datasets. The PAR directly mentions political systems, economic systems, rapid population growth, press freedom, ethical standards in public life, low-income levels, and a lack of disaster preparedness (Wisner et al. 2004). Social Determinants of Health Conceptual Framework also directly points out socioeconomic and political context, governance, health policy, and education variables (WHO 2010 a). I matched these variables with datasets on CPI, HDI, population living in urban areas, international migrant stock, and IHR and HEP. Second, for variables without a direct independent dataset match, I applied aggregated data sets IHR & HEP, HDI, and CPI which encompass variables from the models. As an example, the HDI (See Figure 5) examines three critical criteria of economic development; life expectancy at birth, mean years of schooling and expected years of schooling, and Gross National Income per capita (See Figure 3). While an exclusive data set on actual per capita income is not included in this study, GNI measure of purchasing power parity in HDI encapsulates an economic measure. Finally, some independent variables were generated based on their relevance to pandemic outcomes as indicated in literature. For example, research identifies a strong correlation between air passenger travel with pandemic outcomes (Grais et al. 2003; Khan et al. 2009; Mukherjee, et al. 2010; Brockmann & Helbing, 2013). I, therefore, included air transport data to my variables. Literature also discusses the perennial communication gap prevalent in pre, during and post disaster situations (Quarantelli

1982; Holmes 2008; Vaughn & Tinker 2009; Palttala, et al. 2011; Powell, Hanfling, & Gostin, 2012). To accommodate communication in the study, I reviewed traditional and non-traditional modes of communication, namely radio, television, and cell phone subscription respectively.

Despite a consensus on the need for research on social vulnerability and determinants of disasters, extant research reflects limited investigation into it (Mileti et al., 1995; Logue, 1996; Peacock, et al. 1997; Kilbourne et al. 2006; Lee & Fidler 2007; Oliver-Smith 2012). Pandemics, in particular, are minimally studied from an integrated public health, disaster management approach. Public health institutions, medical researchers, and practitioners have almost exclusively led the charge in pandemic research (Schartung, et al. 2010). Consequently, most pandemic research follows a single stream approach based in epidemiology, microbiology, virology, and public health (Osterholm 2005; Stohr 2005; Dingwall, Hoffman, & Staniland, 2013). Garoon and Duggan (2008) also note that pandemic discourse remains within the scientific, political, and legal domain with minimal attention to social, cultural and ethical concerns.

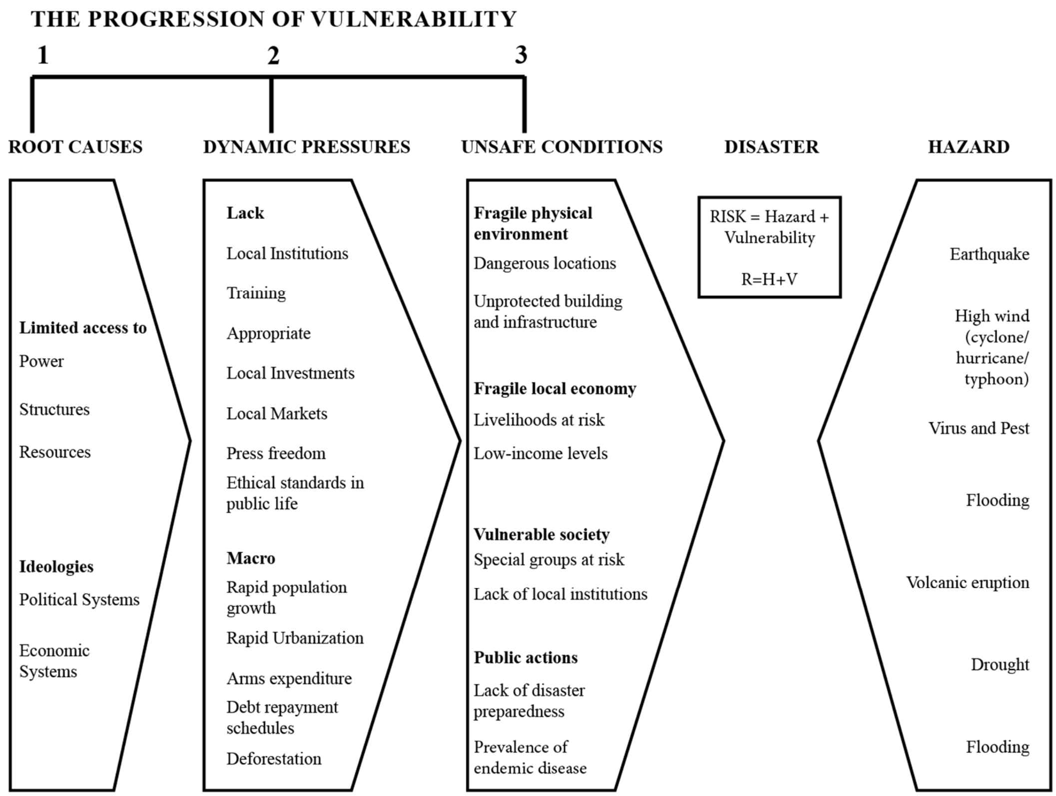

Figure 3: The Pressure Release Model (PAR) the progression of vulnerability. Source Wisner Blaikie, Cannon, and Davis (2004)

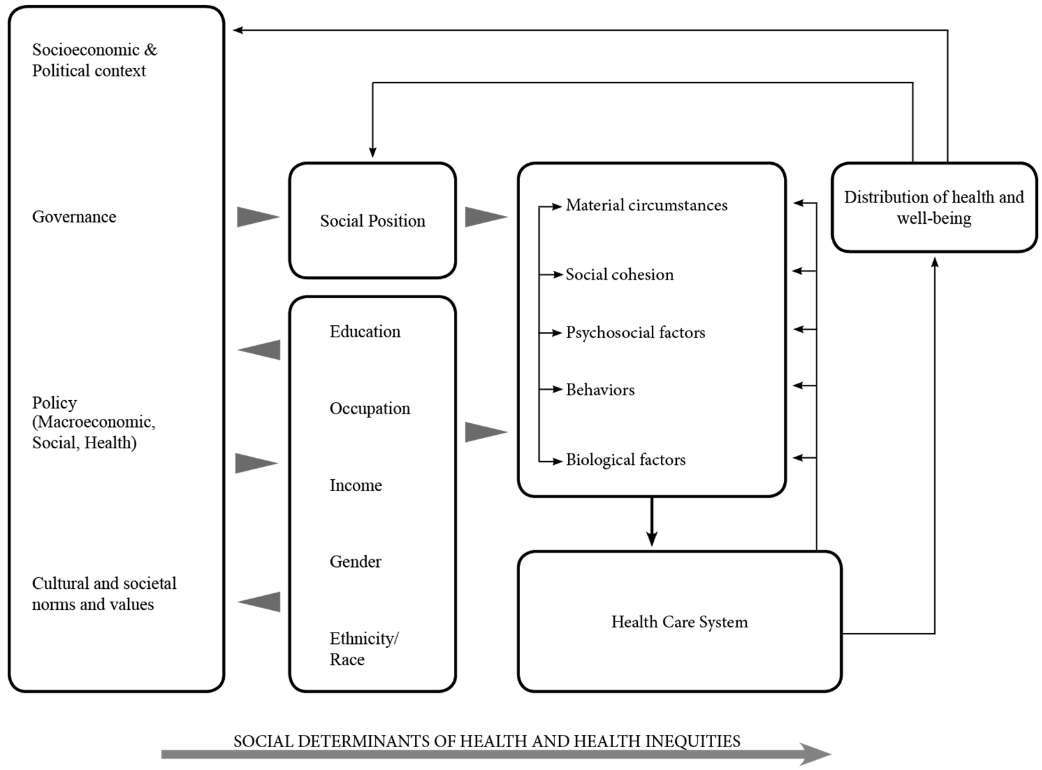

Figure 4: World Health Organization's Social Determinants of Health Conceptual Framework WHO (2010, a)

The independent variables of the study will investigate national indicators related to health, education, communication, population, air transport and governance. The variables represent more than an economic indicator perspective. They include a spectrum of critical measures for development Toya & Skidmore (2007). In the next section, I introduce the independent variables.

HEALTH VARIABLE

Within the context of emerging and re-emerging infectious diseases, entire populations are heavily dependent on the role medical services and public health plays to protect them from the ravages of outbreaks and treat them in the event of one. During health emergencies, high patient volume, hospital surge, and demand for medical resources and information are heightened (Garrett, 2003). Evidently, public health infrastructure must exponentially scale up to meet the demands brought by health emergencies such as pandemics (Gebbie, 1999; Baker, et al. 2005). To facilitate this demand a robust health infrastructure anchored on a strong public health practice is paramount (see Figure 3) (Baker et al. 2005). Baseline components of a countries public health infrastructure are its human resources, technical, and financial support, all of which are dependent on direct budgetary allocation (Garrett, 2002; Baker et al. 2005). These components are what support the development of networked information and knowledge system, public health workforce and organizational capacity necessary for managing health emergencies (Baker et al. 2005).

As countries experience socio-economic development and growth direct financial resource allocation to health and safety is vital (Toya & Skidmore, 2007). This is particularly salient in low income and middle-income countries where limited resources are typically insufficient for meeting its country health needs (Ravishankar et al. 2009). Developing countries, marginalized and minority communities are especially vulnerable during health emergencies because of inadequate public health resources (Baker & Koplan 2002; Garrett 2003; Baker et al. 2005; Osterholm 2005; McLafferty 2010). To bridge the gap between health needs, public-private partnerships for health assistance and development are available from governmental and non-governmental organizations, as well as countries (Ravishankar et al. 2009). International Health Regulations provide an organizational framework for WHO member states (Marks-Sultan, et al. 2016). The WHO mandated and supported IHR approach aims at strengthening organizational capacity, information and knowledge systems, surveillance, and laboratory practice for health emergencies.

