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Disaster, war, conflict, complex emergencies and international public health risks

PhD Dissertation

Preventive Medicine

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CHAPTER 1: PhD study résumé

Résumé of the project

Introduction

In the 21st century, the prevention of illness, disease and risks to health ushered in public health and medical practice with mixed results. War, hybrid warfare, conflict, complex emergencies and disasters remain significant public health risks and areas of strategic concern; focused epidemiological study in health policy remains elusive. The paradigm shift from major world powers leading global affairs and affecting global health to multiple state and non-state actors vying for power and influence regionally has possibly led to an increase in small scale and low intensity conflict with high morbidity and mortality, including communicable diseases. This global shift has led to an increase in human suffering and is indirectly proportional to the quantifiable decrease of health and food security, as well as a higher mortality rate. This thesis describes and elucidates these seemingly disparate streams of public health, applying epidemiological methods and evidence-based practice and concluding that the prevention of disease needs a global reset.

Background

The basic research carried out for this PhD project includes: 1) mental health surveys and trauma associated with war; 2) the migration of, and the need for, advanced medical personnel and their services in war and hybrid warfare, including how the negative movement or adverse flow through 'brain drain' of doctors affects disaster; 3) a quantitative study of infectious diseases, health and human security associated with state stability and the mitigation of state failure; 4) a qualitative food security review, the origins of food security and its impact; and 5) the general concepts of health security and the need for institutions that promote the prevention of disease (Quinn et al., 2011; Quinn et al., 2013; Quinn et al.,

2014). This research project is independent, apolitical and not tied to any national process or platform. The basic conclusions of this qualitative and quantitative research are that state stability is directly linked to health security and that there are identifiable health metrics and indicators for both 'health' and for 'state stability' that can be measured directly and in aggregate with valid results and novel conclusions. Additional studies based on this research have also concluded that doctor and healthcare worker migrations share similar trends of economic incentives at economies of scale, among others.

Most importantly, we conclude that war, hybrid warfare, conflict, disasters and complex emergencies and their negative and debilitating effects on health and human security can be prevented. The deleterious effects of state failure can be averted through an evidence-based prevention policy, risk assessment models and by quantifying the disease risk of communities in fragile and failed states. Furthermore, I conclude that, unlike state fragility and state failure, state stability and health security can be predicted. Further research is needed to describe these features more clearly with respect to disease and the state.

The Centers for Disease Control and Prevention (CDC) describes *global health security* as the capacity required for countries to prepare for, and respond to, public health threats and to reduce the risk of these threats crossing borders. This paradigm is being challenged. The risk of disease spread is especially high for resource-poor countries with less-developed public health systems and weak institutions that fail to prevent, detect and rapidly respond to emerging public health threats, i.e. disasters, epidemics, conflicts and expanding non-communicable diseases (NCDs).

It should be noted that war and hybrid warfare are not interchangeable terms. In this thesis, we define 'hybrid warfare' as a form of military statecraft that has made former Soviet republics fear that Russia implements subversion rather than conventional military engagement. In this thesis, hybrid warfare is conceived of as a strategy that marries conventional deterrence and insurgency tactics. In other words, "the belligerent uses insurgent tactics against its target while using its conventional military power to deter a strong military response" (Lanoszka, 2016).

Furthermore, hybrid warfare deploys a series of synchronized, layered, well-planned and coordinated diplomatic, cyber, economic, informational, kinetic, false media, fake news, propaganda and psychological tactics; hybrid warfare is a form of fighting that includes a range of multimodal activities conducted by state or non-state actors (Wilkie, 2009; Huovinen, 2016; Fox, Amos and Rossow, 2016; Popescu, 2015). Emphasis is placed on the simultaneous and unprecedented fusion of a variety of means, such as political, military, economic/financial, social and informational means using conventional, irregular, catastrophic, terrorist and disruptive/criminal methods to achieve political objectives (Lovelace, 2016; Abbot, 2016; Jacobs and Lasconjarias, 2015). One possible objective of hybrid warfare is to prolong a state or international organization (i.e. the North Atlantic Treaty Organization (NATO), the European Union (EU) or the European Defense Forces) from responding to invasion and attack.

It should be noted and reiterated that state stability does not predict state failure but can help identify and assess key risk factors, as well as better describe health security by using epidemiological research methods and research principles. It should be no surprise that war, conflict, complex emergencies and many diseases that reduce health security are indeed preventable. These are preventable through the core foundational principles of primary, secondary and tertiary prevention. Despite this well-known tenet of public health, more than one billion people annually suffer from preventable illnesses related to morbidity of diseases (including NCDs like trauma) and to war and disaster (the prevalence and incidence of the global disease burden is poorly quantifiable and 'one billion' is an estimate from the World Health Organization (WHO) (2014) and the CDC (2013)). Indeed, these principles can be applied to states in conflict and on the verge of interstate war, as well as to those states at higher risk of calamity from reduced infrastructure, disease and climate and environmental change (as they lack institutions to buffer shocks). Based on the findings reported in this thesis, such basic preventative principles that cross the epidemiological barriers into public health policy are:

(1) Prevention of conflict in high-risk communities, states and regions before it erupts.

(2) Quick identification of those communities, populations and states that have initiated violence and acts of conflict in order to rapidly mitigate the further spread of violence and reduce the incidence and prevalence of trauma (NCDs) and communicable diseases. (In some instances, the state may be the main perpetrator of violence and intervention may challenge those states that have not met their social contract obligations.)

(3) Supporting, guiding and providing health-based assistance to those communities, populations and states in conflict and post-conflict settings. This should focus on regions experiencing a long development phase of growth (where peace and stability operations are most challenged) and those communities that experience increased incidence and prevalence of communicable diseases and NCDs.

The direct and indirect impact of disasters, wars and complex emergencies on the health and well-being of populations is qualitatively clear; however, implementing epidemiological data analyses and basic hygiene study methods have not yet been comprehensively carried out to quantify the human, health and food security risks that negatively affect health across nations. Essentially, epidemiological, hygiene and public health principles are applicable to the growth, stability and development of fragile and failed states. We portray this in a positive feedback loop of health security engendering more state stability and in the negative feedback loop of a lack of health security engendering state failure. Some basic conclusions based on this research are that both communicable diseases and NCDs play roles in health security and that the growing incidence or prevalence of preventable illnesses leads to state fragility and failure.

This interdisciplinary research project was initiated in 2007 and has been further pursued since the beginning of the PhD in 2009. The preliminary phase included a review of human security challenges in the 21st century by examining multiple perspectives. This paper integrates several perspectives and disciplines – epidemiology, hygiene, medicine, public health and global affairs. This evidence-based research reveals that the delineation between a natural and human-induced disaster has become blurred over time. It shows that, despite the

many health indicators not influenced by human action, many truly are and the underlying factors that contribute to the short-term, medium-term and long-term impacts of such complex emergency events on populations and their public health are quantifiable, in some stages predictable, and (we propose) preventable.

Methodology

The general methodology behind this research was carefully selected based on a thorough literature review of peer- and non-peer-reviewed articles and country assessments made in the field and on the ground by the PhD candidate (John Quinn), who personally gathered data in Iraq, Jordan, Ukraine, Macedonia, Bosnia and Herzegovina, Timor-Leste, Indonesia, Kurdistan, Israel, the Occupied Palestinian Territories (oPt) and several border regions throughout the Middle East. The specific methodology selected for each published paper is detailed in the Appendix (all the articles published that are pertinent to this thesis can be referenced in detail in the Appendix).

This also includes the multivariate data analysis of infectious disease profiles, risk and multiple state stability measures that create a nexus of international public health/global health, medicine, epidemiology, international relations and global affairs. To arrive at the conclusions presented in this thesis – which is a culmination of eight years of work – and to make it more robust and powerful for policy considerations and for multiple streams of future research, it was conceived as an interdisciplinary, transborder and international project.

While conducting this research, I met and collaborated with the Minister of Health for Timor-Leste in the name of Charles University in Prague, First Faculty of Medicine. I worked with the deputy Ministers of Health and Defence in districts throughout Ukraine. I liaised with Iraqi public health workers via US military and non-governmental organizations throughout Iraq. I interviewed multiple public health players in Palestine and the United States Agency for International Development (USAID), and coordinated with multiple European Commission (EC) offices in Asia and South America. I presented at NATO-

organized conferences in Kyiv and Brussels, presented key findings at press briefings in Geneva and Kyiv, and introduced a plan to the Deputy Prime Minister in Ukraine (2014). I treated patients, established clinics in times of war and disaster, received enemy fire, and became proficient with medical evacuation procedures in war and military situations. These are among an untold number of other operations that are methodologically incalculable and were undertaken for the betterment of the research outcomes and conclusions. This PhD project is a culmination of many subprojects that may seem different and disjointed from a specialist's site picture, but define the 21st-century need for interdisciplinary global health study.

For ease of reading, all epidemiological and biostatistical methods, calculations and formulas have been placed in one chapter, with their relevant applications to the research offered throughout. This simple presentation of complex computation should make clear the level of fluency in basic epidemiological and biostatistical methods that was applied regarding global health and prevention in this research and the papers published (and later presented in each chapter).

Study designs in epidemiology

This research is an amalgamation of descriptive studies and case reviews. In the following section, I describe a sample of the study design from the published research and the overall thesis's foundation. For clarity, a cross-sectional study is observational in nature. Observational studies collect data from a group of people in order to assess the frequency of disease (and related risk factors) at a particular point in time; typically, these studies ask the question 'What is happening?'. The main outcome measures from observational studies can be disease prevalence (see chapter 9 related to all calculations and definitions) and risk factor association with disease, but these studies usually do not establish the definitive causality of risk factor with disease.

The second methodology reviewed and implemented in this thesis project includes case-control studies, which are observational and retrospective in nature. Case-control studies compare a group of people with a disease to a group without the disease; they look for prior exposure or risk factor. Case-control studies ask 'What happened?'. These studies end with an odds ratio (OR). For example, a conclusion may be that the health of populations in fragile or failed nations is poorer and at risk of higher fatality rates of preventable diseases and illnesses (such as measles) than other populations living in moderate or stable countries with access to vaccines.

Alternatively, cohort studies are observational but differ from the two types defined above in that they can be prospective or retrospective in focus. Cohort studies compare a group with a given exposure or risk factor to a group without such an exposure; these studies look to see if exposure to a risk factor or agent increases the likelihood of disease. These studies can be prospective (asking 'Who will develop the disease?') or retrospective (asking 'Who developed the disease in the exposed vs the non-exposed groups?'). As can be seen when looking at populations across states, observational studies are difficult if not impossible to control and can be methodologically unsound when put into practice.

Cohort studies end with relative risk (RR). For example, Aginam (2011) reports that "populations living without access to primary healthcare services and basic immunizations had a higher risk of newly becoming sick (incidence) and/or of dying from preventable illness than those who have access to primary healthcare services and vaccines." Removing immunizations from a population to see what happens would not represent the scientific standards accepted in the research community and is otherwise unconscionable. Nevertheless, cohort studies do have a role in global health research when dealing with other factors such as advanced NCD drugs, e.g. for cancer, diabetes or hypercholesterolemia.

Material

In order to carry out such interdisciplinary research, many factors need to be considered to understand the new challenges for the national, regional and global actors that protect,

prepare, mitigate and respond to the health, safety and security of populations. This is relevant for current practice, as well as to disseminate the lessons learnt so that they are available for future public health programming in conflict, disaster and complex emergencies. Furthermore, the methodology includes a broad exploration of political, economic, social, cultural, environmental and ecological factors of events such as poverty, economic inequality, disease and decreased health security. It also takes into account how the core principles of hygiene, epidemiology and prevention can be applied to global and public health in order to address the shortlisted global problems through best practices and evidence-based policy.

The qualitative and quantitative aspects of this research project have included the evaluation and health impact of natural disasters, complex emergencies, human conflict and war, human migration and refugee displacement on populations; this analysis was carried out using theoretical and evidence-based research. Humanitarian and state-funded responses may vary from other forms of emergency programs, such as sound methodological approaches that guide research, education, training and analysis that improve preparedness. In sum, some key outcomes of this thesis devise novel policy approaches to mitigating and preventing war, conflict and complex emergencies in the ever-increasing 'new global normal'[1] challenges.

This broad-based and interdisciplinary approach to improve our understanding of the multiple factors that influence the prevalence and incidence of both communicable diseases and NCDs and overall morbidity and mortality associated with conflict, war and complex emergencies concludes with evidence-based policy. Data included widely and freely available data sets from WHO, the World Bank and the CDC, as well as lead investigations, anecdotal field research and an overall review of current best practices across state and non-state actors, providing relief and medical and developmental assistance.

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1 Please refer to: Hampson, F. O. and Malone, D. (2002) *From reaction to conflict prevention: Opportunities for the UN system*. Lynne Rienner Publishers; and Weiss, T. G. (2016) *Global governance: Why? what? whither?* John Wiley & Sons. The notion of the 'new global normal' is loosely described by the author as multiple small-scale conflicts, the rise of non-state actors, pandemic disease threats, growing NCDs and infectious diseases, ecological and environmental degradation and poverty as referenced throughout this thesis.