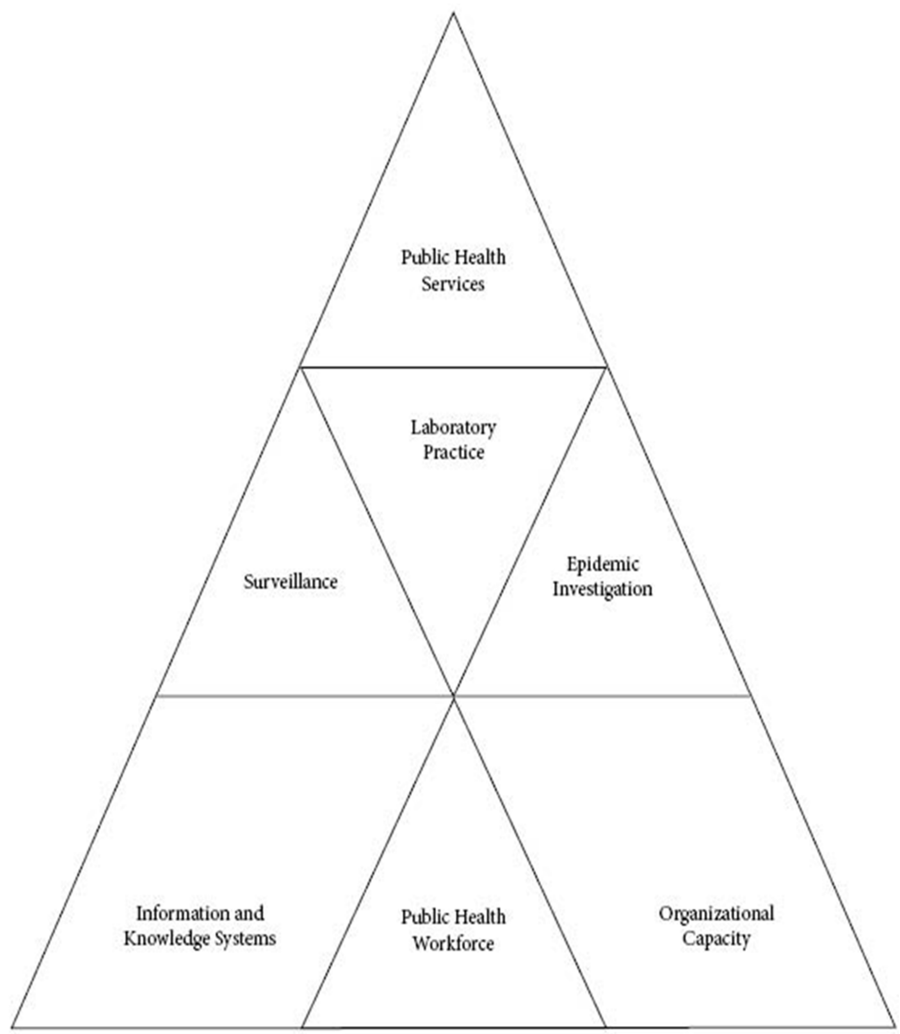

Figure 5: Public health practice model (Baker et al., 2005)

EDUCATION VARIABLE

People are not equally unhealthy (Kenkel 1991). Educational attainment plays a role in how a population achieves and maintains its health. Specific patterns of health that cause this inequality are evident from observation as well as formal scientific research. Research identifies formal schooling as the most important positive correlate of good health (Kenkel 1991; Tierney 2006; Grossman 2008; Eide & Showalter, 2010). The premise is that people with a higher education level are more likely informed on health and health behavior (Kenkel 1991). Additionally, people with poor health often attain low education due to illness.

Research advocates the incorporation of health education in school curriculum (Smith, 2003) as a means of improving public health. This is necessary because it provides an effective vehicle for increased awareness and learning. It teaches students about health, and they can, in turn, influence their parents and others within their society (Grossman 1972; Acemoglu & Angrist, 2000; Smith 2003; Bruine de Bruin et al. 2006; Grossman 2008). Formal learning opportunities, therefore, empower individuals and communities with relevant health information which in turn can enhance decision-making in the event of public health disasters (Toya & Skidmore, 2007). Grossman (1972) articulates that there is an increased efficiency of household health commensurate with education obtained. On the contrary, poor adult literacy skills impede reading, comprehension, and thinking of health-related information (Nutbeam 2008). The ability to access, interpret, share, and make decisions on health emergency information is important for building resilience, and supporting recovery efforts as well (Fothergill et al. 1996; Santos-Hernández 2006; Santos-Hernández & Morrow, 2013).

COMMUNICATION VARIABLE

"One of the most important considerations in the event of an infectious disease outbreak is communication… " (Holmes 2008, p. 350). The role of communication is specifically geared toward dispelling fear, and influencing decision-making among various publics towards self-preservation (Osterholm 2005; Bruine de Bruin et al. 2006; Lee & Fidler 2007; Davis, Stephenson, Lohm, Waller, & Flowers, 2015). Since the Acquired Immune Deficiency Syndrome (AIDS) outbreak, the role of public health literacy and communication has expanded exponentially. Public health communication as a key component for actively engaging health experts, communities, and people affected by disease (Holmes 2010). Communication is also an integral part of public health surveillance and monitoring with direct implications for victim survival and recovery post disasters (Foege 1986).

Within the global health governance structure spearheaded by WHO, communications is considered one of four critical functions of influenza governance (Lee & Fidler, 2007). Communication during all phases of pandemics plays a critical role in "… maintaining confidence in, and cooperation with, public health control and prevention efforts." (Lee & Fidler, 2007 p. 227). Before active pandemic outbreaks, establishing communication channels and strategies with the public is important for supporting outbreak compliance. During outbreaks, a compliant population is essential for the successful execution of pharmacological and non-pharmacological pandemic mitigation strategies (Ferguson et al. 2005). Communication messaging and outlets are central to delivering messages as well as receiving feedback (See Figure 4). For message delivery, public health professionals engage in media supported health campaigns and education programs (Kenkel 1991; Seeger & Reynolds 2007; Gesser-Edelsburg et al., 2014).

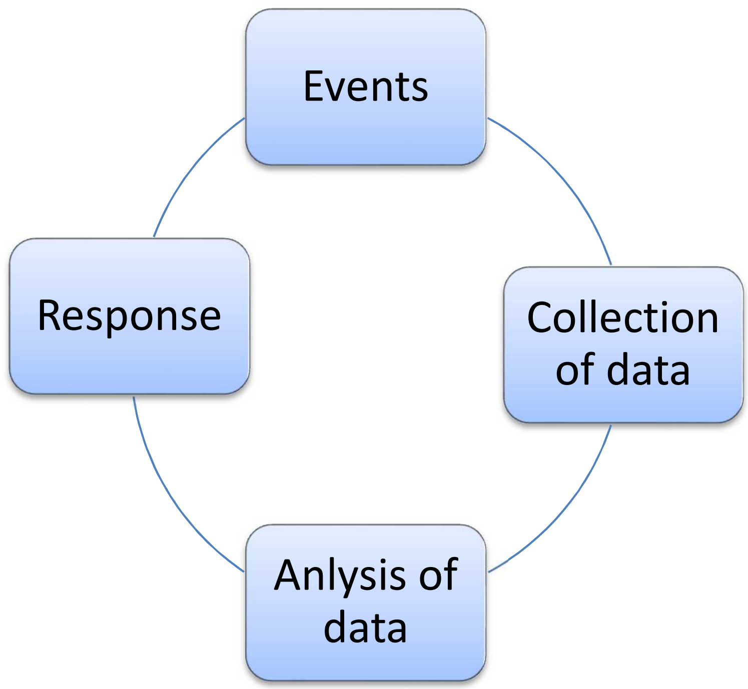

Figure 6: The surveillance cycle. Foege (1996)

POPULATION VARIABLE

Disasters occur within a spatial dynamic directly affecting people within its range of impact. Majority disasters have a predictable range of impact based on the epicenter of the event (Kaufmann 2007). The unique challenge of pandemics is that by the time one is declared, its geographical span and impact are evolving exponentially and at unpredictable rates. Pandemics are by their nature characterized by having an impact beyond national boundaries, and the inability to contain them is always the imminent threat (Kaufman, 2007, WHO 2005; Pike et al. 2010; McLafferty 2010). Population movement and density pose significant challenges for realistic infectious disease and pandemic control strategies (Hufnagel, Brockmann, & Geisel 2004; Stern & Markel, 2004; Ferguson et al. 2005). Migration in search of better economic and social opportunities results in excessive settlement in specific geographic locations deemed as offering better opportunities. Globally, over 244 million people, the equivalent of 3.3% of the world's population, are migrants living in countries other than their country of origin (UNPF 2015). They are more vulnerable to health emergencies because of inadequate support systems and resources in their new home countries (Costello et al. 2006).

AIR TRANSPORT VARIABLE

Travel volume and patterns are relevant because they facilitate the transfer of pathogens from source of origin and beyond (Stern & Markel, 2004; Grady et al. 2012). Globalization and the need to travel for leisure and business elicit increased interconnectedness over quicker timeframes worldwide (Smith 2005). This demand has made rapid travel more feasible and extensive (Omran 1971; Fidler 2001; Johnson & Mueller, 2002; Hufnagel, et al. 2004; Brahmbhatt 2007; Stern & Markel, 2004; Hughes et al. 2010). Whether transitory or permanent, intensified contact between humans during travel plays a critical role in pathogen transmission (Omran, 1971; McLafferty, 2010).

GOVERNANCE VARIABLE

Governance is a term that connotes local, national and international structures and processes of public and private administration (Weiss 2000). It is a process that seeks to co-operatively accommodate the needs and affairs of people without inherently causing harm (Rosenau 1995). Key among governance stakeholders are citizens, government, civil society, media, and the private sector, so governance is not the purview of public governments alone (Graham, Amos, & Plumptre, 2003). While good governance seeks to balance societal needs equitably external influences such as politics, discrimination, and corruption result in disparate human development.

The worst impact of pandemics is felt among people living in poverty (Garrett 2003; Dutta-Bergmann, 2005; Uscher-Pines et al. 2007; Blumenshine et al. 2008; Thomas et al. 2010; Dawood et al. 2012). Research identifies people living in poverty as the first and worst affected due to their preexisting vulnerability and low safety margin (McMichael, Nyong, & Corvalan, 2008; Wiwanitkit, 2015). They are plagued by pre-existing ill health, malnutrition, poor sanitation, unaffordable health services, and limited access to self-preserving information (Brundtland 1987; Garrett 2003; McMichael 2006; Burke et al. 2010; Marmot et al. 2008; Dawood et al. 2012; Varshney 2014). Poverty, compounded by environmental factors such as climate change and urbanization exacerbate vulnerability to disasters (McMichaels 2006; Costello et al. 2008; Marmot et al. 2008). While understanding, quantifying and mitigating financial poverty is integral to public health, economic criteria do not capture the complexity of governance and its effects on health (Kaufmann 2007; Flanagan et al. 2011).

Leading international, regional and local health organizations recognize the correlation between poverty and poor health outcomes. There are strong advocates for eradicating poverty as a means of achieving improved human development and health outcomes within international, national and grass root level organizations. The United Nations Development Program (UNDP) as an example, in an effort to capture and "put people back at the center of development" expanded its interpretation and quantification of human dynamic and vulnerabilities (UNDP, 1990). The UNDP developed the Human

Development Index (HDI) to quantify and integrate additional factors pertinent to alleviating poverty.

In conclusion, this chapter provided extant literature upon which this study is grounded. Laying out a historical background, conceptualization of the extreme event. I discussed operationalization of pandemics from an international and national perspective, and the challenges posed by pandemics globally. The second section of this chapter gave an overview of the six independent variables as global social determinants of health. The next chapter addresses methodology, research design, population, and unit of analysis for the study variables. I discuss the data sources of each variable systematically. The final section covers study research questions.

CHAPTER III

METHODOLOGY

Introduction

Imbalance between the natural, human, and constructed environment triggers disasters, causing direct and indirect impact (Dynes 1974; Mileti 1999). The purpose of this study is to examine, describe, and analyze the relationship between health, education, communication, population, air transport, and governance variables as social processes and determinants of health with a health outcome, H1N1 2009 mortality. This chapter will address the methodological process used to answer six research questions. The first section of this chapter begins with the research design of the study, population and unit of analysis, and data sources. In the second section I address in detail the dependent and independent variables and their operationalization. I also discuss each indicator used to measure the variables, and their data sources. The third section reviews the six research questions, their respective hypotheses and the statistical analyses performed to analyze research data.