For example, the term 'slow onset event' describes food insecurity and potential famine risks and the new tools developed to forecast these and warn governments, organizations and civil society about such populations at risk. There exist similar warning systems for communicable or infectious diseases at varying stages of application. These slow onset events may take months to years to manifest and involve multiple sectors affecting health. Practical policy solutions are offered in each chapter and are proposed as evidence-based best practices to determine their usefulness in terms of human health security challenges in the 21st century.

Definitions, trends and current body of knowledge

Any new field of study inevitably faces the problem of defining its key concepts and terms. In this subchapter, we discuss the terminological challenges pertinent to the topic of disaster medicine. The first major issue here is that defining global health as 'everything to all people' inherently leads to a loss of efficacy and focus; therefore, below, we propose a more focused and limiting definition.

Secondly, relatively new and broad concepts found in interdisciplinary literature in the global public health debate – e.g. health security, human security, economic security, sustainable development and fragile and failed states – remain elusive. In other words, there are no completely agreed-upon definitions. These concepts are being hotly debated across academic disciplines and yet remain inconsistent; most terms and definitions are disputed and pose difficulty in offering accurate descriptions for discussion. Indeed, such seemingly disparate topics present the specialist with a dilemma over where to start and what to offer in the debate – hence the major conflict in academic and policy circles.

For the purposes of this thesis and to remain within the framework of global public health's current debate, we hold the definition of 'health security' to be access to essential health services and protection from environmental and behavioral risks that diminish public health for the individual and communities (Ng and Prah Ruger, 2011; Labonté and Gagnon, 2010).

This definition frames health security as an aspect of human security, which is the "freedom from want" and access to lifesaving clinical and public health interventions (Kent, 2005).

Plainly, health and human security converge in terms of definitions, as adequate access to healthcare resources is grounded in community-based primary healthcare and basic hygiene access. These concepts also emphasize the protection of populations against external and internal threats and shocks, oppressive state regimes, failing state systems and failing extractive institutions. In addition, health security protects vulnerable communities against infectious diseases and pandemics and, in general, provides the basics in public health and collective security for populations and communities.

Health security has evolved over time to encompass many entities that compose the present nexus of health and security. The United Nations (UN), WHO, the Asia-Pacific Economic Cooperation (APEC) and the EU approach the definition of 'health security' through the following specific areas: emerging diseases; global infectious diseases; deliberate release of chemical and biological materials; radioactive incidents; violence, conflict and humanitarian emergencies; and natural disasters and environmental change (Aldis, 2008; Chiu et al., 2009; Macrae, 1998).

The two major types of disease are infectious diseases and NCDs. Global infectious diseases are those that are transmissible and communicable between people due to the presence and growth of a pathogen; examples include bacteria, fungi, parasites or a virus, such as Ebola in 2014–2016 and the Zika virus in late 2015 and 2016 (Kasper and Fauci, 2010). NCDs, on the other hand, are not transmissible from person to person via any vector or pathogen but are linked to behavior and are currently far more numerous. As such, NCDs pose a major threat to health security in the 21st century. Examples of NCDs include hypertension, obesity, diabetes and cancer (although some cancer/malignancies are found to be caused or otherwise linked to viral strains).

Exploring the links between state fragility or failure and a wide variety of communicable diseases and NCDs is the chief focus of this PhD research project. The global disease

burden of NCDs is significant and cannot be entirely overlooked. At present, there is no clear causal link between infectious diseases and that of state fragility or failure. An increased rate of infectious diseases does not necessarily lead to violence or state collapse (Patrick, 2011, p. 208). It is the effort of the many publications related to this thesis to address the null hypothesis (H_0) and to disprove this and instead find a link between infectious diseases and state stability. Many also explore what role, if any, NCDs actually play. Regarding this, the state's provision of adequate health security for its population is the first line of defense against public health and complex emergencies and is a core component in providing human security at the most basic levels. In sum, we address where the state is placed to prevent communicable diseases and NCDs for citizens, and explore where state stability matters.

Furthermore, food security and poverty in general are also aspects of health and human security (this may sound obvious, but it is far from a commonplace concept across disciplines in the literature). Food security refers to adequate access to food, food markets and sustainable agriculture. Poverty is loosely defined as having limited or no financial capital, no access to capital or equitable finance, and no access to adequate and equitable work; the consequence of which is the loss of human, food and health security (Quinn and Bencko, 2012). Food security is obtained when all people at all times have access to sufficient, safe and nutritious food to maintain a healthy and active life, as well as access to adequate water and sanitation (World Food Summit, 1996). Food security is a complex sustainable development issue that is linked to health security through malnutrition, human growth and development, the immune system and disease susceptibility among many other factors, but also to sustainable economic development, sustainable environmental systems and equitable trade and finance. Food security may be acute, chronic, market-induced or seasonal in origin.

With this, the next key term is 'sustainable development'; it is defined as the equitable and democratic process that focuses on increasing living standards, is consistent, shows positive growth evenly spread across communities and populations, and does not rapidly diminish natural resources, human capital or otherwise cause creative destruction in the short or long

term (Acemoglu and Robinson, 2012; Collier, 2007; Stiglitz, 2006). Sustainable development is not just a humanitarian concern; healthy populations are an essential aspect of economic development and global order and stability.

Economic security is a collective concern for economic well-being between states and their populations; morally, it is understood that humankind has a common concern for the economic well-being of states and the belief that economic insecurity breeds state and individual instability, conflict and violence. Economic security in the context of public policy and global health is the ability of a state to follow its choice of policies in order to develop the national economy and globally compete as desired (Akpeninor, 2012; Nye, 1974). At a personal level, economic security is understood as having access to work, financial resources or income to support a consistent standard of living; it includes financial solvency and future access to work and cash flow. Market manipulation reduces global economic security.

Defining fragile and failed states – along with the arbitrary and possibly incorrect labeling of such states – poses major challenges to global health policy for most of the developing and resource-poor world. State fragility and potential failure must be placed in the context and on the spectrum of state fragility, taking into account multiple matrices of data for comparison and analysis and understanding that each state has myriad complex variables to overcome. Data indicators used to measure state fragility and failure in the study instruments of this research are summarized in each chapter; categories and definitions under scrutiny are reviewed and discussed in detail, as they relate to the metrics of health and correlate to disease and disease risk.

However, it can be agreed upon that fragile states are found in crisis and exhibit geographical, physical and fundamental economic constraints, internal strife, gross management flaws, overgrown greed and despotism, handicapping nepotism, debilitating external attacks and decreasing health security and physical health in terms of their citizens (Gros, 1996; Rotberg, 2003). When states are consumed by violence, they cease to deliver basic human or health security or any level of public health; these governments lose credibility and the state becomes questionable and illegitimate in the hearts and minds of its

citizens (Rotberg, 2004; Fund for Peace, 2011). Furthermore, fragile states experience a slow disappearance of state institutions and a reduction in the rule of law, which leads to a deteriorating health security situation (Acemoglu and Robinson, 2012; Naim, 2005; Zartman, 2005). Economic strife and human conflict threatens health security and leads to an increase in infectious diseases, physical trauma, malnourishment and mental health disorders (Collier, 2007; Hotez, 2008; Hotez 2001; Catelano, 1991; Paris, 2001).

In sum, we propose that the combination of deteriorating health, human, food and economic security contributes to and may exacerbate state fragility and possibly state failure (Schrecker, 2012). This research project systematically reviews how the strength of state institutions and public health successes in fragile states can improve state stability, especially in conflict and post-conflict settings.

This research also includes a basic risk characterization of war, conflict and complex emergencies from a very practical standpoint, with emphasis on exposure, dose and mitigating effects. Specifically, for risk information to be useful for decision makers and policy makers, what is known about the potential harms of a toxin, agent or biological insult must be appropriately conveyed. The risk assessment process involves: identifying, weighing, and choosing scientific studies that can be relied upon; selecting models to estimate dose response (war and conflict and complex emergencies can loosely be calculated into a 'dose') and potential exposures; and developing quantitative portrayals of risk to state failure. This research stream focuses on ways to appropriately characterize risk for fragile and failed states, including the attendant uncertainties, in order to better inform risk management decisions that affect health policy and dictate health outcomes.

Approaches to hazard identification in risk assessment – including methods for identifying and judging the quality of relevant studies and approaches for assessing the weight of evidence for causal relationships between war and health – are considered. It is key to highlight the importance of the quantitative characterization of uncertainty for sound public health decisions in evidence-based policy.

Another aspect of global health and development involves healthcare financing and economics. This is a relatively new field of study with the core tenets of applied economics. There are many ethical issues when assigning value to any object, including healthcare and its provision. However, as the least developed and developing nations face many growth challenges, finance becomes a barrier to the provision of healthcare for its citizens and an area where corruption and graft can flourish – especially in times of financial austerity and sociopolitical instability (Quinn and Bencko, 2014).

Lastly, a frequently overlooked aspect of global health in war, conflict and complex emergencies is psychological and mental health on the population and community levels. The impact of risk exposure and war and conflict exposure on civilian and military populations is significant and is only presently being made clear in the clinical evidence from recent human conflicts in the Middle East, the African Continent, Europe and Asia in terms of long-term and chronic exposure.

Bias and error

The many and very broad methods of reviewing and collecting data related to populations, war-torn states and failed nation states and reaching any conclusions are prone to error. We discuss a few basic principles of bias and error here and in each publication and subsequent chapters as potential limitations within the research methodology; I also delineate type I and type II errors. It is important to appreciate that epidemiological principles or bias and error are applied throughout the research PhD project and in each publication and subsequent chapters.

However, a comment must be made related to bias as a potential shortcoming of global health research. For example, selection bias is the nonrandom assignment of participation in a study group; in clinical medicine, this is most commonly a sampling bias. Examples include only studying inpatients (Berkson's bias); failure to follow-up when early mortality may play a role; and healthy worker and volunteer bias, where the study subjects are healthier or

otherwise skewed against the population and are not representative of a given population (Katz et al., 2014).

Examples of how and where selection bias may play a role in this PhD project are: in the selection of countries to study or communities within a nation state (i.e. Eastern Ukraine states of Donetsk and Luhansk vs other, non-invaded regions); in the focus on specific NCDs (i.e. hypertension, diabetes, cancer) or specific infectious diseases (i.e. HIV/AIDS, TB, malaria and Ebola, Zika, etc.); and in using certain indicators or metrics of health instead of others. To mitigate selection bias from occurring, the study instruments involved were either case studies, or countries were randomized by the use of research instruments that account for it (please see the methodology on the Failed States Index (FSI) and others in aggregate in each chapter and the Appendix to this thesis with all the related publications). Randomization is a way to control for bias and can make results more robust, more precise and more accurate in terms of drawing conclusions and possibly for causality.

Furthermore, precision is the consistency and reproducibility of a test, its reliability and the absence of random variation (Katz et al., 2014). Random error reduces precision in a test. An increase in precision will mean a smaller standard deviation (see below and the chapter related to statistical methods for further details and discussion). Accuracy is the trueness of measurements, i.e. the validity of the data obtained. This is the absence of systematic error or bias in a test or study. Systematic error in a study or method will reduce accuracy. When applying these principles to the study of health security across states, accuracy is difficult to control for and proved to be a major challenge in research methodology for this PhD project.

Global projects

Not all research and academic aspects of this PhD project fall into a standard publication format. However, many components and aspects of the research were tests that were implemented and carried out within country and regional assessments and other related projects. These assessments are descriptive in nature and not experimental, but some key

recommendations based on the assessment results are descriptive and have helped to direct public health policy in their respective regions and countries.

Please find the list and table in the Appendix of the assessments carried out under the methodology and framework of "Disaster, war, conflict, complex emergencies and international public health risks". Some of these assessments were funded by private companies and may not be reproduced or are no longer the proprietary information of the author (John Quinn); all publications that can be reprinted are available in the Annex of this dissertation.

Main outcomes and conclusions

This PhD program has described the problem of state fragility, disaster, war and conflict within the framework of global health. The outcomes are related to policy solutions for governments and key ministries in the countries visited. Some of these proposed complex solutions have already been implemented in foreign nations with positive preliminary results; some recommendations and policy prescriptions have been stalled.

As noted earlier, this research and completed project has also led to the establishment of the PCGH (please see updated details at: www.pcgh.lf1.cuni.cz). The cross-pollination of academic research and practical disciplines engenders innovation, new ideas and growth. As students, young doctors and young researchers in medicine, the need for an interdisciplinary global public health research collaborative (found in the PCGH) is needed in order to challenge old paradigms and bring about new ideas for both new and old global problems through evidence-based and creative solutions.

The PCGH is a collaboration between the Institute of Hygiene and Epidemiology, other faculty departments and partnered global institutes. This venture is not only a networking forum for research collaboration, but also fundamentally enhances communication, data results and the conclusions of all departments and projects related to public health. It allows experts and students to commingle in the academic space and publish, create and provide insight into global health troubles. The PCGH offers research and policy recommendations

for governments, ministries and small agencies at risk of or experiencing disaster, at risk of or in war, at risk of or in conflict and at risk of or experiencing complex emergencies; core features of the research focus on mitigating state and health morbidities through prevention.