Research Design

The design of this study is an *ex post facto* correlational study. A correlational study is non experimental and is designed to describe relationships among variables. It provides empirical evidence suggesting whether two or more variables are or not related (Gay, Mills, & Airasian, 2012). For this specific study, the type of correlational design I use is a prediction design. This design is used to identify variables that can effectively predict an outcome. The statistical procedure I used in this design is the stepwise multiple regression. The independent variables are: health, education, communication, population, air transport, and governance. The dependent variable is the H1N1 2009 mortality. Secondary quantitative data is used to examine the relationships using statistical procedures (Creswell 2014). The study is not designed to identify any causal relationship, but rather proposes to identify relationships among variables (Gay et al. 2012). Specifically, how well the six variables relate and predict the dependent variable. In the next section I discuss the population of the study and the unit of analysis.

Population and unit of analysis

The population for this study is UN member states listed as WHO members in 2009. Sampling procedures are not applied for this study because all member states are included. The year 2009 is relevant because it was the year H1N1 2009 broke and was declared a pandemic. Multiple sources were used to gather data on specific variables from all 193 countries. The sources are discussed in the next section.

Data Sources

Data for the dependent and independent variables in this ex post facto correlational design is secondary, and is obtained from UN and UN constituent organizations and Transparency International. Dependent variable data, H1N1 2009 mortality, was obtained from the WHO. The World Bank (WB), United Nations

Statistics (UNSTATS), United Nations Educational, Scientific and Cultural Organization (UNESCO), International Telecommunication Union (ITU), United Nations Populations Division (UNOP), and United Nations Development Program (UNDP) are data sources for the six independent variables, (See Table 4).

Use of data from international and national organizations such as ECDC, WHO, UNDP, UNESCO, ECDC, CDC, TI, PAHO, and ITU in technical reports, peer reviewed journal articles, opinion pieces and for policy formulation worldwide is pervasive. At the onset of the outbreak, researchers Fraser, Donnelly, Cauchemez, Hanage, Kerkhove (2009) used air transportation data from Mexico, and WHO laboratory confirmed H1N1 cases to examine the potential of the H1N1 influenza strain. Research on the severity of the ongoing pandemic using data was conducted by Gaarske, Legrand, Donnelly, & Ward et al. (2009) using WHO, CDC, and PAHO data. Their goal was to generate mortality ratios in support of healthcare planning worldwide. The confluence of school opening and potential H1N1 outbreaks was examined by Chao, Halloran & Longini, (2010) using CDC data towards the end of the outbreak. Communication strategies for tracking levels of disease and public concern through social media were examined by Signorini, Segre, and Polgreen in (2011) using CDC and WHO data. To date, retrospective research based on data collected by international and national organizations from is used in studies such as understanding new risks created by the H1N1 2009 vaccine (Miller et al. 2013), and review of IHR implementation during H1N1 2009 (WHO c 2011).:1 provides a list of these and other pertinent disaster studies that have used international and national organization data to evaluate variables similar to those of this study.

The decision to use secondary data for this study is based on its cost effectiveness, large sample size, quality, and availability. The unit of analysis for the study is WHO member states (N=193), and I investigate 13 indicator variables per country. Such data are available online from international organizations, including UN and UN constituent bodies, and Transparency International. As a result, it is possible to contribute to new knowledge without extraordinary resource restrictions necessary to collect such large data. There are however, challenges in using secondary data. Inadvertently, a researcher using secondary data is not involved in research design nor data collection, which limits familiarity with the process (Johnston 2014). Data specificity is also affected with the choice of using secondary data because the researcher is limited to the goal of the original data collectors. Missingness for some indicators is also an additional challenge with secondary data when indicator data is not reported. In the next section I discuss in detail the dependent and independent variables and their operationalization.

Table 4

Studies that have used International and National datasets

Study Title	Data Source	Authors
Pandemic potential of a strain of influenza (H1N1): Early findings	WHO	Fraser, C., Donnelly, C.A., Cauchemez, S., Hanage, W. P., & Van Kerkhove, M. D. (2009).
Pandemic versus Epidemic Influenza Mortality: A pattern of changing age distribution	WHO	Simonsen, L., Clarke, M. J., Schonberger, L. B., Arden, N. H., Cox, N. J., & Fukuda K. (1998).
Assessing the severity of the novel influenza A/H1N1 pandemic	WHO, CDC, PAHO	Garske, T., Legrand, J., Donnelly, C.A., Ward, H., Cauchemez, S., Fraser, C., Ferguson, N. M., & Ghani, A. C., (2009).
Global burden of hypertension: analysis of worldwide data.	WHO	Kearney, P. M, Whelton, M., Reynolds, K., Muntner, P., & He, J. (2005).
Improvements in pandemic preparedness in 8 Central American countries, 2008-2012	WHO	Johnson, L. E.A., Clara, W., Gambhir, M., Chacon-Fuentes, R., Marin-Correa, C., Jara, J. et al., (2012)
Political and social determinants of life expectancy in less developed countries: a longitudinal study.	UNDP & UNESCO	Lin, R., Chen, Y, Chien, L., & Chan, C. (2012)
* Environmental considerations for common burial site selection after pandemic events.	UNESCO	Ritz, K., Dawson, L., & Miller, D. (Eds). Williams, A., Temple, T., Pollard, S. J., Jones, R. J. A., & Ritz K. Chp 7 (2009)
Eighteen years of research on AIDS: Contribution of and Collaborations between different World Regions.	UNDP – HDI	Falagas, M. E., Bliziotis, I.A., Kondilis, B., & Soteriades, E.S. (2006).
Gender inequality and HIV transmission: A global analysis	UNDP	Richardson, E. T., Collins, S. E., Kung, T., Jones, J.H., Tram, K. H., Boggiano, V.L. et al., (2014)
Schools opening dates predict pandemic influenza A(H1N1) outbreaks in the United States.	CDC	Chao, D. L., Halloran, M. E., & Longini Jr., I. M. (2010).
Projections of Global Mortality and Burden of Disease from 2002 to 2030	WB & WHO	Mathers, C. D., & Loncar, D. (2006)

Social Capital: A missing link to disaster recovery	WB	Nakagawa, Y., & Shaw, r. (2004).
Volunteered Geographic Information and Crowdsourcing Disaster Relief: A Case study of the Haitian Earthquake	ITU	Zook, M., Graham, M., Shelton, T., & Gorman, S. (2010)
Research approaches to mobile use in the developing world: A review of the literature	ITU	Donner, J. (2008)
Pandemics in the Age of Twitter: Content Analysis of Tweets during the 2009 H1N1 Outbreak	WHO	Chew, C & Eysenbach G. (2010).
Risk of narcolepsy in children and young people receiving AS03 adjuvanted pandemic A/H1N1 2009 influenza vaccine: retrospective analysis.	WHO, ECDC	Miller et al., (2013)

Study Variables

One dependent variable, and six independent variables are examined in this study. The independent variables encapsulate a cross section of indicators measuring socio-economic, cultural, environmental, and political influences (King, 2009; Carter-Pokras & Baquet 2002; McLafferty 2010: Thomas, et al. 2013). Table 5 presents a summary of the study variables, their operationalization, and data sources.

Table 5

Operationalization and Data Sources for study variables.

	Variable	Operationalization	Data Sources
Dependent Variable	H1N1 2009 Pandemic Mortality	Number of laboratory confirmed deaths from the H1N1 2009 influenza pandemic. Level of measurement – ratio.	WHO www.flucount.org
HEALTH VARIABLES			
Indicator1	Health expenditure per capita	Sum of public and private health expenditures as a ratio of total populations. Level of measurement – ratio.	World Bank (WB) http://databank.worldbank.org/data/reports.aspx?source=2&series=SH.XPD.PCAP&country=
Indicator 2	IHR capacity and Health Emergency Preparedness	Regulations to measure 13 core capacities attained towards preventing international spread of disease. Level of measurement - ratio	WHO http://www.who.int/ihr/capacity-strengthening/en/
Indicator 3	Adult Mortality rate	Probability of dying between 15-60 years (per 1000 of population) 2011. Level of measurement - ratio	WB http://gamapserver.who.int/gho/interactive_charts/mbd/adult_mortality/atlas.html
EDUCATION VARIABLES			
Indicator 4	Education expenditure	Education expenditure per student as a % of GDP. 2009 Level of measurement – ratio.	UNESCO http://data.uis.unesco.org/index.aspx?queryid=190
Indicator 5	Adult literacy 15yrs and above for both sexes	Adult literacy 15years and above for both sexes in 2009. Level of measurement - ratio	WB http://databank.worldbank.org/data/reports.aspx?source=2&series=SE.ADT.LITR.ZS&country=
COMMUNICATION VARIABLES			
Indicator 6	Radio	Radio channels by technical penetration above 75% of households. Level of measurement -ratio	UNESCO www.uis.unesco.org/DataCentre/Excel/Media/Radio%20channels%2
Indicator 7	Television	Television channels by technical penetration above 75% of households. Level of measurement - ratio	UNESCO www.uis.unesco.org/DataCentre/Excel/Media/TV%20channels%20by
Indicator 8	Cell Phones	Cell phone subscription (per 100 people). Level of measurement – ratio.	International Telecommunication Union (ITU) http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx WBhttp://databank.worldban

			k.org/data/reports.aspx?source=2&series=IT.CEL.SETS.P2&country=
POPULATION VARIABLES			
Indicator 9	Population living in urban areas	People living in urban areas. Level of measurement - ratio	World Bank http://databank.worldbank.org/data/reports.aspx?source=2&series=SP.URB.TOTL&country=(WB)
Indicator 10	International migrant stock	International migrant stock as % of total population (2010) Level of measurement – ratio	World Bank (WB) http://databank.worldbank.org/data/reports.aspx?source=2&series=SM.POP.TOTL&country=
AIR TRANSPORTATION VARIABLE			
Indicator 11	Civil Air Transportation	Air transportation passengers carried in domestic and international aircraft passengers registered in the country in 2009 Level of measurement - ratio	World Bank (WB) databank.worldbank.org/data/reports.aspx?source=2&series=IS.AIR.PSGR&country=
GOVERNANCE VARIABLES			
Indicator 12	Corruption	Corruption Perception Index (CPI) measure of perceived levels of public sector corruption. Level of measurement - ordinal	Transparency International (TI) www.transparency.org/research/cpi/cpi_2009/0/
Indicator 13	Human development	Human Development Index (HDI) Ranking of countries based on their human development. Level of measurement – ordinal	UNDP 2010 Hdr.undp.org/en/data

The following section discusses the dependent and independent variables used in the study. A brief context of each variable is presented followed by how the variables were measured in this study.

Dependent Variable

The dependent variable for the study is H1N1 2009 pandemic mortality. World Health Organization is the pre-eminent authority for global monitoring, surveillance, and coordination of response to potential and actual pandemic outbreaks (Mercer 2006; WHO

2009; Dawood, et al. 2012). Member states of WHO are signatories of International Health Regulation (IHR) and are legally mandated to activate pandemic specific protocols. Upon declaration IHR signatories are expected to report mortality data to WHO for the duration of the declaration (IHR 2005). Laboratory confirmed pandemic mortality from H1N1 2009 was reported to WHO but excluded influenza suspected deaths as well as influenza related deaths from other chronic diseases, pneumonia and cardiopulmonary conditions (Global Security Homeland Security; 2011; WHO 2011,d; Dawood et al. 2012). While gathering laboratory confirmed pandemic mortality data is widely acknowledged as problematic and a gross underestimation, WHO data is the most reliable global dataset available (WHO 2011; Dawood et al. 2012; CIDRAP 2012). In this study, H1N1 2009 mortality is measured by total number of laboratory confirmed deaths per member state.