Structure of the thesis

The format is descriptive and reiterates many published works associated with the PhD study, but also draws on the background literature review to offer relevance to the seemingly disparate topics of global health, international relations, global affairs, clinical medicine and primary prevention in health policy. A separate chapter describes, in context, the calculations and epidemiology used to carry out the assessments and projects.

The full original versions of the published chapters and papers can be referenced in the Appendix to this thesis. Chapters on associated projects, key findings and impact are also provided in addition to the core and bulk of the thesis, which is dedicated to publications and key findings. A list of commonly used abbreviations in this research and dissertation is provided, as are a comprehensive bibliography and additional materials. It is the effort of this approach to provide a comprehensive but simple means for review, critique, discussion and the ultimate defense of the thesis.

CHAPTER 2: Disaster and conflict medicine

Introduction

Disaster and conflict medicine is a new medical and academic specialty. The focus is to bring order in a time of great chaos – bring order to a patient, to a region, to a country or to a mass casualty disaster. The amount of social and political upheaval throughout the planet from 2011 – including the Arab Spring, the launch and expansion of the Islamic State of Iraq and Syria (ISIS) or the Islamic State of Iraq and the Levant (ISIL), the Russian annexation of Crimea and incursions into Eastern Ukraine, a global outbreak of the Ebola and Zika viruses and the lingering and ongoing epidemiological time bombs of NCDs across all countries – have created new challenges for global health actors.

These risks and health threats are coupled with the many other natural disasters associated with ecological degradation that define unprecedented risk and threat in the global pursuit for health. Disaster and conflict medicine joins intense emergency medical and surgical approaches with those of public health and epidemiology at a policy level to serve not only individual patients, but also communities and populations. All disasters are unique because each affected community has different social, economic, cultural and baseline health conditions, institutions and systems; the need for evidence-based practices rooted in prevention and preparedness is absolutely crucial to crisis mitigation (Partridge et al., 2012).

This thesis will not detail or outline *disaster and conflict medicine* as the specialty per se, but will rather walk through the PhD research and associated publications on disaster and conflict medicine and how it fits within the framework of this PhD project's research focus. The overriding principle applied in global health programming support – and hence in this PhD thesis – can be summarized as follows: apply the evidence-based practice of prevention medicine to public health policy for the betterment of health across communities and

populations. It is postulated in this thesis that better health outcomes for populations are generated by applying primary and secondary prevention to global health and global affairs. In the next section, clinical best practices and the associated publications related to disaster and conflict medicine will be unpacked in greater detail.

Disaster and conflict medicine

In the following section, the foundation and background of this thesis's topic will be explored. The first publication, "A Year Off in Iraq: Medicine in the Midst of War", offers a snapshot of public health and cultural differences that kept Iraq low on the health security spectrum. The war and conflict in Iraq (2003–present) caused destruction and further deteriorated a very fragile health security scenario. This article unpacks daily routine and patient volumes of scattered trauma and scared Iraqis with many NCDs and environmental risk factors that exacerbate untreated or undiagnosed hypertension, diabetes, respiratory illnesses and neoplasia (Lee et al., 2014; Rahim et al., 2014). Indeed, these risk factors – which are increased in Iraq due to inconsistent food, and economic and health security – lead to many preventable illnesses (Quinn, Zeleny and Bencko, 2015). Not all conflicts and disasters are associated solely with increased incidence and prevalence of trauma-related illness; a preventable illness incidence explosion can also be an outcome.

The next published paper, "Letter from the Field: Health Security in Kurdistan", takes us to the far north of Iraq to the semi-autonomous region of Kurdistan (i.e. the Kurdish Regional Government (KRG)). This paper describes the health security portrait of a nation in tatters and in an economically abysmal state due to conflict and war in Iraq.

A key factor in Kurdistan is that it shares autonomy with the main government in Baghdad. Healthcare budgets are difficult to describe but what occurs is a dichotomous system where the public and private sectors exist side by side; the public sector has no funding and too many patients, while the private sector has private funding and also too many patients. Most clinicians work between these two systems through the questionable business practices of healthcare economics. The outcomes are poor health security for citizens, no standards of

care and an overall broken system. Of course, these shortcomings are exacerbated by war and conflict in a region that, until recently, was an island of relative human security. These aspects have been dashed with the onset of the ISIS/ISIL and many regions are occupied by brutal military regimes. Autonomy and sovereignty in the KRG will be in question if and when violence related to ISIS/ISIL ceases.

Duty of care

One of the sub-questions and theoretical puzzles that needed to be solved through this research was that of the responsibility to protect duty of care for patients – specifically, with the state as main guarantor. In effect, the question relates to where the impetus to provide healthcare and health security falls: with the state (in the form of a Ministry of Health)? State sovereignty is "the supreme, absolute, and uncontrollable power by which an independent state is governed and from which all specific political powers are derived; the intentional independence of a state, combined with the right and power of regulating its internal affairs without foreign interference" (West, 2008; Bouvier, 1856).

However, in the post-Westphalian world, sovereignty no longer offers any protection for state borders or from intervention by other states; rather, there is a new form of responsibility that holds states accountable for the human and health security of its inhabitants, a new and emerging concept. The Peace of Westphalia is a series of treaties signed to end multiple wars and establish a world order of sovereign states, including how these states are to communicate and work with one another. Disaster and prevention medicine that is rooted in hygiene and epidemiology methodology and practice is the tool that enables states to carry out such duty of care.

Health and human security are carried out within the framework of the state's responsibility and duty to protect. The UN document of the 2005 World Summit outlines three pillars of the responsibility to protect as listed and adapted below (UN General Assembly, 2009):

(1) "The State carries the primary responsibility for protecting populations from genocide, war crimes, crimes against humanity and ethnic cleansing, and their incitement."

(2) "The international community has a responsibility to encourage and assist States in fulfilling this responsibility."

(3) "The international community has a responsibility to use appropriate diplomatic, humanitarian and other means to protect populations from these crimes. If a State is manifestly failing to protect its populations, the international community must be prepared to take collective action to protect populations, in accordance with the Charter of the UN."

Duty of care and a responsibility to protect together create a state failure mitigation policy through primary and secondary prevention principles in epidemiology and they ensure health security. The prevention of state failure and the maintenance of health security mean that states have to accept responsibility and work with major policy players to bolster not only state institutions, but also the ability to provide basic services to citizens. This nexus of state and international and donor community support to prevent genocide and state failure and to ensure health security is not so easily realized in practice, as some communities in those states may contribute to the problem.

The principles of duty of care and the responsibility to protect are enshrined in Article 1 of the Genocide Convention and are embodied in the principle of 'sovereignty as responsibility'. In tort law, a duty of care is a legal obligation that is imposed on an individual requiring adherence to a standard of reasonable care while performing any acts that could foreseeably harm others. It is the first element that must be established to proceed with an action in negligence and is the spirit of the law in the Hippocratic oath. Said plainly, duty of care stems from the responsibility to protect. Most importantly, the ideas of duty of care and the responsibility to protect are weighed against health and human security in war and conflict zones.

Duty of care in disaster medicine and the question of burden of care or the opportunity for best practice are raised in subsequent papers. This explores the concept and unpacks the duty of care paradigm in conflict zones and how it relates to best practices in medicine. These core concepts of duty and responsibility apply to individual patients and the population and relate to global health policy.

Health, war and the state

The idea of engendering an environment of health and human security for the population is new, and many states do not meet this challenge (Quinn et al., 2011). Indeed, state institutions and health policies are the guiding principles of enabling a state to provide any level of health and human security, especially in times of disaster, external shock, conflict and war (Quinn et al., 2012; Quinn et al., 2015).

Infectious diseases and public health

Communicable diseases such as polio and tetanus present a clear threat across the Anti-Terrorist Operation (ATO) zone and all of Eastern Ukraine, with inadequate access to prevention and vaccination, poor hygiene and lack of basic services. The UN Office for the Coordination of Humanitarian Affairs (OCHA), in collaboration with humanitarian partners, reported in January 2015 that unless a solution is found, no antiviral and TB treatment will be completely effective, leaving millions at risk. Access to basic medicines for cardiovascular disease, hypertension and many other NCDs is very low, with poor supply and no clear plan put forth by the Ministry of Health to mitigate such disasters. NCDs will be a major hazard to health security for this high-risk population under constant threat. There is an additional, acute need to procure adequate supplies of the polio and tetanus vaccines for the civilian, enemy and Ukrainian populations in the East.

Summary

Ukraine is a fragile sovereign nation state still teetering on the brink of failure. Basic services due to war in the East are not met and have led to increased morbidity for the civilian population and mortality from battlefield trauma. Disaster and conflict medicine is a new

medical specialty. Globally, health experts face a myriad of challenges to health security. The main concerns include: social and political upheaval, communicable diseases and NCDs, and disaster. Disaster and conflict medicine joins intense emergency medical and surgical practice with that of public health policy. This connection of disciplines serves individual patients and populations at risk of deteriorating or with no health security. All disasters are unique because each affected community has different social, economic, cultural and baseline health conditions and systems; the need for evidence-based practices rooted in prevention and preparedness mitigates the risk of loss to health security for populations.

The overriding principles of this PhD thesis and the work associated with the publications and all global health programming support boils down to one simple principle: apply an evidence-based practice of prevention medicine to public health policy. In applying primary and secondary prevention to global health and global affairs, it is postulated in this thesis that better health outcomes for populations are generated. In the next section, clinical best practices and associated PhD publications related to disaster and conflict medicine will be unpacked in greater detail.

CHAPTER 3: Disaster and conflict medicine: Clinical best practices

Introduction

Natural and man-made disasters have occurred throughout human existence. Arguably, however, the frequency and intensity of human conflict affecting civilians and other non-combatants with war and war-fighting activities has increased in severity, quantity and nature (Schütte, 2015, pp. 107–110). This chapter of the thesis describes my publications associated with how best medical practices are applied in disaster and emergency. Clinical medicine in disaster does not stop at emergency war surgery; the need for a full continuum of care includes education, prevention, reaction and treatment, secondary and tertiary prevention, rehabilitation and preparation. All of these aspects are required for best practices. This chapter focuses on a few core topics related to this continuum.

The first publication, "Student Scientific Conference, Post-traumatic Stress Disorder in War and Disaster", was co-authored with an economist and serves to set the scene. It reveals novel research data that explores the use of private military contractors and exposure to war-fighting activity. The use of non-combatant private contractors has increased with the advent of the wars in Afghanistan and Iraq in 2001 and with new outbreaks of violence throughout the Middle East, Europe and Asia. This paper reviews the symptom severity for post-traumatic stress disorder (PTSD) and potential diagnoses of 22 private contractors that work in a war zone using the standardized Post-traumatic Stress Diagnostic Scale (PDS). The results show that the potential PTSD diagnosis is slightly higher than in the general population and that the symptom severity scores are slightly elevated.

Materials

Mental health effects of war can be negative for individuals and populations. The quantification of these effects is only starting to be elucidated. The combination of stress in war and war-like activity, together with long-term exposure to potentially traumatic stress, may affect mental health. Little is known regarding to what extent these and other factors promote a PTSD diagnosis. Here, we investigate the PTSD symptom severity in 22 non-combatant civilian contractors working in Iraq and their potential PTSD diagnosis.

Methods

The 22 participants, selected by convenience sampling of private military contractors providing services for the US military collecting enemy ammunition program, were interviewed and asked to fill in the PDS questionnaire in the English language. The PDS is a 49-item self-reporting measure recommended for use in clinical or research settings to measure the severity of PTSD symptoms related to a single identified traumatic event. The PDS is unique in that it assesses all of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria for PTSD.

Results

We found a prevalence of the PTSD diagnosis in 7.3% of respondents with a symptom severity score mean of 20. We also recorded 11% respondents scoring 'severe' for both level of impairment of functioning and symptom severity rating who did not qualify for PTSD diagnosis based on all other DSM-IV criteria. The mean symptom severity score for all respondents was 9.6 and the mean number of symptoms endorsed was 6.4 for all participants.

Discussion

The psychological strain among the study participants was average to high. Traumatic stress experienced during war and war-related activities has potentially put the study participants at risk of PTSD. No contractor interviewed was in Iraq against their will or was being forced

by any known authority to work there, nor was anyone forced to take the PDS questionnaire against their will. Furthermore, the level and duration of war and war activity exposure were not reviewed or quantified. The specific exposure to small arms fire, explosions, roadside bombs and convoy attacks were not quantified for this study group. This data cannot show causality or a linkage between war and PTSD, but it can describe (in the 22 respondents working in Iraq) the prevalence of PTSD potential diagnosis, symptoms severity score and the level of functioning and impairment. The exposure level to war and war-fighting activity was not assessed in this study. A categorical diagnosis of PTSD can be made with an algorithm that requires that the individual's responses meet the following criteria.