Independent Variables

There are six independent variables in this study: health, education, communication, population, air transport, and governance. Each of the independent variable is measured through relevant indicator data. Except for air transportation, every other variable is represented by more than one indicator. Health variable is measured by 3 indicators, education variable has 2 indicators, communication variable has 3 indicators, population has 2 indicators, and governance has 2 indicators. The following section will discuss how each variable indicator was measured.

Health Variable

As countries develop, allocation of more resources to health infrastructure and safety is considered a basic public health practice towards improving quality of life (Toya & Skidmore, 2007). The overarching components of health infrastructure are human resources, technical, and financial support (Garrett 2002). Baker & Koplan (2002) also include health related services, research, policies and laws as key components of health infrastructure. Surveillance, epidemiology, laboratory capacity, strong science, and research make up the backbone of public health critical to pandemic management (Baker et al. 2005; Ferguson et al. 2005). During pandemics, a robust health infrastructure is critically important for pharmacological and non-pharmacological responses. Vaccine stockpile acquisition, storage, distribution and dispensing are heavily dependent on health infrastructure (Ferguson et al. 2005; Uscher-Pines et al. 2006; Lee & Fidler 2007).

Health expenditure per capita

The health expenditure per capita variable for this study captures financial allocation to health by public and private organizations as a ratio of population (WB 2009). Member states are responsible for developing pandemic preparedness plans including the provision of financial resources towards improving health (WHO 2009, Pickles 2006). Additional contributors towards per capita health also include non-governmental and private sources who are included in this measurement. The health expenditure per capita indicator is measured by the sum of public and private health expenditures as a ratio of total population.

International Health Regulations (IHR) capacity and Health Emergency Preparedness (HEP)

This indicator measures how well a country has progressed along IHR protocols for developing core capacities for minimizing spread of disease, and enhancing response to acute public health risks (CDC 2016) . Member states are legally mandated to self monitor and annually report to WHO their progression in developing core capacities, and areas needing improvement (IHR 2012). The core capacities are, national legislation, coordination and national focal point communications, surveillance, response, preparedness risk communications, human resources, laboratory resources, points of entry, zoonotic events, food safety, chemical events and radio nuclear emergencies. Specifically, member state capability levels range from less than one which is foundational level, level 1 is considered moderate, level two indicates strong technical capacity, and three represents advanced capability (IHR 2012). In this study, IHR capacity and HEP preparedness is measured by a score that reflects achievement level of member states. Achievement level is itself measured by progress achieved on specific core capacities (IHR 2011).

Adult mortality rate

A distinctively unique mode of pandemic outbreaks is that each pandemic affects a demographically different group from seasonal flu (WHO 2011 c). It is impossible to predict with precision which age group will be affected by a pandemic because each is a novel phenomena, with unfamiliar characteristics. Adult mortality rate measures the probability that a fifteen year old will die before reaching their 60^{th} birthday for a specific year. The indicator is relevant for this study because people below the age of 65 were most afflicted during the H1N1 2009 outbreak (Shrestha et al. 2009; WHO 20111 c). The indicator is also relevant because adult mortality rates are not homogenous by country or region. Globally, adult mortality rates are highest in low-income countries and lowest in high income countries. As an example between a low and high income country, Sierra Leone has a life expectancy of 34 years while Japan has an 81.9 year life expectancy (WHO, 2004). A gap that is over two times in life expectancy and explained by socio-economic difference. However, even within the general trend determined by socio-economic status of countries, there are multiple factors that affect adult mortality within communities. Examples of this are, male mortality is higher than that of females by two times in WHO regions, and adult mortality in vulnerable communities is higher than in less vulnerable communities such as people living in poverty, immigrants, and indigenous populations (La Ruche et al. 2009; Vaillant et al. 2009; WHO 2011).

Education Variable

Individual education, skills and knowledge not only benefit individuals, but also enable a spillover effect to extended community members (Grossman 1972; Acemoglu & Angrist, 2000). The less education people have the less informed they are about health matters and do not stand to equally benefit from health information. Member states are responsible for education policy development and implementation through allocation of public and private resources (Smith 2003).

Education expenditure

Education expenditure per student as a % of GDP is captured in this indicator as a proxy measure for possession of skills and knowledge that can affect individual health (Kenkel 1991; Tierney 2006). The data source for public expenditure on education as % of GDP is UNESCO which provides aggregated data on the percentage of money spent on education per student for each member state as a percentage of GDP (UNESCO 2007).

Adult literacy

Adult literacy captured for this study is the percentage of the population aged 15 and above who can comprehend what they read and write as well as make simple arithmetic calculations (WB 2015). Literacy rate is an indicator that evaluates education attainment, and can be used as a life skills predictor. The data source for adult literacy is UNESCO (2015). The organization provides adult literacy rate, as a percentage of population for both sexes.

Communication Variable

Public health professionals use traditional and non-traditional media channels for education campaigns pre and post pandemics, risk communication, and feedback (Kenkel 1991; Seeger & Reynolds 2007; Dawood et al. 2012; Gesser-Edelsburg et al. 2014). Radio and television channels are critical for communicating public health campaigns across rural and urban settings. Member states are responsible for identifying communication channels requisite for coordination and pandemic preparedness. The communication variable for this study captures radio and television channel penetration data above 75% of households, and global mobile phone subscription data. Radio and television channel penetration is defined as the estimated % of homes that can receive a given channel. The radio and television measurement indicates the potential audience by geographic coverage, which for this study is at 75% (UNESCO 2013).

Radio

For this indicator, radio penetration data by total number of radio channels available to over 75% of the population per member state was obtained (UNESCO 2009). The premise of this variable is that radio communications offer traditional and non traditional media opportunities for pandemic information dissemination.

Television

For this indicator, television penetration data by total number of television channels available to over 75% of the population per member state was obtained (UNESCO 2009). The premise of this variable is that television communications offer traditional and non traditional media opportunities for pandemic information dissemination.

Cellphones

This indicator is relevant to the communication variable because of its unprecedented adoption across the globe in rural and urban areas and its role in facilitating communication (Comer & Wikle, 2008; Intermedia, 2010). Cellphones provide a unique opportunity for their role in enhancing mobile health applications, particularly in developing countries and remote areas (Chip, Velthoven, & Car, 2015). Member state mobile cellular subscription data from International Telecommunication

Union (ITU 2009) is used to measure cell phone subscription. Mobile cellular telephone subscriptions measure the per capita number of postpaid and active prepaid accounts within the last three months (ITU 2009).

Population Variable

The population variable for this study captures data from population living in urban areas (WB), and international migrant stock data (UNOP) for every member state. Population density and mass gatherings cause crowding, increase human to human contact and add stress on public health infrastructure (Omran, 1971; Barret et al. 1998; Abubakar et al. 2012). This inadvertently creates opportunity for transmission of infectious disease and impedes containment. Urbanization and immigration trends increase population density, and unchecked result in crowding both capable of increasing vulnerability to disasters (Brett & Oviatt, 2013). Both factors create conducive environment for the transmission of pathogens in pandemics (Morens et al. 2004; Jones et al. 2008; WHO 2016).

Population living in urban areas.

Population density poses significant challenges for the development and implementation of pandemic strategies (Hufnagel, et al. 2004; Stern & Markel, 2004; Ferguson et al. 2005). Travel, density, and patterns of settlement have direct impact on expediting transmission of diseases because this offers exponentially increased opportunities for contact (Omran 1971; Hufnagel, et al. 2004; Hu, Nigmatulina, & Eckhoff, 2011). Distinguishing factors between rural and urban populations include; population density, predominant type of economic activity, services and facilities, and size of population. Population density data offers insight on degree of density per country and is defined based on UN department of economic, social affairs and population division (2011). In this study, total number of population living in urban areas is reported as a percentage of total population by member state.

International migrant stock

International migrant stock is the number of foreign born people in a member state, including refugees and economic migrants (WB, 2015)). The relevance of this indicator is based upon the distinct vulnerabilities of this group, who are more likely to experience health disparities (Hutchins, et al. 2009). Migrants tend to be more mobile within their new country, live in densely populated areas, and have limited social capital. This therefore limits access to basic health needs increasing their risk of infection during pandemics. In this study, total number of migrant stock is reported as a percentage of total population by member state.

Air Transportation Variable

Civil air transportation

The air transportation variable for this study captures civil passengers carried in domestic and international aircraft registered in member states (WB 2009). Analyzing air traffic patterns and passenger itineraries plays an integral role in contact tracing, and likely geographical spread of infectious disease (Brockmann, et al. 2006). Table 6 depicts twenty countries receiving travellers from Mexico and the correlation between confirmed imported H1N1 and number of passengers (Khan, et al. 2009). While member states are responsible for developing and applying pandemic response plans with WHO's assistance, collaborating with international organizations such International Air Transport Association (IATA) contributes to pandemic planning.

Table 6
Countries receiving largest number of passengers from Mexico

Countries Receiving the largest numbers of passengers from Mexico during March and April 2009 and importation of the Influenza(A) (H1N1) virus associated with travel to Mexico as of May 25, 2009.			
Country rank	Country	No. of passengers arriving from Mexico	Confirmed Importation of influenza A(H1N1) virus
1	United States	1,744,665	Yes
2	Canada	149,137	Yes
3	France	47,501	Yes
4	Spain	42,815	Yes
5	Germany	33,448	Yes
6	Cuba	29,123	Yes
7	Argentina	28,789	Yes
8	Italy	24,252	Yes
9	Brazil	23,125	Yes
10	Guatemala	19,719	yes
11	United Kingdom	17,993	Yes
12	Colombia	16,583	Yes
13	Japan	12,014	No*
14	Chile	11,499	No*
15	Venezuela	11,464	No+
16	Panama	11,238	Yes
17	Costa Rica	10,912	Yes
18	Netherlands	8,942	Yes
19	Peru	8,356	No
20	Switzerland	6,576	Yes*

* As of May 25, 2009, Japan, Chile, and Peru reported 343, 74, and 25 confirmed cases of H1N1 influenza virus infection, respectively, although no known associations with travel to Mexico were identified.

+ As of May 25 2009, Venezuela had no reported cases of confirmed H1N1 influenza virus infection.

Source: NJEM Khan, Arino, Hu, Raposo, Sears et al. (June 29, 2009). *New England Journal of Medicine.*

Governance Variable

The governance variable for this study captures member states corruption perception (CPI) of the public sector as measured by Transparency International (TI), and human development ranking as measured by UNDP. The highest impact of pandemics is felt among people living in poverty because they are more vulnerable to infectious diseases and have limited access to self-preserving skills and influence (Garrett 2003; Dutta-Bergmann, 2005; Lawrence, 2006; Uscher-Pines et al., 2007; Blumenshine et al., 2008; Thomas, 2010; Dawood, et al., 2012). This study examines CPI and HDI as proxy data for governance.