Conflict, war and disaster and NCDs

As previously described, trauma medicine is not the only specialty required for disaster and conflict medicine. NCDs are of growing importance in areas of conflict and the need to distinguish between medical emergency and chronic conditions is of note. The medical outcome is great when reviewing the undifferentiated patient with chest and epigastric discomfort and taking into account epidemiological risk profiles. Indeed, NCDs have prevalence across patient populations in geographic and conflict areas, possibly impacted by economic, political, social and health shocks (Donilon, Bollyky and Tuttle, 2015). However, the details of sensitivity and specificity of tests are also of note when weighing the risk, benefit and validity of diagnostics tests against the clinical picture of patient presentations.

Clinical best practices in remote and battlefield medicine

Historically, about 20% of all injured soldiers die in battle and 90% of those die before they are treated in a medical facility (Bowen and Bellamy, 1998). To salvage any of those casualties, medical care must be administered immediately and appropriately in care under fire and on the battlefield when safe to do so. The major processes of dying after a traumatic injury on the battlefield have been described as hypovolemic shock from trauma, low blood volume and end tissue and organ failures. This uncoupling is the result of blood loss after injury. In acute trauma and major catastrophic bleeding, tissues and end organs begin

irreversible damage, on average, within one hour (Schaider et al., 2013). This Golden Hour is hotly contested in the medical community and is a guideline, not a rigid rule for battlefield trauma.

Conclusion

Evidence-based clinical medicine practiced through developed, developing and conflict settings is best for patients. Ukraine is at war and is a fragile state with many gaps in terms of providing best practices for patients and providing health security for the state and occupied regions. This leaves these vulnerable populations at risk of deteriorating health security. Basic sovereignty is trampled by global conflict, and human loss due to preventable conflict-related death increases morbidity and mortality.

CHAPTER 4: Global public health risk in disaster, war and conflict

Introduction

In clinical medicine, risk refers to the possible peril related to a particular condition or treatment. For example, risk may be derived directly from an illness or indirectly from the process or method involved in the diagnosis and/or treatment of that illness. Epidemiology is a bit more specific about risk, offering: *attributable risk* or the amount or proportion of incidence of disease or death (or risk of disease or death) in individuals exposed to a specific risk factor that can be attributed to exposure to that factor (the difference in the risk for unexposed or exposed individuals); *empiric risk*, which is the probability that a trait will occur or recur in a family based solely on experience rather than knowledge of the causative mechanism; *genetic risk*, which is the probability that a trait will occur or recur in a family based on knowledge of its genetic pattern of transmission; and, finally, *relative risk*, which is the ratio of the incidence rate among individuals with a given risk factor to the incidence rate among those without the disease or other outcomes.

When evaluating environmental risk and its perception, psychosocial and psychosomatic factors may be of fundamental importance for public health programming and the promotion of quality of life. This applies not only in the case of indoor environment related complaints but also to non-ionizing electromagnetic radiation and electro-ionic microclimate, among many others (Quinn and Bencko, 2010).

Public health crisis in war and conflict: Failed states and health security

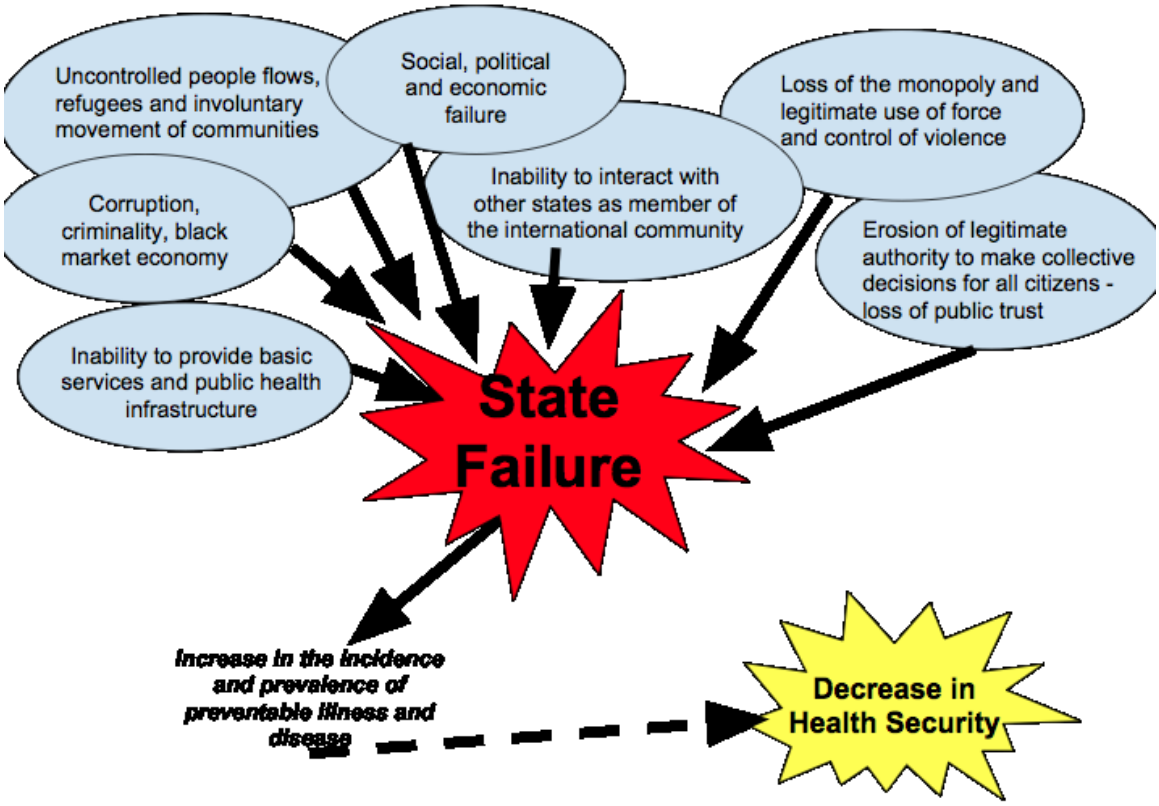
The public health status of populations is multifactorial and linked to war and conflict. Public health crisis can erupt when states go to war and health security is reduced. This study design reviews (in aggregate) multiple indices of human security, human development and the legitimacy of the state in order to describe the predicted global health portrait. We find

that the paradigm shift of large global powers to non-state actors and proxies impact regional influence through scaled conflict and present major global health challenges for policy makers. Small-scale conflict with large-scale violence threatens health security. The paper concludes that health security is directly proportional to state security.

Introduction

Health security is directly proportional to state sovereignty, legitimacy and the mandate to provide health services (Quinn et al., 2013; Quinn, Zeleny and Bencko, 2014). Health security is negatively impacted across fragile and failed states, while regional conflicts intensify and manifest globally (Williams, 2008). The connection between violence and health is difficult to study, and many considerations regarding approach have been applied. This aggregate research through the core measures of country status and multiple development indices in public health and health indicators provides rigorous information regarding how much the general indices relate to tangible health security. By proxy, health security is implemented by incidence of preventable disease.

Figure 1.



Aggregate research describes combined data from several measurements, such as those related to health security and multifaceted concepts of conflict and health. Based on this aggregate research model and at the individual level of health, it is observed that health behaviors and outcomes have multilevel determinants and can be predictable (Marshall, 2008; Von Korff, 2008). The perspective of multilevel analysis acknowledges the importance of both individual and environmental variables in determining health behaviors and outcomes at the level of the indivisible unit and in conceptualizing multiple levels of organization relevant to a particular research question and the individual (Diez-Roux, 2009).

Objectives and methods

We used aggregate analysis with spread data, constructing a model by merging diseases (cholera, tuberculosis (TB), malaria and measles) into a single variable: 'agreg', which is a

simple sum of cumulative incidence. Incidence can be described as a rather rough variable to implement in such an analysis, as attributes of diseases used in the aggregate analysis (measles, cholera, TB and malaria) are extremely diverse. These ailments affect different populations globally and are generally widely dissimilar; nonetheless, they are preventable.

Statistically, however, generality is not lost, as disease burden, public health infrastructure and prevention programs aimed at disease mitigation when following best practices for these diseases are similar in nature. For example, measles, cholera and TB are preventable through vaccination (albeit with varying seroconversion and efficacy rates) and malaria is preventable through primary prevention measures (chemoprophylaxis, mosquito bed nets and sprays, prompt diagnosis, and initiation of effective therapy). Diagnosis of these diseases can be performed clinically or through diagnostic procedures. However, these diseases can be difficult and expensive for poorly resourced public health infrastructures to prevent and treat.

Finally, measles, cholera, TB and malaria are endemic in most of the resource-poor and developing world; these regions are where fragile and failed states originate. Thus, the argument that populations are or would be indifferent about getting these diseases is rejected. This variable is the proxy for health security, as a high risk of exposure to deadly infectious diseases is a prime example of inadequate health security and the variable itself is not interdependent with other variables (indices implemented with this research do not have incidence of infectious diseases included), which allows for clear statistical analysis.

The multiple indices used in this analysis involve high-level data composed of a multitude and combination of individual data. By combining multiple indices with data sets for economic, health, social and behavioral, political, security and overall health status, this aggregate research concludes regarding human health trends in the data – i.e. the health security environment or portrait. The indices used are listed in Table 1.

Table 1. Summary of indices implemented
Failed States Index (FSI)
State Fragility Index (SFi)
Public Integrity Index (PII)
Political Stability Index (PSI)
Human Security Index (HSI)
Economic Fabric Index (EFI)
Environmental Fabric Index (EnFI)
Social Fabric Index (SFI)
Literacy rate (LR)
Life expectancy at birth
Specific diseases in the population: *measles, cholera, TB and malaria*

Failed States Index (FSI)

The US Fund for Peace publishes the annual FSI listing those countries that are failed states or at great risk of becoming so. There are multiple metrics that rely on key social, political and economic indicators that compose this index. The reason for including this index in the aggregate analysis is that the included diseases are preventable through vaccination programs promoted by state health ministries and departments, as well as through basic public health and hygiene measures (clean water, access to night-time mosquito nets or repellents, immunization and educational programs, etc.) based on health security infrastructure promoted by organized and properly funded state governmental health institutions.

Humanitarian aid programs are great but can be very inconsistent, have difficult-to-achieve successes that are not reproducible and are under donor strain given global social, political and environmental complex emergencies; often, strong state institutions would have been a better alternative when possible (Hughes, 2009; Moyo, 2011). The assumption and expectation of using the FSI for this aggregate analysis is that states without, or with decreased exposure to, conflict and war will be stronger states, will not be fragile or failing states and will promote the health security of the population (correlated with an assumed lower incidence of measles, cholera, TB and malaria).

State Fragility Index (SFi)

The SFi combines scores measuring two essential qualities of state performance: effectiveness and legitimacy. These two quality indicies combine scores on distinct measures of the key performance dimensions of security, governance, economics and social development. The SFi utilizes a set of eight indicators to measure state fragility in previous years and examines changes in each indicator over time (Marshall and Coll, 2011). The SFi helps look at overall state fragility.

Human Security Index (HSI)

The HSI covers 232 countries and societies. It is not intended to become an annual index for publication but is rather a result of over 25 years of indicator development. Steady advances in characterizing different aspects of the human condition have resulted in indicators – covering an increasing number of countries – on a wide variety of subjects; the HSI is an attempt to create an index on people-centric human security (HSI, 2012). Components of the HSI include data from the EFI, EnFI and the SFI. In sum, the HSI can be considered as an index of 30+ leading economic, environmental and social indicators related to health and state stability (HSI, 2012).

Economic Fabric Index (EFI)

The EFI uses the gross domestic product (GDP) per capita, adjusted for pricing, purchasing power parity (PPP), equality of income distribution (income and finance distribution) and financial and economic governance (which is described as the risk of hardship through unsustainable trade or debt or from a catastrophic healthcare governance disaster). The EFI is implemented in this aggregate analysis for the economic status of the population and is the reason why the GDP per capita is not included alone, as it is of much bigger interest when combined with other main economic factors (especially income distribution) than as a standalone variable. Economic security is directly linked to health security.

Environmental Fabric Index (EnFI)

The EnFI examines environmental vulnerability, environmental protection (access to clean water, etc.), policies and deliverables and overall environmental sustainability in a population. The EnFI is the main variable containing environmental information for the HSI.

Social Fabric Index (SFI)

The SFI lists health education, information empowerment and protection of (and benefits from) diversity and peacefulness governance, including protection from official or illegal corrupt practices and food security (HSI, 2012). This is very powerful, as the information in this combined index is much more valuable because it captures a descriptive side of society.

Literacy Rate (LR)

LR is the percentage of people who are literate in a given country. The importance of this factor is indirect – it is expected that a more literate population would be able to inform itself better about the prevention of disease (especially measles, cholera, TB and malaria), as well as educate itself about health promotion in general for the family unit, and would be able to demand health security promotion and measures in the form of policy from state institutions. An illiterate population increases public health risk and may be linked to poor health security status and state fragility.

Life expectancy at birth

This variable serves as the comparison of the results in terms of the extent to which the indexes explain the incidence of preventable lethal diseases and the extent to which they explain actual life expectancy. In global health, policy and resources are devoted to reducing the incidence, duration and severity of major diseases that cause morbidity (but not always their rate of mortality) and to reducing their negative impact on human life (WHO, 2014).

Infant mortality and political crisis are not proposed to be linked; however, infant mortality is a better indicator for democracies prone to failure than it is for less democratic states. It is also an indication of maternal health security (Quinn, Zeleny and Bencko, 2014; Rotberg, 2004). It is important to capture both fatal and non-fatal health outcomes in a summary measure of average levels of population health. Healthy life expectancy (HALE) at birth adds up the expectation of life for different health states, adjusting for severity distribution; this makes it sensitive to changes over time or differences between countries in the severity distribution of healthy states (Alesina et al., 1996).

Preventable illness and infectious diseases

Conflict and war are inextricably linked to human disease and deterioration in health security (Quinn et al., 2014; Quinn, Zeleny and Bencko, 2013; Helman, 1993; Lymon, 1993; Ottaway and Mair, 2004). Many infectious diseases are preventable through vaccination, simple prevention measures and basic access to standardized primary healthcare. Measles, cholera and TB have been selected as the leading infectious diseases in order to find linkages to health security reduction in conflict areas.

Routine measles vaccinations for children, combined with mass immunization campaigns in countries with low routine coverage, is a key public health strategy to reduce global measles deaths (CDC, 2014; Peltola, 1994). More than 20 million people are affected by measles each year (CDC, 2014). The cholera disease burden is estimated to be 3 to 5 million cases and 100,000 to 120,000 deaths due to cholera every year. Approximately 80% of cases can be successfully treated with oral rehydration salts and even prevented via vaccine (WHO, 2014).

Areas with low sanitation and no potable water due to war and conflict are at increased risk of cholera. It is estimated that approximately one third of the world's population is infected with TB, that there are 8 to 9 million new cases of TB and nearly 2 million deaths each year from TB (Peltola, 1994). Globally, malaria is the most important parasitic disease that threatens health security annually.

Results

The analysis of the data is done through a two-stage least squares (2SLS) method (Quinn, Zeleny and Bencko, 2013), where it is instrumented with the FSI and by the SFI. The reason is that the FSI is a general observation index and, thus, it is expected to be correlated by any variable that is not put into the equation, making it residual. The SFI, however, is very highly correlated with the FSI and is a restricted index; thus, to assume that its correlation with non-included variables is non-existent or at least very small would be indirect. For most variables, observations for different years are not identified; the only data available is in a cross-sectional format. In order to counter heteroscedasticity, White robust residuals are implemented.

For the 2SLS estimation, the FSI is first estimated using the SFI. The results are in Table 2.

Table 2. Linear regression with White robust residuals				
Dependent variable = FSI				
Number of observations	83	R-squared	0.9018	
F(1,81)	743.79	Root MSE	7.4413	
Prob>F	0.000			

Variable	Coefficient	Standard error	t-statistic	P>|t|
Constant	**164.6428**	3.784455	43.51	0.000
SFI	-159.9359	5.864374	43.51	0.000

To answer the initial question, the most natural testing method is a simple linear regression in the form of:

[redacted] (equation 1)

This trivial method offers FSI as a significant (p-value < 0.001) variable for explaining the incidence of preventable infectious diseases. However, the overall explanatory power seems rather limited, as the coefficient of determination is only 0.10. In order to get a more practical answer, an extended model is implemented. The model takes the following form:

[redacted] (equation 2)

Instead of the HSI, the main three parts are used: the EFI, EnFI and SFI. The SFI is, however, already being used for FSI instrumenting, so it is not used in the estimation by itself. The model estimation results are in Table 3.

Table 3. Linear regression with White robust residuals				
Dependent variable = agreg				
Number of observations	141	R-squared	0.2522	
F(4,136)	8.72	Root MSE	5161.9	
Prob>F	0.000			
Variable	Coefficient	Standard error	t-statistic	P>|t|
Constant	16509.01	5476.253	3.01	0.003
IVFSI	2.689046	25.52681	0.11	0.916
PI	-167.6503	64.6096	-2.59	0.011
GI	-36.25174	73.51627	-0.49	0.623
EFI	-10629.49	7259.811	-1.46	0.147
EnFI	-10941.05	7046.882	-1.55	0.125

The explanatory power of the model has improved significantly to 0.2253. While that is still not high, given the size and variance of the examined sample, it is not insignificant. What is more intriguing is the specific results themselves – FSI and Government Instability (GI) turn out to be completely insignificant with respect to the dependent variable, while Policy Institutions (PI) takes over as the main explanatory variable.

The EFI and the EnFI are also fairly significant, but surprisingly at a rather lower level. Yet their coefficients have a higher-level coefficient compared to other variables, suggesting that their potential impact may be much higher. This means that the FSI on a global scale is unable to explain incidence of infectious diseases, which may be against conventional expectations. The model also provides a prompt explanation: the FSI mostly contains government stability-themed components.

With GI by itself being irrelevant, the FSI takes over the insignificance as well. The problem is much more technical than social, as the results suggest that what truly matters is the ability to take action through strong institutions and policy implementation; as long as the institutions necessary for such a move exist and are operational, the status of the remainder of the state's public sector is irrelevant.

Higher magnitude factors are population income and environmental conditions. The former is the obvious indicator of whether people can prevent contamination by infectious diseases by themselves, while the latter is a good indicator of the likelihood of contracting the disease given environmental conditions. Thus, while external conflict or general government instability may have an adverse effect on the creation of necessary policy institutions, it is the institutions themselves and fundamental factors (economic and environmental conditions) that play a major role in infectious disease prevention and possibly in ensuring health security for populations.

The main issue of the previous model is that health security is not only the incidence of preventable infectious diseases, but includes many other factors. Thus, these results reflect only a part of the portrait. So, in order to solidify these results, the same model is created but with a wider dependent variable, one that includes health security and (unfortunately) many more variables. The average result of the smaller and larger models should then be a more accurate result than that of any one model. For the dependent variable, life expectancy (LE) is used. The model calculation is seen below:

[redacted]

(equation 3)

The results of its estimation are given in Table 4.

Table 4. Linear regression with White robust residuals				
Dependent variable = LE				
Number of observations	83	R-squared	0.6907	
F(6, 76)	35.65	Root MSE	5.4144	
Prob>F	0.0000			
Variable	Coefficient	Standard error	t-statistic	P>|t|
Constant	35.60688	6.432873	5.54	0.000
IVFSI	-.1775256	.0430917	-4.12	0.000
PI	.210276	.1081607	1.94	0.056
GI	.0656733	.1495496	0.44	0.662
EFI	23.60701	10.20632	2.31	0.000
EnFI	3.911065	6.798452	0.58	0.567
Agreg	-.0004447	.0001607	-2.77	0.007

The results are quite different from the previous case. The FSI is very significant in this model, with life expectancy decreasing in increasing values of FSI (as would be predicted). PI remains at approximately the top of the explanatory variables, as it is still highly significant. The EnFI and EFI no longer share the same importance – the EFI has almost six times as much of an impact in scale than the EnFI, which has lost importance in this model and has become barely significant.

As for scale, since the FSI is approximately 100 times larger in units than the EFI and the EnFI, it has about the same effect on life expectancy as the level of income, only in the opposite direction. The economic situation of a country or population has then about twice as much impact as these other variables. Finally, the coefficient of determination is up to 0.6907, which is more than double that of the previous model. This suggests that there is much less unexplained variance than in the previous case, which is both expected and important, as it should be the case that aggregate variables (in our case, the indices) are better at explaining other aggregate variables than concrete ones.

Comparing the results of both models, they fit perfectly. For the EFI and the EnFI, we made a case for health security to be well instrumented by incidence of preventable infectious diseases. Their switching roles when it comes to diseases and life expectancy is perfectly logical, because life expectancy requires significantly more factors (influenced by an individual's income) than the prevention of infectious diseases. Furthermore, life expectancy has more factors involved that are more important than the environment alone. Avoiding mosquitoes and other infectious but preventable illnesses from birth in sub-Saharan Africa is extremely difficult, but an individual can extend their life through a healthy lifestyle, including access to nutritious and abundant food and access to quality primary healthcare and disease prevention in general. This is the environment that engenders health security.

Conclusion

This aggregate research has reviewed indices and variables related to the public health of populations in countries that are in crisis, are fragile and many that are failed states. The FSI,

used to measure the quality of national-level institutions, does not capture all variables related to state fragility and health. An explanation is provided by the EFI and the EnFI. They both have a very large impact on the incidence of preventable infectious diseases and give a new context to the issues faced by states in providing environments for health security.

The matter is divided into two levels: the primary cause and the resolution of effects. The primary cause seems to be the quality of the environment, which greatly reduces the incidence of preventable infectious diseases. In parallel, there is the nationwide issue of improving the quality of the environment, which is impossible at only the individual or citizen level. Environmental policy is difficult in each state, as all states share the same global environment and poor health effects from a bad environment are transborder. On the other hand, personal wealth is capable of mitigating the problems caused by a poor environment (personal wealth is captured by the EFI, as its main component is income per capita). Indeed, economic security can dictate health security.

To summarize, the data suggests that, to improve health security in fragile and failed states, policy focus should seek to resuscitate fragile states, mitigate the loss of failed states, provide health security in the form of prevention, prevent environmental degradation, engender economic security, improve environmental conditions that affect health and, finally, empower the population to counter the impact of poor environmental conditions.

Limitations

The FSI is contested as a good aggregate to review the listed variables. Some opponent researchers describe the index as deficient, stating that it is counterproductive to states as diverse as Colombia, Malawi, Somalia, Iraq, Haiti and Tajikistan with data in aggregate. The main points of contention with the FSI relate to its inability to distinguish capacity gaps, security gaps and legitimacy gaps that the states experience, that these gaps often do not coincide in a given country, and that the logical responses to each of the three gaps diverge in significant ways (Corbett et al., 2003). Lastly, the status of HIV/AIDS and associated data

were not directly used in this analysis as health indicators due to the disproportionate geographical representation and regional disease burden.

CHAPTER 5: Food security in war, conflict and complex emergencies

Introduction

Food equals health security. In the chapter "Food security, public health, financial regimes and international law" (Chapter 23 in *Human Health and Ecological Integrity*, May 2012), we breakdown the relationship between human health and food security and how this relates to global health and disease.

Humankind has rarely been able to find a balance between adequate food production, allocation and consumption. Owing to the complex interplay of economic issues, growing populations and consumption patterns, energy reallocation, natural resource depletion and geopolitical instability, global food security is now a public health crisis.

Public health and food security

Adequate and clean water help stave off infectious diseases and waterborne illnesses. Access to a nutritious and consistent food supply enables child development and individuals to thrive and provides for others in both the family and community. Consumption in both the developed and developing worlds is a leading factor in the world's growing pandemic of obesity, diabetes and cardiovascular disease.

Inadequate nutrition arises not only through access issues, but also through the soil itself, which must be capable of producing foods that are nutritious and people must have the minimum required to toil the land and produce food. Through over-farming and the reallocation of agricultural land (from food to energy supply), the depletion of elements essential for nutritious food is becoming evident everywhere. Soil, water supply and inclement weather are only some of nature's services that are under extreme stress. The table below offers some basics about micronutrient deficiencies and health.

Table 5. Micronutrient deficiencies and related illnesses	
Micronutrient	*Illness*
Vitamin A (retinol) deficiency	Leading to vision and eye disorders
Iron deficiency	Leading to muscle weakness and abnormalities, anemia and mental development disorders
Zinc deficiency	Leading to developmental retardation and congenital malformations
Fluoride deficiency	Leading to dental caries
Iodine deficiency	Leading to thyroid enlargement (goiter) and cretinism
Copper deficiency	Leading to anemia and mental retardation
Vitamin C deficiency	Leading to scurvy and poor wound healing
Vitamin D deficiency	Leading to rickets and osteomalacia
Folate and vitamin B12 deficiency	Leading to megaloblastic anemia
Niacin deficiency	Leading to pellagra, memory loss and

	disorientation
Thiamine deficiency	Leading to beriberi, muscle weakness and wasting

For the poorest billion people on this planet, poverty is inversely proportional to food security. With the inability of a region or population to grow or purchase its food, food security becomes increasingly tenuous and the risk of food shortages and political instability rises. Despite the fact that more of the developed world has health issues associated with the overconsumption of food (such as obesity, diabetes, hypertension and cardiovascular disease), the developing world is quickly catching up in terms of all of these NCDs and entirely preventable diseases.

The public health issues of imbalanced nutrition, inadequate access to food security and the misappropriation of resources at the governmental and household levels are seen around the globe and affect billions of people. They are compounded by an inadequate access to nutritious food, plus large scarcities building up in the world of global agriculture. Among these scarcities are: arable land, fresh water, fossil fuels for energy and for fertilizer production, appropriate farm technology and access to this technology, and fish supplies. Put simply, food prices have risen sharply from two main causes: investors that are speculating on growth and the price of grain, and the conversion of would-be food products to ethanol for use as biofuels. Water quality for consumption and agriculture is tightly linked to this dynamic. The use of food crops for biofuel production and energy, as opposed for consumption, is causing direct public harm.