Corruption Perception Index (CPI)

Corruption Perception Index CPI is an annual report on the perception of public sector corruption in countries worldwide. Pertinent data is gathered from thirteen data gathering organizations such as regional development banks, World Economic Forum, Freedom House, and World Bank (Transparency International, 2009). Specifically, CPI evaluates ground level information in each member state for issues such as bribery of public officials, kickbacks in public procurement, and embezzlement of public funds. The 2009 CPI index scored 180 countries from highly corrupt to very clean on a 1-10 scale. Lower ranked countries were determined as untrustworthy and with poorly functioning public institutions while higher ranking countries have higher degrees of press freedom, information access and standards of integrity for public institutions (TI 2009; TI 2016). The index ranks rather than scores countries. This means that a low scoring country does not indicate the country as most corrupt or as having the most corrupt people, but rather is perceived as being one in which a majority people are exposed to corruption by powerful individuals, leaders and public institutions.

Human Development Index (HDI)

The human development index captures composite data on three dimensions; long and healthy life, knowledge, and reasonable standard of life for people living in member states (See Figure 5) (UNDP, 2009). The three dimensions are calculated based on specific indicators for life expectancy at birth, mean years of schooling, expected years of schooling, and Gross National Income (GNI) per capita. Human Development Index (HDI) then ranks countries based on these findings. In this study, HDI ranking serves as proxy data for member state resilience to pandemic impact.

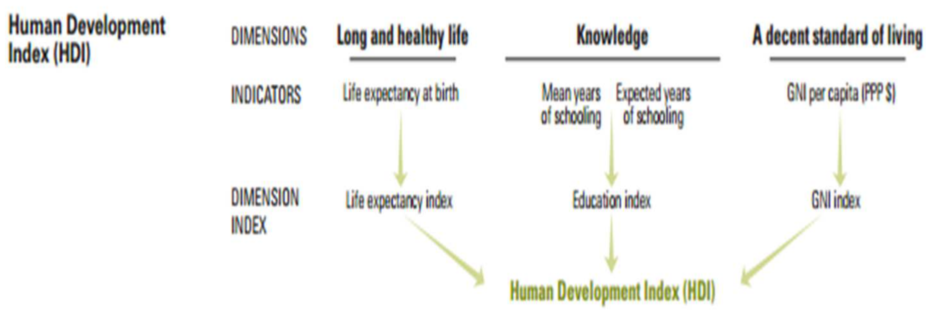

Figure 7: The Human Development Index

Source: United Nations Development Programme – Human Development Reports. Retrieved from

Research Questions

This study is guided by the following research questions and hypothesis.

Research Question 1 – Health Variable

What is the relationship between each of the three health indicators and H1N1 2009 pandemic mortality?

H_1: There will be significant negative relationship between health expenditure per capita and H1N1 2009 pandemic mortality..

H_2: There will be significant negative relationship between IHR capacity and HEP preparedness, and H1N1 2009 pandemic mortality..

H_3: There will be significant positive relationship between adult mortality rate and H1N1 2009 pandemic mortality..

Research Question 2 – Education Variable

What is the relationship between each of the two education indicators and H1N1 2009 pandemic mortality?

H_4: There will be a significant negative relationship between education expenditure and H1N1 2009 pandemic mortality.

H_5: There will be a significant negative relationship between adult literacy and pandemic mortality and H1N1 2009 pandemic mortality.

Research Question 3 – Communication Variable

What is the relationship between each of the three communication indicators and H1N1 2009 pandemic mortality?

H_6: There will be a significant negative relationship between radio channel penetration and H1N1 2009 pandemic mortality..

H_7: There will be a significant negative relationship between television channel penetration and H1N1 2009 pandemic mortality..

H_8: There will be a significant negative relationship cell phone subscription and H1N1 2009 pandemic mortality..

Research Question 4 – Population Variable

What is the relationship between each of the two population indicators and H1N1 2009 pandemic mortality?

H_9: There will be significant positive relationship between higher populations living in urban areas and H1N1 2009 pandemic mortality.

H_{10}: There will be significant positive relationship between higher international migrant stock and H1N1 2009 pandemic mortality.

Research Question 5

What is the relationship between the air transport indicator for this study and H1N1 2009 pandemic mortality?

H_{11}: There will be significant positive relationship between pandemic mortality and air transport indicators during the H1N1 2009 outbreak.

Research Question 6

What is the relationship between governance indicators and H1N1 2009 pandemic mortality?

H_{12}: There will be a significant positive relationship between corruption perception index and H1N1 2009 pandemic mortality.

H_{13}: There will be a significant positive relationship between human development and H1N1 2009 pandemic mortality.

In the next section I address research design, population and unit of analysis, data sources, dependent and independent variables, and proposed data analysis methods for this study.

Statistical Analysis

I used SPSS version 23 for Windows for my data analysis. In the first step, the complete dataset was screened for missing data and outliers by variable. I conducted univariate analysis in which I examined box-whisker plots, frequencies, and histograms, measures of central tendency (mean, median, mode) and spread (variance and standard deviation).

Bivariate Correlation

Bivariate correlations for all variables were obtained with the goal of examining the pattern of relationship among independent variables, and also between the independent variables and the dependent variable. This was necessary during data analysis to examine potential redundancy among independent variables and assesses if multicolinearity is present or absent (Vogt 1999).

Multiple Regression

Prior to performing the analysis, multiple regression assumptions were examined and met (Gay, Mills & Airasian 2012). These assumptions are linearity, multicolinearity, independence, and residual assumptions.

Assumption 1 – Linearity

For the linearity assumption the bivariate correlations between the independent and the dependent variables, scatterplots were examined and correlation analysis ran. For this assumption to be met it was expected that the bivariate correlations would be statistically significant and the scatterplots would portray a pattern of linear relationship.

Assumption 2 – Multicolinearity

The Multicolinearity assumption deals with high correlation among independent variables. This assumption was assessed or examining bivariate correlations among the independent variables. In addition, the variance inflation (VIF) factor was used to confirm the presence or absence of Multicolinearity among the independent variables. A

VIF of greater than 10 indicates presence of Multicolinearity (Myers 1990; Stevens 2009).

Assumption 3 – Independence

This assumption deals with independence of the data. Since each member state and their associated variables are exclusive this assumption was met. I examined scatter plots for each variable for standardized residual versus standardized predicted scores. The pattern was not defined and therefore the assumption was met.

Assumption 4 – Residuals

a. Normal distribution

The residual assumption was assessed through examination of histograms, Q-Q plots, and scatter plots for standardized residual versus standardized predicted scores. For the normal distribution assumption to be met, the residual histograms and Q-Q plots were examined.

b. Have a mean of zero.

To assess this assumption, I examined the scatter plot for standardized residual versus standardized predicted scores. The scatter plots followed a normal distribution with a mean of zero therefore meeting this assumption.

c. Have a constant variance.

I examined the scatter plot for standardized residual verses standardized predicted scores as a means of assessing variance. The scatter plot pattern was constant and the assumption for each independent variable met.

After all the assumptions were examined and met, hierarchical multiple regression were conducted to predict the dependent variable. The indicators were entered as a block in each step to find unique contributions of each group of indicators. Squared multiple correlation was examined for both magnitude and statistical significance at alpha=. 05.

Summary

This chapter begins with discussing the research design, population and unit of analysis. This is followed by a detailed discussion on data sources and operationalization of the variables. In the next section, I present study variables beginning with the dependent variable, followed by six independent variables. I delve into each variable describing it further and discussing specific indicators used to measure it. The next section is a review of study research questions and hypothesis. The final section of the methodological chapter discusses statistical analysis. I discuss the bivariate correlation, and hierarchical regression procedures. The results of data analysis are presented in Chapter IV.

CHAPTER IV

RESULTS

The purpose of the chapter is to present the analyses for each of the research questions. The population for this study is 193 United Nations (UN, 2000) member states listed as WHO members in 2009. The unit of analysis is individual member states. The first section reports on descriptive univariate analysis for the study variables. The second section will report on the bivariate analysis. The dependent variable is mortality rates from the 2009 H1N1 pandemic, and the independent variables are health, education, communication, population, air transport, and governance. The research questions investigate the relationship between each independent variable – health, education, communication, population, air transport, and governance – and H1N1 2009 pandemic mortality. The final section will present results from statistical analyses conducted to answer each research hypothesis.

Descriptive Statistics

In this section I report on the number of member states, range, mean, standard deviation, and variance by indicator. All countries had some indicators, but not all countries had all the variables suggested for this study. The indicators that had complete (193) member state data are cell phone subscription, health expenditure per capita, and education expenditure as a % of GDP. Radio and television channel penetration are the least reported with an N of 36 and 34 respectively. Table 7 provides the distribution of the indicators by measures of central tendency, mean, median, and mode. Measures of spread which are variance and standard deviation, are also presented in Table 7. I examined both skewness values and histograms to determine departure from normal distribution for each variable.

Table 7

Descriptive Statistics – Missing, Mean, Median, Mode, Std. Deviation, Std. Error, and Skewness.

	Valid	N Missing	Mean	Median	Mode	Std. Deviation	Std. Error	Skewness
H1N1Deaths	193	0	128.95	5.00	0	804.978	.175	12.494
Health Exp.	193	0	931.0378	257.9676	.00	1651.06488	.175	2.548
IHR & HEP	123	70	57.973	59.200	59.2	20.5445	.218	-.134
Adult Mortality	189	4	203.857	172.000	76.0[a]	125.8373	.177	1.192
Education Exp.	193	0	2.1497	.0000	.00	2.60744	.175	.838
Adult Literacy	128	65	84.2266	92.0000	100.00	17.10285	.214	-1.183
Radio	36	157	11.417	6.000	1.0	17.7561	.393	3.719
TV	34	159	34.029	10.500	1.0	58.3529	.403	2.639
Mobile phone	193	0	81.2650	85.1302	.00[a]	44.16610	.175	.086
PopLivUurbArea	188	5	55.862	57.000	61.0	23.1993	.177	-.024
IntlMigStock	192	1	9.119	3.800	.4	14.1475	.175	3.056
Air Transport	140	53	16050197.23	1532189.00	21784.00	62502082.80	.205	9.075
CPI	175	18	3.989	3.300	2.5	2.1173	.184	1.054
HDI	193	0	2.197	2.000	2.0	1.3278	.175	-.125

In order to examine departure from normality, skewness values were divided by the standard error of each variable. Values greater than 3.3 indicated departure from normality (Tabachnick & Fidell, 2013). Table 8 shows each indicator skewness value. Indicators IHR and HEP, Mobile phone subscription, population living in urban areas, and Human Development Index had a less than 3.3 value implying there is no problem with skewness. Indicators with a moderate skewness value are adult mortality rates, education expenditure, adult literacy, radio penetration, television penetration, and corruption index. The other indicator values namely health expenditure, air transport, and international migrant stock are skewed.

Table 8

Standardized skewness values for independent variables.

	Indicators	Standardized Skewness
No problem with skewness		
Indicator 2	International Health Regulations (IHR) capacity and Health Emergency Preparedness (HEP)	.64
Indicator 8	Mobile Phone subscription per capita	.80
Indicator 9	Population living in urban area	.14
Indicator 13	Human Development Index (HDI) Ranking	.71
Moderately skewed		
Indicator 3	Adult Mortality Rate 15-60yrs	7.01
Indicator 4	Education Expenditure per student as % of GDP	4.80
Indicator 5	Adult literacy	5.53
Indicator 6	Radio channels by technical penetration 75% households	9.46
Indicator 7	Television channels by technical penetration 75% households	6.55
Indicator 12	Corruption Index Score (CPI)	5.73
Skewed		
Indicator 1	Health expenditure per capita	14.51
Indicator 10	International migrant stock	17.46
Indicator 11	Civil air transportation passengers carried.	44.27

Distribution of H1N1 2009 deaths by geographical regions is presented in Table 9. The minimum mortality range is 0 and the maximum deaths were 1302. The regions with the most reported deaths were the Americas, and South East Asia, while the minimum was on the African region.