In addition, excessive use of fertilizers in combination with inappropriate and aggressive farming techniques have led to macronutrient and micronutrient depletion in the soil. Other factors include diminishing access to appropriate financial support and an increasingly

unstable climate. All of these factors make increasing global food output extremely difficult. We will see that the key to public health action and improvement in terms of the food security crisis is found in climate change reduction. The public health situation in relation to agriculture and food security is getting worse, but why?

Policy failure

Feeding the world's hungry is not entirely possible, nor is there a credible and evidence-based policy that has proven to work and is reproducible around the globe. After significant double-blind field research, it has been found that poverty leads to a world where those without enough to eat may save up to buy a TV instead of adequate food for their family; thus, more money does not translate into more food and making rice cheaper can sometimes even lead people to buy less rice.

Indeed, when many communities have gained more access to wealth and can afford adequate and balanced food supplies, many opt for the better tasting and less nutritious option purely as a right of becoming 'civilized'. As communities and societies gain more access to wealth, the greatly needed outcome of more balanced consumption is not guaranteed and is sometimes even hindered as more and more market forces encourage the purchasing of luxuries as opposed to adequate nutrition. Education regarding these at-risk communities is needed in the form of primary prevention – to prevent misguided family and household expenditures on poorly nutritious food and other superfluous purchases that are not directly linked to their own food security, public health and overall well-being.

Finance, food and health

Economics are directly linked to public health. In the following two sections published as "Food Insecurity: How to orchestrate a global health crisis" (June 2013) and "Food is security: The nexus of health security in fragile and failed states" (2014), we discuss the links between international markets and famine.

Specifically, in 2007–2008, the world experienced over one billion people going hungry. This complex food security and public health crisis has many levels, actors and stakeholders. There is no equity with regard to access to food markets, unbalanced consumption of nutrients and poor state institutions; all these negatively impact food security. Global financial products and regimes can greatly influence food prices and, if not properly regulated, this can lead to market manipulation and starvation. This paper discusses the basics of food security in a public health framework and describes the legal and financial mechanisms that lead to food insecurity (Quinn and Bencko, 2014). One of the main outcomes of this paper is establishing and describing the determining factors of human conflict that affect food security (please see Table 6).

Table 6. Determining factors of human conflict that affect food security
Access to food at the market: price variability and supply
Rural and agricultural infrastructure destroyed
Loss of livestock and access to arable land
Deforestation, desertification and rising water levels
No access to water for irrigation; water infrastructure destroyed
No consistent access to seed, farm technology or human capital
Migration flow: large influx of people into one region, with insufficient people in another
The use of landmines and other explosive devices throughout arable land
The use of food access as a weapon

In this paper, we conclude that famine, starvation and food insecurity experienced by people around the world are of human origin. Natural events such as drought and flood often exacerbate food insecurity, but underlying man-made problems and events bring it to the fore. Fragile and failed states, investment speculators and climate change lead to food insecurity. Policy and human action can mitigate these problems by states providing inclusive and accountable state institutions.

In the last paper of this section, "Food is security: The nexus of health security in fragile and failed states", all of these elements join to create the nexus of *global health security*. Specifically, global food security is a major development challenge dictated by state stability and resilience to geopolitical and economic shocks; it is linked to health security. Fragile and failed states are at risk of extreme poverty that could lead to war and conflict. Fragile states experience corrupt financial regimes and are influenced by skewed global market systems and reduced equitable market access that decrease food and health security.

This qualitative review describes the critical cross sections of food security, the influence of global market systems and state stability, and institutions that form the nexus of global health security. We outline how the manipulation of free market systems and decreased state capacity not only decreases food and health security but also contributes to state fragility and failure. Improved public health policy mechanisms, decreased dependence on foreign financial structures and extractive mechanisms are crucial to improving food and health security at present, and to further increasing state stability in the future.

Table 7. Factors of human conflict that affect food security	
Key factor	*Consequence*
Access to food, equitable and consistent markets	Price shocks and price variability lead to supply disruption
Rural and agricultural infrastructure destroyed	A decrease in local supply and disruption in food distribution networks
Loss of livestock and access to arable land	Decrease in yields and caloric availability
Deforestation, desertification coupled with rising coastal levels and decreasing potable water tables	Climate change disruption of food availability, natural resource depletion and access to water for consumption
No consistent access to quality seed, farm technology or human capital	Cycle of poverty with poor access to basic technology and high yield seed
Migration and human flow: large influx of people into one region, out of another region	Market shock, rapid increase in food demand and price variability
The use of landmines and other explosive devices throughout arable land	Reduction in arable land access, increased risk of injury or death
The use of food as a weapon	When food resources and access are in scarcity, coercion of communities and populations can ensue (Kissinger, 1974)

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Table 8. Indicators used to measure state fragility and state failure (adapted from Fund for Peace, 2012 with permission). These metrics are implemented in the methodology for assessing state fragility by the FSI

Social	Economic	Political	Military and policing
Demographic pressure	Uneven economic development	Corruption	Drug trade and illicit economy
Natural disasters and environmental degradation	Access to improved services	Government effectiveness Political participation	Human rights and rule of law
Disease and public health	Poverty and economic decline	Water, sanitation, basic infrastructure and energy	Human trafficking
Food scarcity, malnutrition	Unemployment	Quality healthcare	Incarceration, torture and executions
Mortality	Purchasing power, inflation	Civil liberties and political freedoms	Rebel activity, military coups, bombings
Refugee and internally displaced peoples		Internal conflict, riots and protests	
Human flight and brain drain		Foreign assistance, peacekeeper presence	Foreign military intervention

Results

Table 9. Summary of the FSI, the Global Food Security Index (GFSI) and malnourishment against estimated population						
Country	**FSI_{2012} rank** (Fund for Peace, 2012)	**$FSI\ CS_{2012}$ (composite score)**	**$GFSI_{2012}$ rank (1 = best score)**	**$GFSI_{2012}$ score (100 = best score)**	**Malnourishment prevalence[1]**	**Number of undernourished population**
Somalia	1	114.9	Not ranked	Not ranked	No data	data/Unknown
Congo (Democratic Republic)	2	111.2	105	18.4	39%	4.1 million
Sudan	3	109.4	96	27.6	22%	8.8 million
Chad	4	107.6	104	20.2	13%	0.5 million
Zimbabwe	5	106.3	Not ranked	Not ranked	57%	5.5 million
Afghanistan	6	106.0	Not ranked	Not ranked	30%	3.7 million
Haiti	7	104.9	102	24.5	No data	No data
Yemen	8	104.8	83	33.3	40%	1.7 million

Iraq	9	104.3	Not ranked	Not ranked	No data	No data
Central African Republic	10	103.8	Not ranked	Not ranked	14%	2.9 million

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[1] Taken from the UN Food and Agricultural Organization (FAO) "Hunger Statistics: 2006–2008".

Summary

Food equals health security; this quantitative analysis describes and unpacks the multiple components of health and economics in the framework of security. Owing to the complex interplay of economic issues, growing populations and consumption patterns, energy reallocation, natural resource depletion and geopolitical instability, the current state of global food security has led to a public health crisis. Famine results from human action and mistakes, and makes health security for affected populations difficult to achieve.

CHAPTER 6: Health security in war, conflict and complex emergencies

Introduction

The phrases 'human security' and 'health security' remain hotly debated. Many clinicians, epidemiologists, diplomats and policy makers refuse to observe the links between health, international affairs and health policy. This chapter brings together many published works with key definitions and core concepts.

Health security for all

This chapter is a significantly reduced version of the chapter published in the book *Health Security for all?*, as mentioned above. The description of health security as a state-only related issue with the emergence of biosecurity threats is discussed (i.e. anthrax, viral hemorrhagic fevers, prion disease, Yellow Fever, antibiotic resistance and many others). The Annex offers these details at length. In a globalized world, emerging and infectious diseases are a great threat to at-risk populations throughout the developed and developing worlds.

Table 10. Countries and associated morbidity and mortality selected (multiple years)									
Country	Country population (2010)	*Failed States Index 2010* rank (collective score)[2]	**Selected infectious diseases for the year 2010** Malaria[3]	TB[4]	Cholera[5]	Measles[6]	GDP (PPP) per capita (in US dollars ($)) 2009	Life expectancy at birth in years, both sexes[7] 2010	Neonatal mortality rate (per 1,000 live births)[8] 2010
Somalia	9,331,000	1 (113.4)	386,929	11,075	208	13	No data	51	53
Chad	11,227,000	2 (110.3)	182,415	8,411	67	165	610	48	46
Sudan (before North-South split)	43,552,000	3 (108.7)	2,686,822	26,001	13,681	68	1,294	59	37

[2] Foreign Policy and US Fund for Peace Annual Collaboration (2011). Update available at: http://www.foreignpolicy.com/failedstates and http://www.fundforpeace.org/global/?q=fsi. This index draws on some 130,000 publicly available sources to analyze 177 countries and rate them on 12 indicators of pressure on the state during the year 2010 (refugee flows to poverty, public services to security threats and health indicators). Taken together, a country's performance on this battery of indicators relates to stability.

[3] World Malaria Report 2010. Annex 7 A: Reported malaria cases and deaths, 2009. Geneva, World Health Organization, 2010. Available at: www.who.int/malaria/world_malaria_report_2010.

[4] The number of new and relapse TB cases diagnosed and treated in national TB control programs and notified to WHO. World Health Organization (2010) *Global tuberculosis control 2010*. Geneva. Available at: www.who.int/tb/publications/global_report/. Since production of the report, updated figures were received from some countries that may differ from the published figures in the report. The numbers shown are as of 24 January 2011. WHO regional, income group and global figures exclude territories and may differ from those figures in the publication.

[5] Cholera Annual Report (2009) *Weekly Epidemiological Record*, No. 31, 2010, 85:293–308. Available at: www.who.int/wer.

[6] Data provided by Member States through WHO/UNICEF Joint Reporting Form and WHO Regional offices. Geneva, World Health Organization (2010). Available at: www.who.int/immunization_monitoring/data/en/.

[7] World Health Organization (2011) *World Health Statistics*, ISBN 978 92 4 156419 9. Available at: http://www.who.int/whosis/whostat/EN_WHS2011_Full.pdf. World Health Organization (2011) *Mortality Data*. Geneva. Available at: www.who.int/healthinfo/statistics/mortality/en/.

[8] "National, regional and worldwide estimates of stillbirth rates in 2009 with trends since 1995: A systematic analysis", *The Lancet*, Volume 377, Issue 9774, pages 1319–1330, 16 April 2011, doi:10.1016/S0140-6736(10)62310-0.

Congo (D. R.)	67,758,000	4 (108.2)	92,855	9,765	93	1	160	55	36
Haiti	10,085,000	5 (108.0)	49,535	No data	16,111[9]	0	646	62	27
Zimbabwe	12,754,000	6 (107.9)	736,897	42,504	68,153	853	449	49	29
Afghanistan	32,358,000	7 (107.5)	386,929	25,417	662	2,861	485	48	53
Central African Republic	4,487,000	8 (105.0)	175,210	8,743	No data	11	454	48	45
Iraq	32,105,000	9 (104.8)	1	9,385	6	30,328	2,090	66	23
Cote d'Ivoire	21,395,000	10 (102.8)	1,847,367	22,571	5	183	1,106	50	39
Guinea	10,217,000	11 (102.5)	812,471	8,357	42	264	407	52	40
Pakistan	177,807,000	12 (102.3)	4,242,032	264,248	99[10]	863	955	63	42
Yemen	23,833,000	13 (100.3)	138,579	8,562	55	130	1,118	65	29
Sierra Leone	5,977,000	30 (92.1)	646,808	11,524	No data	31	341	49	49
Egypt	81,097,000	45 (86.8)	94	9,685	No data	608	2,270	71	11
Russia	142,914,000	82 (77.7)	107	126,227	No data	101	8,684	68	6
Belarus	9,468,000	83	No data	5,250	No data	0	5,075	70	5

[9] Estimated data from the CDC for 2010, available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5945a1.htm.
[10] Estimated data from 2010 by WHO, available at: http://www.who.int/csr/don/2010_10_25/en/index.html.

		(77.9)							
Turkey	73,722,000	104 (71.5)	84	16,757	No data	4	8,215	75	12
Ukraine	45,668,000	110 (69.0)	No data	36,075	No data	No data	2,468	68	7
Czech Republic	10,542,000	152 (42.4)	No data	638	No data	5	18,139	77	2
United States	316,042,000	158 (34.8)	No data	11,545	10	71	45,989	79	4
United Kingdom	62,300,000	159 (34.1)	No data	7,008	16	1,212	35,165	80	3
Sweden	9,471,000	175 (22.8)	No data	515	No data	3	43,654	81	2
Norway	4,976,000	176 (20.4)	No data	258	No data	2	79,089	81	2

The table above is not exhaustive by any means and only serves as a brief snapshot of selected health indicators as they relate to state fragility and failure. There have been significant discussions on which indicators should and should not be used to describe the public health and human security of populations. This chapter does not seek to establish any set of key public health data to indicate the health of a population, nor does it seek to back any one indicator for use in further research. The table above only seeks to bring into context the connection between political, social public health, economic and human security indicators and state failure and public health.