Table 9
Distribution of H1N1 2009 mortality by Geographical Regions

Region	N	Min	Max	Mean	SD
Africa	45	0	93	3.73	16.06
Americas	33	0	1035	99.27	213.88
E. Mediterranean	21	0	267	47.24	69.11
Europe	54	0	627	82.74	138.94
S.E. Asia	13	0	1302	130.31	356.49
W. Pacific	24	0	775	54.38	161.09

I conducted analysis of variance to examine if there were significant differences in the number of deaths by the six geographical regions. ANOVA results are presented in Table 10. These results indicate that there is no statistical significant mean differences in 2009 H1N1 mortality by the geographical regions; $F(5,184) = 2.25$; $p = .051$. This suggested that on average, the number of deaths in the six geographical regions during the 2009 H1N1 pandemic were about the same

Table 10
ANOVA summary of 2009 H1N1 mortality by Geographical Regions

	Sum of squares	df	Mean Square	F	Sig.
Between Groups	288399.45	5	57679.89	2.25	.051
Within Groups	4715749.92	184	25629.08		
Total	5004149.37	189			

I conducted additional regression analyses to find out how well each of the indicators predicted the H1N1 2009 mortality by the six geographical regions. I wanted to find out which indicators were common across the regions and those unique to each region. Table 11 provides a summary of the analyses by region. For the health indicators, Region 1 had only health expenditure as statistically significant. All the other regions had none of the three health indicators as statistically significant. None of the education indicators were sufficient to run a six region analyses. On communication, radio channel penetration was significant in Region 4. However, Regions 2 , 3, 5 and 6 had insufficient communication data. For population indicators, population living in urban areas was significant in Regions 1 and 2 but not significant in the other four regions. However, international migrant stock was significant in Region 4. Air transport was significant in Regions 1, 2, 4, 5, & 6 but not in Region 3.

Table 11

Regression analysis for variables related to the H1N1 2009 pandemic mortality by Geographical regions.

	Reg1		Reg2		Reg3		Reg4		Reg5		Reg6
	N=25		N=19		N=20		N =37		N =15		N=23
Health	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta
HealthExp.	.473	.02	.113	.73	-.565	.07	-.083	.73	.000	1.0	-.359
AdultMort.	.018	.924	-.472	.185	-.292	.357	.103	.678	.279	.601	-.335
IHR &HEP	.293	.146	-.227	.491	.391	.120	.122	.513	.308	.395	.456
R^2	**.368**		**.0292**		**.236**		**-.046**		**-.201**		**.105**
Education	-	-	-	-	-	-	-	-	-	-	-
Communication	N = 12	Sig.	N=5	Sig.	N=7		N=22	Sig.	-		-
Radio Channel	-.124	.752					.548	.013			
Cell phone	.433	.289					-.164	.416			
R^2	**.16**		**-**		**-**		**.352**		**-**		**-**
Population	N = 47	Sig.	N=34	Sig.	N=23	Sig.	N=53	Sig.	N=14	Sig.	N=26
Popn Urban	.419	.016	.420	.021	-.021	.971	.309	.057	-.114	.735	.286
Int.Mig.Stock	-.251	.139	-.007	.970	-.250	.434	-.329	.043	-.142	.676	-.305
R^2	**.132**		**.177**		**.067**		**.101**		**.034**		**.039**
Air transport	N=24		N=21		N=18		N=48		N=13		N=20
Civil aviation	.923	.000	.496	.026	.105	.688	.576	.000	.737	.006	.981
R^2	**.852**		**.246**		**.011**		**.332**		**.543**		**.963**
Governance	N=46		N=30		N=23		N=51		N=15		N=20
HDI	-.127	.446	-.190	.520	.166	.572	-.306	.176	.312	.572	.256
CPI	.23	.167	-.133	.653	-.079	.619	-.259	.250	.275	.619	.239
R^2	**.094**		**.017**		**.043**		**.040**		**.033**		**.056**

Region 1 = Africa; Region 2 = Americas; Region 3 = East Mediterranean; Region 4 = Europe; Region 5 = S.E. Asia; Region 6 = W. Pacific

Relationship hypotheses testing

To test the relationship between each of the thirteen indicators (IV's) and the H1N1 2009 mortality, I conducted a one-tailed bivariate correlation. The results are presented in Table 12. For each correlation coefficient between the indicator and H1N1 2009 mortality, I looked at statistical significance and the direction of the relationship. Seven indicators had statistically significant relationship with the 2009 H1N1 mortality. These were IHR & HEP positively related with (ρ = .241; p= .004); Adult mortality negatively related (ρ = -.202; p=. 003); a dult literacy positively related ((ρ = .217; p=. 007); radio penetration positively related (ρ = .610; p=. 000); television penetration positively related (ρ = .539; p=. 001); population living in urban areas positively related (ρ = .116; p=. 012); and air transportation positively related (ρ = .541; p=. 000). Based on these results, seven of the relationship research hypotheses were supported and six were not. There were no statistically significant relationships between the H1N1 2009 mortality and health expenditure, education expenditure, cell phone subscription, international migrant stock, Human development index (HDI) and Corruption Perception Index (CPI).

Table 12
Correlation Matrix of all study variables

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13
H1N1 Deaths	--	.078	.241	-.202	.080	.217	.610	.539	.118	.116	-.075	.541	-.069	.079
Health Exp.	.141	--	.305	-.486	.179	.378	.074	-.119	.378	.500	.360	.300	-.457	.769
IHR &HEP	.004	.000	--	-.395	.231	.466	.070	-.193	.425	.355	.128	.294	-.209	.400
Adult Mort.	.003	.000	.000	--	-.248	-.474	-.099	-.106	-.607	-.537	-.346	-.253	.601	-.554
Edu. Exp.	.136	.007	.005	.000	--	.280	.147	-.147	.162	.271	-.009	.017	-.109	.338
Adult Lit.	.007	.000	.000	.000	.001	--	.252	.241	.580	.484	.250	.118	-.628	.422
Radio	.000	.355	.372	.286	.196	.098	--	.865	.199	.163	.031	.334	-.206	-.007
Television	.001	.246	.189	.279	.207	.123	.000	--	.148	.159	-.040	.088	-.152	-.215
Cell phone	.051	.000	.000	.000	.013	.000	.122	.206	--	.517	.394	.111	-.491	.549
Pop. In Urban	.012	.000	.000	.000	.000	.000	.175	.189	.000	--	.504	.138	-.502	.554
Intl.Mig stock	.151	.000	.081	.000	.453	.002	.428	.412	.000	.000	--	.053	-.396	.473
Air transp.	.000	.000	.002	.002	.420	.121	.036	.331	.098	.055	.270	--	-.153	.323
HDI	.172	.000	.011	.000	.066	.000	.114	.199	.000	.000	.000	.037	--	-.637
CPI	.151	.000	.000	.000	.000	.000	.484	.123	.000	.000	.000	.000		--

Numbers above the diagonal are correlation coefficients. Numbers below the diagonal are significance levels.

Legend

DV – Dependent Variable Pandemic Mortality X1 – Health Expenditure per capita

X2 – IHR capacity and HEP

X3 – Adult Mortality rate

X4 – Education Expenditure

X5 – Adult Literacy

X6 – Radio Channels

X7 – Television Channels

X8 – Cell Phone subscription

X 9 – Population living in urban areas

X 10 – International Migrant stock

X 11 – Air Transport

X 12 – Corruption Index

X 13 – Human Development Index

PC – Pearson Correlation

Prediction Hypotheses testing

The next step I conducted was a series of regression analyses to examine how well the indicators predicted the H1N1 2009 mortality. A six-step block multiple regressions was conducted with the H1N1 2009 as the dependent variable. At each step all the indicators for each variable were entered simultaneously to predict the dependent variable. I identified significant indicators in the first regression, which I used to run a reduced model. Table 13 provides a summary of the two models. The results are as follows: Of the three health indicators, only IHR & HEP was statistically significant explaining 6% of the variance in H1N1 2009 mortality. Of the two education indicators, Adult literacy was statistically significant explaining about 5% of the variance in the H1N1 2009 mortality. Radio penetration was the only significant predictor of the 2009 H1N1 mortality out of the communication indicators and it explains 37% of the dependent variable. Both population indicators, population living in urban areas and international migrant stock were statistically significant predictors and the explained 6% of the variance in the dependent variable. Civil air aviation was significant and explained 29% of the dependent variable. However none of the government indicators were statistically significant predictors of the 2009 H1N1 mortality.

Table13
Regression Analysis Variables related to 2009 H1N1 pandemic mortality among WHO member states.

	Model I		Reduced Model	
	Beta	Sig.	Beta	Sig.
Health Indicators				
Health expenditure	-.081	.437		
IHR capacity & Health Emergency preparedness	.222	.025	.241	.008
Adult Mortality	-.111	.304		
R^2 (N= 121)	**.068**			**.058**
Education Indicators				
	.089	.330		
Adult literacy	.193	.036	.217	.014
R^2 (N= 127)	**.055**		**.047**	
Communication Indicators				
Radio	.338	.261	.610	.000
Television	.319	.286		
Cell phone	-.026	.862		
R^2 (N = 32)	**.396**		**.373**	
Population Indicators				
Population in urban	.270	.001	.270	.001
International migrant stock	-.208	.013	-.208	.013
R^2 (N = 185)	**.060**		**.060**	
Air transport indicator				
Civil air transportation	.541	.000	.541	.000
R^2 (N = 138)	**.293**		**.293**	
Governance Indicators				
Corruption Perception Index	-.095	.340		
Human Development Index	.019	.850		
R^2 (N = 173)	**.012**			

Based on these regression results, I conducted a hierarchical regression with only the significant predictors. I did this by entering the indicators by block. By performing the block regression, I was able to find unique contribution by block of indicators. Table

14 presents the summary of the results. In Model 1 IHR & HEP were not statistically significant, neither was adult literacy as shown in Model II. Model III had statistically significant population indicators, and Model IV had both population and air transport as statistically significant. A reduced model showed that only international migrant stock and civil air transport were statistically significant and explained R^2 =33% of H1N1 2009 mortality. None of the governance indicators were statistically significant.

Table 14:

Block Regression analysis for variables related to the 2009 H1N1 pandemic deaths among WHO member states.

(N = 63)	Model I		Model II		Model III		Model IV		Reduced Model	
Variables	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig	Beta	Sig.
Health Indicator										
IHR &HEP	.176	.169	.136	.338	.128	.352	-.016	.891		
Education Indicator										
Adult Literacy			.092	.513	.022	.882	-.002	.985		
Population Indicators										
Pop. In urban areas					.365	.030	.342	.015	.151	.070
International Migrant stock					-.398	.010	-.309	.015	-.204	.014
Air transport indicator										
Civil air transport							.553	.000	.529	.000
R^2	**.031**		**.038**		**.155**		**.44**		**.327**	

Summary

For each of the six research questions, at least one indicator had a statistically significant relationship with the dependent variable H1N1 2009 mortality. Two of the health indicators showed a significant relationship with the 2009 H1N1 mortality. International health regulations (IHR & HEP) was positively related suggesting that the higher the IHR the higher the 2009 H1N1 mortality. However, a negative relationship between adult mortality indicates that the lower the mortality rates the higher the 2009 H1N1 mortality. Education had one significant indicator, adult literacy rates for both sexes above 15years. Adult literacy was statistically significant related to H1N1 mortality. The three communication indicators were radio above 75% of households, television channels by technical penetration above 75% of households, and cell phone subscription per capita. Radio channels by penetration above 75% and television channels by penetration above 75% were statistically significant related with H1N1 2009 mortality. The two population indicators were population living in urban areas and international migrant stock. Population living in urban areas is statistically significant related with H1N1 2009 mortality. The air transport indicator, civil air transportation passengers carried in domestic and international aircraft, is statistically significant correlated with H1N1 2009 mortality. In the final variable, governance, two indicators, Corruption Perception Index (CPI) and Human Development Index (HDI) are considered. Under a one tailed test, both indicators are statistically significant related with H1N12009 mortality.