For example, there are significant controversies about using GDP (PPP) per capita as an indicator due to the wide range of wealth and human utilization. GDP (PPP) per capita is the GDP at PPP of countries per capita, or the gross sum value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of

fabricated assets or for depletion and degradation of natural resources (World Bank, 2011). It is often reported in current US dollars (USD).

Health security is achievable for the eight billion people on planet earth. Healthcare policies at national and international levels have exposed the many challenges and shortcomings of broad-based policy and have been met with mixed success. This chapter discusses health security as it relates to human security in the very dynamic health and security environment of the modern world. In the past decade, many people have been brought out of economic poverty with an increased quality of life while many remain left behind. In many regions and for many populations, life expectancies have increased as a result of improvements in prenatal, maternal and child healthcare, immunization campaigns, road traffic standards and trauma treatment and reduction, as well as access to rapidly expanding advancements in medicine. Conversely, other regions and communities have been left behind and the widening gap between the rich and the poor, spiraling healthcare costs, the commercialization of healthcare and the emergence of new pathogens have contributed to healthcare crises at a global level.

There are shortcomings in global health policy and approach. The deterioration of environmental support structures and relentless population growth contribute to the health security status of people globally and render sustainable healthcare for all an extremely challenging goal. This chapter discusses the present global situation of health security and offers potential solutions that the governments of rich and poor countries can pursue to achieve health security for all. The conventional model of health-related support and aid has fallen short in the past century and requires significant reform in order to provide health security. Different problems are not solved by one solution. Although potential solutions for developing countries are very different, only a coordinated, cooperative approach promises a chance of success in the long term.

Evidence-based public health practice has recently progressed significantly and offers exponentially growing standards and best practices relating to human security and healthcare outcomes. Public health has been challenged with a deteriorating human security situation

due to the advent of growing small-scale and low-intensity conflict and war, emerging and reemerging infectious diseases and communicable diseases and quickly growing NCDs across cultures, socio-economic classes and countries. The main assumption that must be made, understood and accepted is that all people on the planet deserve access to public health and primary healthcare resources, basic medical standards and human security. These concepts are basic human rights that must be protected.

Timor-Leste: Describing the links between health security and prevention

The interdisciplinary chapter "Fragile States, Infectious Disease and Health Security: The case for Timor-Leste" in the *Journal of Human Security* (April 2014) describes the links between human and health security and state stability. This section of this chapter is a very brief synopsis of how health and prevention can lead to a more stable state and how this can, in turn, add to health security for citizens. Timor-Leste is a very young and developing nation state. Endemic infectious diseases and weakened health security, coupled with its growing and inclusive public institutions, keep Timor-Leste fragile and in transition on the spectrum of state stability. The objective here is to systematically review Timor-Leste's state and public health successes, showing how a fragile state can consistently improve its status on the continuum of stability and improve health security for the population.

The study uses a state case study approach, together with a disease burden review and a basic description of a health portrait in relation to Timor-Leste's fragile state status. Disease burden and health security are directly proportional to state stability and indirectly proportional to state failure. Timor-Leste is a clear example of how public health can feed into increased state stability. Our discussion attempts to describe how the weak and fragile island nation of Timor-Leste can continue on its current path of transition to state stability by increasing health security for its citizens.

We surmise that this can be realized when public policy focuses on primary healthcare access, inclusive state institutions, basic hygiene and preventative vaccination programs. Based on our review, the core findings indicate that, by increasing health security, a positive

feedback loop of state stability follows. The use of Timor-Leste as a case study better describes the connection between public health and health security, as well as state stability, development and inclusive state institutions that promote health security.

The broad and relatively new concepts found in interdisciplinary literature on the global public health debate regarding health security, human security, economic security, sustainable development and fragile and failed states remain elusive. 'Sustainable' means to be upheld and maintained at a certain level. A sustainable model in healthcare is one that receives input, possibly from the state and other stakeholders, provides a service and standard of care and is ready and able to continually provide that service in a cycle system with inputs, outputs and health security offered at a certain level for patients or end users.

Again, there are very few universally agreed-upon definitions; these concepts are hotly debated, inconsistent, disputed and pose difficulties in terms of offering accurate descriptions for discussion across disciplines. For the purposes of this paper and in order to remain within the framework of the current global public health debate, we define health security as the access to essential health services and protection from environmental and behavioral risks that diminish public health (Ng and Ruger, 2011; Labonté and Gagnon, 2010). This definition frames health security as an aspect of human security, which includes core features such as freedom from want "and access to lifesaving clinical and public health interventions" (Kent, 2005).

Health security and human security converge in terms of definitions as the adequate access to healthcare resources. This is grounded in community-based primary healthcare and basic hygiene access, and emphasizes the protection of populations against external and internal threats of conflict and structural violence. Health and human security protect against oppressive state regimes, failing state systems and failing extractive state institutions. They also protect against infectious diseases and pandemics and, in general, provide the most basic in public health and collective security. Structural violence is a set of systemic sociopolitical, economic, legal, religious and cultural norms that harm, disadvantage and limit individuals, groups and societies from reaching their full potential (Galtung, 1969; 1971). Structural

violence is often embedded in long-standing ubiquitous social structures, normalized by exclusive state institutions (Gilligan, 1997).

The relationship between health security and state stability is directionally proportional. As health security increases across a population and state, the stability of the state is bolstered (even if only temporarily) and this feeds into a positive feedback loop to further strengthen the state's institutional capacity and stability, which must be embedded in inclusive state institutions for its citizens. What we see when looking into the recent past of Timor-Leste is an improvement in its health security, even if only slightly, against other states in the region, although it is still highly dependent upon aid and external support. This leads to state stability in a positive feedback loop, gaining traction to further strengthen the state's stability and subsequent health security.

This case study concludes that the state is the final *de facto* vassal to offer inclusive institutions that can engender an environment of health security. Corrupt states with corrupt and exclusive state institutions reduce health and human security and may isolate subgroups in the community and society. The private and philanthropic sectors do not offer a sustainable and equitable solution that provides basic healthcare programming and infrastructure; however, a stable state with inclusive democratic practices for its population can offer health security. Health security has evolved over time so that it encompasses many entities that make up the present nexus of health and security.

The UN, WHO, the APEC and the EU approach the definition of health security through the following specific areas: emerging diseases; global infectious diseases; deliberate release of chemical and biological materials; violence, conflict, and humanitarian emergencies; natural disasters and environmental change; and radioactive accidents (Aldis, 2008; Chiu et al., 2007; Macrae, 1998). Environmental degradation may pose the largest threat to health security at present and in the future; it is a cross-cutting theme throughout global human, food, economic and health security.

Global infectious diseases are those that are transmissible and communicable between people due to the presence and growth of a pathogen; examples include bacteria, fungi, parasites or a virus that causes an infection (National Institutes of Health (US)). Communicable diseases differ from NCDs, which are not transmissible from person to person via any vector or pathogen; NCDs are far more numerous and are related to the environment, social behavior and economics.

Due to poorly understood economic stressors and other unidentified factors, NCDs are breaking out in the least developed and in developing nations, where communicable disease incidence and prevalence previously dominated the risk profile. It is true that infectious and communicable diseases are truly global, given the porous nature of state borders and the increasing movement of people globally. Infectious diseases are no longer limited to the tropics, and cardiovascular disease (once encountered only in the developed world) is no longer unseen in developing nation states; it is its own epidemic. Examples of NCDs include hypertension, obesity, diabetes and cancer (although some cancer/malignancies are found to be caused or otherwise contributed to by viral strains).

NCDs are not the focus of this case study, as the direct link with state fragility or failure is not as clear. With this, it is understood that the incidence of trauma and trauma-related injuries and death, classified as NCDs, is indeed higher in regions and states characterized by fragility and instability. Trauma-related morbidity and mortality might be significant in fragile and failed states, and may influence health security and subsequent state stability over time. There are many factors that may contribute to trauma morbidity, such as the age of the population, health and safety standards and practices, state infrastructure, violence, access to munitions and gender-based intuitional violence.

However, this paper focuses on infectious diseases, basic public health structure and institutions, and the link between these factors and state stability. The present literature does not offer a clear causal link between infectious diseases and state fragility or failure, and increased infectious disease does not necessarily lead to violence or state collapse (Kasper, 2010, p. 208). The provision of adequate health security by a state to its population is the

first line of defense against public health emergencies and is a core component in providing human security at the most basic levels. This holds true even though global policy makers and public health professionals do not always agree on accepted definitions.

As described earlier in this thesis, the FSI will not predict future human conflict or state failure, but it can better describe state fragility and help focus attention on fragile and failing states for immediate aid and intervention in an effort to prevent state catastrophe and decreasing health security. The continued strengthening of government accountability and transparency and refocusing on the public health sector are key components of public policy that promote stability. An extremely young state, Timor-Leste, for example, has struggled to maintain unity in government while fighting greater structural weaknesses, including corruption, political polarization and dependence on foreign aid.

One new policy tool can be found with the G7+ (please see for more details: http://www.g7plus.org/), which offers a platform for fragile and failed states to promote stability through organically constructed institutions and public policy. Increasing health security will continue to guide Timor-Leste from fragile to stable statehood. A reinforced public health policy of primary healthcare access, immunizations and increased overall vaccination coverage for the under-five-year-old population may increase health security significantly. Timor-Leste clearly illustrates the link between public health institutions and health security and state stability and development. Lessons learned from Timor-Leste's still complex transition from a post-conflict state to a successful nation can provide international leadership with an example of which it should take note.

Endemic infectious diseases, decreased health security and weak but growing public institutions keep Timor-Leste fragile, while new investment and economic prospects – when handled properly and with efficient and appropriate public health policy – may engender state stability and help to avoid state failure. Health security is directly linked to state security. Public health policy must be implemented in order to prop up the state's fledgling public health sector and still growing democratic institutions. Increasing health security through public health can push Timor-Leste out of fragility and engender sustainable

economic growth, development and, consequently, true statehood. A further example with different variables yet similar challenges with conflict and health can be found in Ukraine.

Health security in Ukraine: Short portrait

The simple numbers put forward in many UN and WHO reports and reiterated by multiple humanitarian and non-regulatory parties – such as the Organization for Security and Co-operation in Europe (OSCE) and the International Committee of the Red Cross (ICRC) – put just over 5.5 to 6 million people living in violence-affected areas. There have been at least 6,300 reported killed and over 17,100 wounded in eastern Ukraine as of 15 February (The Office of the United Nations High Commisioner for Human Rights (OHCHR)/WHO, 2015). The UN Human Rights Monitoring Mission in Ukraine (HRMU) and WHO estimates are based on available official data. Some preliminary mortality totals include: Ukrainian casualties estimated 9,700, including 298 people from flight MH-17 as reported by civil medical authorities (OHCHR/WHO, 2015). However, OHCHR and WHO also report that actual fatality numbers may be considerably higher and totals from 2016 are under contention.

Limited food supplies exacerbate poor medical outcomes and contribute to morbidity and mortality, in addition to direct Russian mortar and Grad rocket attacks – the prognosis is poor. Indeed, NCDs for an aging population throughout Eastern Ukraine are a major public health risk and a concern when not at war, let alone with a breakdown of public services (Luck et al., 2014). Access to pharmaceuticals for diabetes, hypertension and cardiovascular disease in many areas of Luhansk and Donetsk has been entirely disrupted and, in most cases, is non-existent.

As with a majority of human conflict, doctors are seen as pillars in the community, offering not only health promotion but also hope and stability. Health professionals serve as soft targets in war (Quinn et al., 2011). Violence against healthcare workers during the main street protests in 2014 reports a case of police throwing grenades into a makeshift field hospital where medical staff were treating people (Holt, 2014).

Humanitarian financial crisis

Financial concerns at the Ministry of Health and many other systems serving health security for the Ukrainians have exacerbated this. The internal rot of corrupt procurement systems and failed leadership has led to institutional demise due to criminal incompetence. Reforming Ukraine's healthcare delivery system from a Soviet-based secondary care focus to a primary care focus in order to tackle the mortality and morbidity crisis will take decades and steady accountable and transparent leadership (Hankivsky and Vorobyova, 2014).

Infectious disease: Old threats and new risk

Ukraine is not an endemic zone for infectious disease. However, access to essential vaccines for flu and pediatric routine vaccinations such as polio, tetanus and (in some areas) measles are at very low levels or off the shelf altogether, with local bureaucracy acting as a barrier and limiting access in primary healthcare settings. The Ukrainian health system was weak before the crisis and is now completely collapsing in fighting areas and areas with high internally displaced people (IDP) load or in any region requiring surge capacity and resilience to shock or disruption in service delivery due to the security fallout.