Prediction results also showed that the best predictors of the 2009 H1N1 mortality for member states with all thirteen indicators were population living in urban areas, air transportation, and international migrant stock. Further predictions by six geographical regions revealed that different indicators were significant in some regions but not in others. In the next chapter I discuss the implications of these findings to research, theory, and practice.

CHAPTER V

CONCLUSION

Overview

The first official pandemic of the 21st Century (H1N1 2009) brought to the forefront the urgent need for global improvement in integrating management of contemporary infectious diseases (WHO 2009). Specifically, it exposed gaps in healthcare, risk communication, surveillance, health promotion research and development (Cordova-Villalobos, et al. 2009; Hutchins, Truman, Merlin, & Redd, 2009; Fauci & Morens, 2016). Succinctly put, pandemics do not affect the 'haves' and 'have not's' alike (Carter-Pokras & Baquet, 2002; Lawrence 2006; Bolin 2007; Thomas et al. 2010). People living in poverty, marginalized communities, and minority sub-groups are more vulnerable and less resilient to global health outbreaks (Fothergill, Maestas, & Darlington, 1999; Garrett, 2000; Carter-Pokras & Baquet, 2002; Koop, et al. 2002; Barnett &Whiteside, 2006; Kaufmann 2007; La Ruche, et al. 2009; Vaillant, et al. 2009; Mathews et al. 2009; WHO 2011; WEC 2015). This disparity, in developed and developing countries worldwide, results in unequal response during the event and recovery post impact (Watts & Bohle, 1993; Phillips 1993; Cannon 1994; Morrow 1997; Fothergill & Peek, 2004; Waugh 2006). The more vulnerable a population, the worse the effects of disaster experienced (Fritz 1961; Couch & Kroll-Smith, 1985; Fothergill & Peek, 2004).

Despite a consensus on the need for research on social vulnerability and determinants of disasters, extant research reflects limited investigation into it (Mileti et al., 1995; Logue, 1996; Peacock, et al. 1997; Kilbourne et al. 2006; Lee & Fidler 2007; Oliver-Smith 2012). Pandemics, in particular, are minimally studied from an integrated approach encompassing a public health, disaster management approach. Public health institutions, medical researchers, and practitioners have almost exclusively led the charge in pandemic research (Schartung, et al. 2010). This despite the reality the pandemics are public health disasters that cause loss of life and livelihoods disparately based upon social determinants of health. Garoon and Duggan (2008) note that pandemic discourse remains within the scientific, political, and legal domain with minimal attention to social, cultural and ethical concerns.

This study integrates a disaster management and public health approach to social determinants of health and their resultant vulnerability. The study framework is grounded in the Pressure and Release (PAR) model (Wisner et al. 2004) and the Social Determinants of Health Conceptual Framework (SDHC) (WHO 2010 a) Both models expound on socially constructed factors that predispose some people more to the impact of disasters. Specifically, this study investigates the relationship between indicators of health, education, communication, population, air transport, and governance, with mortality from the H1N1 2009 pandemic.

The Social Determinants of Health Conceptual (SDHC) framework by WHO (2010, a) offers insight on how social position in society contributes to health disparities. The model posits that social, economic, and political systems determine the distribution of health and well-being. Social stratification based on income, education, occupation, gender, and race/ethnicity are among factors that influence access to health. Together, the PAR and SDHC offer a multidisciplinary framework upon which this study is based.

Both models apply an ecological model approach to investigating social vulnerability. They are both based on the concept that disasters are process generated rather than singular events (Hannigan 2012). The models draw from multiple disciplines, encompass more than single stream factors, and seek to engage a whole of society processes.

The next section in this chapter presents a systematic interpretation of findings organized by research question. It is followed by a section on limitations of the study and culminates with a discussion on implications for theory, policy, and research.

Interpretation of findings

The first research question addresses three indicators of health namely, health expenditure per capita, IHR and HEP, and adult mortality. Member states highly ranked for meeting IHR & HEP benchmarks experienced higher mortality from H1N1 (2009). This finding supports the premise that pandemics are characteristically unique in their transmission patterns. They traverse geographic boundaries regardless how robust a country's IHR & HEP infrastructures are instated. Studies indicate that there is inconsistent adoption of IHR & HEP worldwide caused by inadequate political will, cultural missteps, bureaucratic red tape, warfare, and resource limitations (Garrett, 2000; Koop, et al., 2002; Barnett &Whiteside, 2006; Lee & Fidler 2007; King 2009; WHO, 2011).

Adult mortality rate had a negative relationship with H1N1 2009 mortality implying that member states with lower adult mortality rates experienced higher H1N1 2009 mortality. This finding aligns itself with one of the distinguishing characteristics of the H1N1 2009 pandemic. The pandemic prominently affected people under the age of 65 (Shreshth et al. 2009; WHO 2011 c). Consistent with literature, member states with low adult mortality are low socio-economic countries with implicit low public health resilience and infrastructure (Carter-Pokras & Baquet, 2002; Marmot 2005; WHO, 2011).

Health expenditure per capita includes the sum of public and private health expenditures dedicated towards supporting member state populations (WB 2009). This indicator was not statistically significant in related to H1N1 2009 mortality. It implies that budgetary allocation to health expenditure does not directly translate to measures for mitigating pandemic mortality. Sachs (2014), and WHO 2014 support this finding to the extent that pandemic preparedness, surveillance, and response have undergone significant financial cuts resulting in compromised pandemic preparedness globally. Ferguson et al. (2005), Uscher-Pines et al., (2006) and Lee & Fidler (2007) also associate compromised health infrastructure as directly affecting pandemic preparedness and response.

The second research question investigated two education indicators namely education expenditure as a percentage of GDP, and adult literacy of both sexes in 2009. The first indicator, adult literacy had a statistically significantly relation with H1N1 2009 mortality. A positive relationship implies that the higher the adult literacy in member states the higher mortality from H1N1 2009 experienced. While extant literature establishes a high correlation between education and health as a necessary vehicle for increased public health awareness, there is minimal research on existing causality between the two (Kenkel, 1991; Arendt, 2005: Bruine de Bruin et al. 2006; Grossman 2008; Eide & Showalter, 2016). However, literature also posits that increased literacy affects not just the capacity to interpret and understand language, but is pivotal for engagement in society (Hernández & Morrow, 2013). The second indicator, education expenditure as a % of GDP, was not statistically significant in relation to H1N1 2009 mortality. Empirical research shows an established link between education and health, but not a causal relationship (Kenkel 1991; Arendt 2005; Tierney 2006; Eide & Showalter, 2011).

The third research question examined the relationship between the communication indicators and H1N1 2009 mortality. I investigated radio channels by technical penetration above 75% of households, television channels by technical penetration above 75% of households, and cell phone subscription per capita. Radio and television channels by penetration above 75% had a statistically significant positive relation with H1N1 2009 mortality. This implies that member states with 75% radio and television channel penetration had higher H1N1 2009 mortality. This finding lends itself to literature findings indicating that while communication is considered critical for infectious disease management, it is yet to be optimized for public health messaging (Lee & Fidler, 2007; WHO 2009; Dawood, et al. 2012). Mobile cell phone subscription was not statistically significant in relation to H1N1 2009 mortality. Despite the ubiquity of cell phones in 2009, study findings reflect what literature refers to as a lack of, or inadequate utilization of bilateral communication outlets inclusive cell phones (Comer & Wikle, 2008; Holmes 2008; Vaughan & Tinker, 2009; Fischer et al. 2011; Rajatonirina et al. 2012 Gesser-Edelsburg et al. 2014).

The fourth research question I examined the relationship between the population indicators and the H1N1 2009 mortality. The two population indicators were population living in urban areas and international migrant stock. Population living in urban areas was statistically significant positively related to H1N1 2009 mortality. This implies that member states with high populations living in urban areas experienced higher H1N1 2009 mortality. According to research (Fisher et al. 2011; Waarbeek et al. 2011; McLafferty, 2010) increased urbanization results in enhanced human-to-human, and human-animal connectedness within confined areas (Barrett et al. 1998). During the H1N1 outbreak, high human-to-human contact was critical in transmitting the influenza pathogen (WHO 2009; Dawood, et al. 2012). Additionally, urbanization increases poverty due to limited resource availability and perpetuates health disparities (Marmot et al. 2008; Fisher et al. 2011; Waarbeek, et al. 2011; McLafferty, 2010). The second indicator, international migrant stock, was not found to be statistically significant to H1N1 2009 mortality. While literature (Jones et al. 2008; Marmot et al. 2008; Abubakar et al. 2012) supports immigration as causing increased population density and stress on public health infrastructure, study findings did not concur.

Research question five a single air transport indicator, civil air transportation passengers carried in domestic and international aircraft is presented as a measure for air transport. The indicator reviews actual numbers of passengers transported within and into a country during the H1N1 pandemic. In this study, air transportation was statistically significant positively related to H1N1 2009 mortality. This implies that member states receiving larger numbers of passengers at their air transport terminals had higher H1N1 2009 mortality. During the H1N1 2009 pandemic, initial introduction of the virus across boundaries happened through '…international travel and human-to-human transmission…" (Mukherjee et al. 2010, p 21). Khan et al. (2009) examined air passenger travel patterns and volume between March and April 2008, the period when importation of influenza was beginning. Their findings support those of this study that air transportation plays a critical role in predicting pandemic transmission patterns (Grais, Ellis & Glass, 2003).

Research question six, two governance indicators, Corruption Perception Index (CPI) and Human Development Index (HDI) are investigated for their relationship with H1N1 2009 mortality. Both had statistically significant relation with H1N1 2009 mortality. Corruption Perception Index (CPI) is positively related to H1N1 2009 mortality, implying that the higher a member state scored on CPI, the higher H1N1 2009 mortality was experienced. This study investigated the relationship of corruption perception pre and during disaster, which is unlike most studies, which review post-disaster corruption (Quarantelli 1999; Mahmud & Prowse, 2012). In an American study on the impact disaster relief has on corruption Leeson & Sorbel (2007) posit that states more prone to disasters receive more relief and have higher incidents of public corruption. Member states perceived as having high corruption are associated with having higher levels of public corruption (TI 2009).

The Human Development Index (HDI) indicator is negatively related to H1N1 2009 mortality, implying that the lower a member state ranked on HDI, the higher H1N1 2009 mortality. This finding is consistent with literature which points to social inequalities as enhancing vulnerability to disasters (Blaikie et al. 2004; Peet & Watts, 2004; Wisner et al. 2004: Bolin 2007; Peacock et al. 2007). Social inequalities are socially constructed and from these emanate human realities that predispose some more to the impact of disasters than others (Oliver-Smith 1986; Durning 1989; Wisner et al. 2004; Morrow 1999).

Prediction results by six geographical regions revealed how the indicators predicted the H1N1 2009 mortality differently. On the health indicators, on Health expenditure was a significant predictor for Africa region. The rest of the regions had none of the health indicators statistically significant. Education indicators by the regions did not yield any results due to their lack of adequate sample data. However, only radio channel penetration was statistically significant in predicting H1N1 2009 mortality in Europe only. None of the other five regions had significant communication indicators. Population indictors, people living in urban areas was significant in Africa and Americas but not in the other four and international migrant stock was significant in S.E. Asia only.

Air transportation indicator was statistically significant in predicting H1N1 2009 mortality in all but Eastern Mediterranean region. None of the two governance indicators were significant predictors of the H1N1 2009 mortality in the six geographical regions.

Limitations

This study is a correlational research therefore causation is not inferred. Instead, the findings identify social determinants that contributed to H1N1 2009 mortality. Another limitation is that the study investigated a specific pandemic the H1N1 2009. This pandemic occurred in a specific space and time. Pandemics are by nature novel, and therefore the findings here, while relevant for understanding essential correlations, cannot be generalized for other pandemics. Utilizing secondary data has inherent limitations. As a researcher, I did not have direct involvement in collecting data and therefore had to rely on how the indicators were measured by the original researchers. Consequently, some proxy data sets while adequate did not capture some study variables precisely. For example, my goal was to capture actual cell phone use during the 2009 pandemic but the data set is not available. I chose to use cell phone subscription data as a proxy.

Data missingness posed an additional limitation in the study. Not all member states had complete data sets for all indicators. Consequently, sample size was reduced for some indicators and that may have affected the magnitude of some of the correlations. A final limitation, not unique to this pandemic yet central for pandemic mortality research, is that official mortality data is underrepresented. For practical purposes WHO only recorded self-reported laboratory-confirmed deaths. During the pandemic some member states discontinued laboratory confirmation of H1N1 2009 and treated all influenza-like illness as H1N1 2009 (WHO, 2014). To compound this further, inconsistent mortality reporting across different WHO regions, and the lack of co-morbidity related death identification contributed to the underestimation (Johnson & Mueller, 2002; Dawood et al. 2012). Despite these limitations, this study provides a foundation to examining pandemic disaster at the macro-level. Specifically, identifying indicators that countries can explore to mitigate pandemic mortality. Thus, this study has implications for practice, policy, and research.

Implications for Policy, Practice, and Research

Historically, pandemics are a high impact low probability phenomenon (Fineberg 2014). However, recent experience with infectious diseases outbreaks such H1N1 2009, Ebola, and Zika expose pertinent concerns about global institutional capability in handling infectious disease. The findings in this study address some of these concerns and are discussed in this section alongside implications on policy, practice, and research.

On policy, the findings of this study highlights key indicators that member state policy makers need to pay attention to in mitigating pandemic disasters. As an illustration for the need for global integration, this study identified inconsistent IHR & HEP implementation by member states correlated with H1N1 2009 mortality. Inadequate national level pandemic preparedness creates social conditions that increase vulnerability within and beyond member state boundaries. Inadequate member state pandemic preparedness also places an additional risk of exposure to local and international medical response staff (Relman et al. 2010; ECDC 2012; Hofman & Au, 2017). Inadequate adherence to IHR & HEP policies also directly affects monitoring, surveillance, and reporting of potential outbreaks. It causes delay in the detection of novel viruses, exponentially increases geographical transmission of the pandemic pathogen, and affects implementation of pharmacological and non-pharmacological protocols (Morens et al. 2004; Jones et al. 2008; McCoy & Dash, 2013).

Findings of this study highlight the need for a more integrated preparedness approach. The whole of society pandemic preparedness model promotes societal, local government, and sub-national involvement in all disaster phases (WHO 2005). The model also emphasizes a multi-sectoral approach involving individuals, communities, public and private entities which is similar to ecological approaches to disaster and public health management (Wisner et al., 2004; Honore 2008). The impact of disasters on human development, in particular to the already vulnerable populations, results in exacerbating hard-won development (Brundtland 1987; Brett & Oviatt, 2013). Specifically, this study finds that people living in member states with low health expenditure per capita, low adult literacy, and perceived high corruption are more susceptible to pandemic mortality. This supports literature on social vulnerability among low socioeconomic communities being high and creating conditions for disparate disaster impact (Brundtland 1987; Garrett 2003; McCoy & Dash 2003; McMichael 2006; Burke et al. 2010; Dawood et al. 2012; Santos-Hernández & Morrow, 2013; Varshney 2014). People living in poverty, perceived high corruption countries, and the marginalized are unevenly affected by pandemics. They are faced with inequitable health services due to inadequate health services, low literacy, and limited access to self-preserving information (Brundtland, 1987; Garrett 2003; McMichael 2006; Burke et al. 2010; Dawood et al. 2012; Varshney 2014). Policy and practice implications that focus on mainstream communities are detrimental to whole of society recovery. Policies should reflect an understanding of who makes up communities and what specific community needs are. Santos-Hernández and Morrow (2013) refer to the need for decision-making personnel having literacy about their communities. Development of health emergency information material must address communities not only in relevant languages and at their literacy levels but must seek socio-culturally accepted modes of information transfer and exchange.

A majority of studies on disaster corruption are dedicated to post-disaster corruption, particularly the physical re-building and recovery processes (Quarantelli 1999; Mahmud & Prowse, 2012; Yamamura 2014). This study analyzed member state corruption perception data for the duration preceding and during the pandemic. Findings from this study suggest that member states with perceived high corruption among public officials experienced higher pandemic mortality. According to Wisner et al. (2004), and Hannigan (2012) disasters and politics are integral to creating or mitigating disasters. While there is no established causal effect between politics and disasters, transparency, and trust of "… information sources and risk managers …" plays a vital role in public perception of risk (Frewer 2003, p. 136). Politics, by extension governance, plays a pivotal role in creation and implementation of disaster policy and resource allocation. Institutions policies with good intent cannot be effectively applied in an exploitative corrupt environment (Hannigan 2012). Neither can governance policies thrive among a population that does not trust those in government (Frewer 2003). It is imperative that global, national, and local policy integrates governance data and oversight before and after policy implementation to optimize effectiveness (Keen 2008).

Practice

On communication indicators, traditional communication outlets indicates that globally, high penetration of radio and television channels plays an important role in mitigating pandemic impact prior and during the outbreak for member states. This finding implies that even in the light of new communication technologies, pandemic communication strategies should maintain traditional media presence globally. From a pandemic strategic approach, communication technologies such as cell phones can and should be used towards decentralizing power through information sharing (Keen 2010). In this study cell phone subscription did not indicate a strong correlation with H1N1 2009 mortality. While this was the first pandemic since the ubiquitous proliferation of mobile phones, it is not evident that the technology was leveraged to save lives and livelihoods. For pandemic preparedness strategy using cell phones to foster interactive processes, and exchange information holds promise for crisis emergency risk communication (Seeger & Reynolds, 2007)

A strong correlation exists between air transportation data and H1N1 2009 transmission (Khan et al. 2009; Mukherjee et al. 2010). Use of air traffic volume and travel itineraries is an imperative consideration for pandemic preparedness planning. It offers insight on where the outbreak originated and possible next transmission location (Budd, Bell, & Warren, 2011; Brockmann & Helbing, 2013). The findings can be used to support point of entry containment strategies such as allocation of thermal scanners, and medical staff at airports. My study also highlights an implication for practice that falls on the data collection process. A review of H1N1 2009 mortality data (Tables 2 & 3) exposes final data inconsistency. While WHO member states are legally mandated to adhere to IHR &HEP protocols, WHO does not have the capacity to enforce these demands on member states. The use of disaster diplomacy, defined as the use of incentives to induce cross-national and organizational compliance is vital (Kelman, 2012). Expanding and emerging fields of disaster management such as disaster diplomacy, complex emergencies, catastrophes, and international disaster management are essential to meeting new global challenges and building global resilience (Cutter 1996; Keen 2008, Kelman 2012, Sylves 2010, Cutter 2016). Quarantelli (2006) in discussing catastrophes as being different from disasters refers to this need by acknowledging they catastrophes have "… quantitatively different demands and needs that surface … requiring innovative and creative actions and measures." (p.6) With globalization, the disaster construct is shifting, and the approach to managing them must translate the changes if lives and livelihoods are to be preserved.

The ecological approach to mitigating disasters by addressing social determinants is a robust approach because it invests within society, addresses grass root level needs, and includes local and indigenous formulations for sustainability. The humanitarian approach of disaster management on the other hand, is one which essentially applies a ‘hit and run' type approach for solving disaster challenges. Showing up to support post disaster impact rather than investing in pre-impact mitigation and preparedness. The humanitarian approach has not been successful in building resilience because of its limited investment in long-term change (Barnett & Weiss, (eds.) 2008; Keen 2010; Hannigan 2012). With geopolitical shifts, political tensions, and economic downturns, humanitarian organizations are intensely challenged in global disaster situations. Participatory processes and investment in holistic human development stands to build and enhance resilience. Cutter (2016), defines resilience as "… adaptive resilience for its capacity to include social learning by individuals, governance structures, or stakeholders in the aftermath of a triggering event." This study supports the adaptive resilience view highlighting the need for making policy and practice decisions that incorporate multiple measures. For example, the concept of basic literacy is implicit across disciplines as the capacity to read, understand, write, communicate and think (Santos-Hernández 2006). This study has adult literacy as one of its indicators for evaluating education in member states. However, a more intricate version of literacy, health literacy which evaluates how people perceive and function effectively in the health care environment during health emergencies would be more beneficial for deciphering pandemic resilience (Nutbeam 2008; Berkman, et al. 2011).

Future Research

The process of doing this original research pointed to a variety of future research opportunities. Overall, research on social determinants of pandemics remains scarce, and opportunity exists for further investigation. Specifically, at the time of this study, some data that would have enriched this study was not available. Examples of unavailable data include gender identification for H1N1 2009 mortality, actual cell phone use data, and climate change impact data. These factors, gender, communication, and climate change, are shown in research as having differential impact at individual, community, and national levels (Fothergill, 1996; Barrett et al. 1998; Enarson 1998; McMichael, Woodruff & Hales, 2006; Bradshaw, 2014; Heffernan, 2015; Vitecoq, 2015). Future pandemic research should incorporate atypical variables for more detailed investigation necessary for understanding societal complexities.

While this focus is necessary for developing global level strategies, sub-national level research is necessary for effective development and implementation of pandemic policies and practices. For example, population stratification data investigating rural and urban settings, as well as indigenous groups would enhance understanding of how groups are differentially affected by pandemics.

In conclusion, Birkland (1998) posits that focusing events provide pause for contemplation and evaluation of policies and practices. The H1N1 2009 pandemic outbreak while dubbed a mild outbreak, highlighted persistent gaps in global pandemic preparedness. When Ebola broke five years later, the world was forced to come to terms with the threat of living in a pandemic era once again highlighting contemporaneous inadequacies in public health outbreak preparedness. Alleviating vulnerability to health emergencies still requires an integrated process that addresses both the medical and social determinants of health

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