The average vaccination coverage in the country is well under 50%. In some regions and communities, most of the children have not been vaccinated at all during the past months. Therefore, outbreaks of polio and measles are likely. About 30% to 70% of healthcare workers have fled the fighting areas or died, so healthcare has broken down and no supplies are available to refill stocks.

As access to Luhansk and parts of Donetsk is not verified, and due to the recent law that limits Ukraine's support to the Donbass regions, many in these areas are deprived in terms of healthcare and health services. Reports about civilian casualties from Debaltseve are still pending. Mortality and morbidity associated with this conflict are still being tallied: over 10,000 have died thus far (Porter, 2015).

The HIV/AIDS epidemic in Ukraine is one of the fastest growing in the world. Moreover, according to WHO, Ukraine is among the 27 high multidrug-resistant tuberculosis (MDR-

TB) burden countries in the world. Despite the adoption of the Stop TB Strategy by the national TB program (NTP), its components have not been sufficiently implemented. Financing of TB control activities mainly depends on the commitment and capacity of the oblast health administrations. Laboratory capacity is limited and case detection efforts mainly focus on mass screenings of the general population.

Priority is given to hospital-based treatment; appropriate treatment depends on the local capacity to purchase the drugs. The provision of directly observed therapy (DOT) is lacking and patient support is limited. MDR-TB control activities are inadequate, as are efforts to address TB/HIV co-infection. There is a lack of anti-TB drugs in the country due to inadequate drug supply management and problems with the procurement of quality-assured drugs. The recording and reporting system is suboptimal, and the expansion of the application software for a nominal electronic database is slow.

Lastly, the WHO-led humanitarian response website aims to streamline information sharing among the humanitarian community in Ukraine. It is easy to navigate and provides useful overviews of contacts, events/meetings, key documents, maps and infographics, statistics and other operational data to mitigate the duplication of services offered, to focus on the areas of greatest need and to help communication with governmental agencies and humanitarian actors. Economic decline may persist with uncertainty and instability (Mankoff and Kuchins, 2015).

Summary

Humanitarian crises are politically and socially charged. The framework of human security and state stability is equally, if not more so, controversial. As actors, donors and organizations move in to help with any catastrophe and disaster or crisis, duplication of services can ensue with poor clinical and public health outcomes. The humanitarian disaster in Ukraine requires fast support and stakeholder involvement in order to mitigate preventable death for at-risk populations. This chapter of the thesis has described, in detail,

the relationship between conflict and disaster, human and health security and state stability. The continuum of state stability is directly linked to health security.

CHAPTER 7: Primary prevention in disaster, war, conflict and complex emergencies

Introduction

The cornerstone of hygiene and epidemiological study is data and the prevention of disease through three major modalities.

(1) **Primary prevention**: This is averting the disease before it occurs. The bulwarks of primary prevention are immunization through vaccination. Vaccinations are antigenic substances prepared from the causative agent of a disease or a synthetic substitute used to provide immunity against one or several diseases (OED, 2016). In global public health, vaccination programs are the bulwarks that enable healthy communities to thrive.

(2) **Secondary prevention**: This is detecting disease and disease processes to avoid complications and sequelae. For example, a routine cervical smear pap test screens for cervical cancer. Ethically, a secondary prevention measure should be performed when adequate resources exist to definitively treat the potential disease found in a screening test.

(3) **Tertiary prevention**: After the disease is diagnosed and treated, tertiary prevention mitigates further sequelae, poor outcomes and disease recurrence. For example, after patients are treated for malaria, significant education must be provided to show the benefits of insecticide-treated bed nets, malaria prophylaxis and pharmacological prophylaxis. There also should be other region-specific education to avoid malaria infection.

These core principles in hygiene and epidemiology practice are the cornerstone of public policy and practice. For the purposes of this thesis, Chapter 9 in *Human Health and Ecological Integrity* (entitled "Public health and primary prevention: Past and present opportunities and barriers") serves as a core review of how these principles affect policy, health and human security. However, a presentation that formed the interlude of the papers discussed below included the abstract *Student Scientific Conference, First Faculty of Medicine* (10 May 2012), "Public Health Crisis in War and Conflict: Failed states and health security". This presentation helped layout much of the details that are unpacked below.

Background

The key pitfall of contemporary medicine is the rapidly growing financial demand on public health policy to deliver best medical practices and outcomes through state-of-the-art diagnostic techniques, modern medications and reducing barriers to care via access to primary healthcare physicians and medical specialties. Regardless of funding, guaranteeing best medical practice and outcomes across healthcare systems remains challenging for many developed countries. The unquestionable effectiveness of previous and current public healthcare is directly reflected in the gradual extension of life expectancy and quality of life, the relative containment of preventable illnesses and the education of the general population regarding the prevention of these illnesses.

Efforts to educate patients in primary prevention – i.e. the prevention of the disease before it occurs – were neglected due to rapid growth in financial expenditure in healthcare. In the future, useful investment in primary healthcare prevention must multiply exponentially across global healthcare systems to guarantee continued progress in disease elimination, an increase in the prevention of illness and to guarantee quality of life. However, as financial crisis and economic uncertainty prevail, the public policy debate will discount prevention and more conservative policy practices will prevail.

The dismissal of primary prevention moves focus from the elimination of disease before it occurs to treating the loudest diseases and illnesses in a society after people are affected and suffering. Furthermore, the equity of care can be brought into balance between the least developed nations and the developing nations through the prevention of diseases – i.e. not relying on costly prompt diagnostic and highly compliant treatment measures. The role of public health policy in primary healthcare prevention and the role of cost effectiveness in the delivery of healthcare and in human health and quality of life are very clear (Walls et al., 2008; Wong et al., 2009; Goetzel, 2009; Roper, 1992; Pickett, 2006).

The present global paradox is that resources and finance in public policy are difficult to maintain at the local and national levels across the developed world for primary prevention in healthcare delivery. This paradox is likely to get worse due to: all governmental and healthcare budgets forced to move focus away from prevention and towards core services dictated by a financial and budgetary crisis; an aging population in the developed world and a growing population in the developing world; the great costs associated with chronic illness and disease; and the negative health effects of geopolitical and social and economic change throughout the world. Indeed, it is very costly and getting more expensive to treat preventable illnesses associated with chronic and acute disease.

Thus, it is overwhelmingly more cost-effective to invest in primary healthcare delivery strategies and prevent illness than it is to treat sick patients. However, curative medicine is far more noticeable than when the prevention of the disease succeeds; there is little obvious or visual benefit in the latter and supporting such preventative measures in the absence of a disease catastrophe is politically and financially difficult. This inability to properly assess disease risk unless people are already sick by policy makers and the public creates obstacles in supporting public health prevention programs. The challenge of 21st-century medicine is the prevention of diseases: primary prevention as an essential contribution to improvement in the quality of life for current and future generations.

Primary prevention, hygiene and epidemiology, and public health

Hygiene and epidemiology are the biomedical branches of medicine dealing with the primary prevention of disease and illness (i.e. the prevention of diseases as the primary goal and the mitigation of disease spread – infectious, non-communicable, chronic and acute). Other preventative healthcare feats, such as the provision of safe drinking water, public health culture, food and water quality standards and the management of vaccination programs, have been seen across European hygiene and epidemiology societies and institutes with significant success. The most significant work of epidemiology throughout time has been disease prevention among communities and regional populations.

The overwhelming results of these activities achieved a dramatic reduction in morbidity and related human population mortality at the turn of the 19th and the 20th centuries and enabled economic stability and growth throughout Europe. Vaccination is one of the most successful public health initiatives for the betterment of global public health and healthcare systems, with successful immunization programs improving the health of populations by preventing vaccine-preventable diseases (CDC, 1999; Stern, 2005; Orstein, 2005). Indeed, prevention outweighs any risk of invasive treatment and acts as a cure to disease.

In public health, the aim of primary prevention is to reduce the incidence of disease and injury by removing the cause of the disease; primary prevention generally involves the prevention of diseases and conditions before their onset takes root (Last et al., 2008). Primary prevention can be done in a variety of ways, such as preventing environmental exposure, improving human resistance to the disease and through patient education in order to diminish high-risk behavior.

In large public health policy arenas, primary prevention programming may include general environmental and sanitary measures, such as maintaining safe drinking water and balanced food supplies, promoting the use of condoms to prevent sexually transmitted diseases and unwanted pregnancies, the use of seat belts and the presence of supplemental restraint systems in automobiles (airbags), and the application of safe and effective vaccines. In

primary healthcare settings, primary prevention – as treatment that maximizes healthcare outcomes in both the developed and the developing worlds – seek behavioral changes and medical compliance in terms of lifestyle, as seen in cardiovascular disease prevention, hypertension screening and diabetic care (Mayes, 2011). Furthermore, primary care is charged with early screening for – and preventing – malignant neoplasm, such as osteoporosis, neurodegenerative diseases associated with aging and even dental caries that include periodontal disease, all of which directly affect quality of life (Bencko, 2011).

Primary prevention is significant in public health programming as it is at the forefront of public policy on limiting disease, encouraging and engendering best practices in medicine and maximizing healthcare outcomes for patients and populations. Primary prevention differs from secondary and tertiary prevention, as the aim of secondary prevention is to detect and correct poor and at-risk behavior as early as possible and tertiary prevention seeks to minimize the extent of the disease and limit disease recurrence. Secondary prevention reduces the prevalence of the disease and overall population disability. Most modes of preventive health screening are examples of secondary prevention.

Screening at-risk patient populations for high blood pressure (which may indicate clinical hypertension) and screening for early breast cancer using mammography and self-examined educational materials are some of the basic secondary prevention measures in use today by many primary care clinics. One variation of secondary prevention is to screen for conditions that might be clinically evident but have gone undetected, such as clinical depression or other mental illnesses (Wallace, 1998; 2010). Tertiary prevention in established illness includes attempts to limit consequent disability and interventions that remove or reduce the recurrence or relapse of the disease (Jones, 2005).

In the Czech Republic, the introduction of major health and political reforms – characterized by the expansion of a market economy, the privatization of government services and democratization and decentralization – have created a turbulent and uncertain environment for the development and management of health services (Holcik and Koupilova, 2000; Bencko, 2007). Some of these changes in the political and social economies are also seen as

opportunities for public health policy formation and implementation. However, despite the best efforts of the public health community and advances in the prevention of disease, there remains significant environmental health issues, communicable diseases and NCDs, such as HIV/AIDS, Hepatitis C, malaria, emerging viral infections and elusive prion particle-related disease. There are constantly growing problems with antimicrobial resistance to standard antibiotic treatment in hospital-acquired infections (nosocomial infections), causing significant morbidity and mortality among at-risk populations.

Prevention or precaution

The public health community struggles with the obesity epidemic brought on by many risk factors and societal issues, including access to food and caloric intake, caloric expenditure and sedentary lifestyle, and a change from an agriculture and agrarian standard of living to a majority urban and city-based one. All of these factors have a direct effect on metabolism, consumption and environmental factors affecting health. Obesity is a major condition that is almost absolutely preventable through patient education and behavior modification.

Additionally, the increasing incidence of malignant neoplasm, a cancer associated with the aging of our population, is on the rise across populations and is seldom discussed in the primary healthcare and public policy debate. The number one uncontrollable risk factor for cancer is age, with genetics and heredity being uncontrollable and contributable. Other lifestyle factors – such as smoking, excessive alcohol consumption (especially spirits or hard alcohol), and high-risk eating habits that include a diet of concentrated fats, smoked meat, a lack of vegetables or fruit and inconsistent meal times – are also found to be risk factors. It is clear that patient health is directly proportional to diet; primary prevention seeks to educate populations and promote health.

The basic issue in current nutritional epidemiology is whether the increased incidence of chronic diseases, including the above-mentioned malignant neoplasm, is the result of something that is contained in the diet in excess or is a manifestation of other external,

uncontrolled causes. In order to address multifactorial disease, it is paramount to apply the basic principles of evidence-based medicine.

As an example, we can use methods of randomization in multicenter studies involving thousands of cases and the corresponding number of controls subjected to genetic analysis in the detection of the protective action of cruciferous plants, cabbage and many other vegetables and fruits against cancer and lung and kidney malignancies. It is therefore desirable to consume a varied diet to dilute the potential risk of uncontrolled flow of potentially harmful contaminants by any food borne disease. This balanced diet is greatly influenced by food cost and the price in local markets. The cost of food for communities is related to climate change and ecological integrity, as it relates to crop yields and access for consumers. Markets that provide cheap and unhealthy food will have less healthy consumers than markets where healthy food is not only abundant but also cost-effective.

An essential part of that context can be communicated through many public policy outlets and the programming of continuous physical activity. This message has been discussed *ad nauseum* through primary healthcare communities, the public health medical community and many other community outlets; the core concepts here of primary prevention are patient education and seeking to adjust the disease burden of obesity before the disease hits the patient. The public health and policy considerations for lifestyle changes remain major obstacles (in terms of population health) for the preventive medicine field to continue to approach and engage for greatly needed change in both the developed and the developing worlds.

Current difficulties in primary prevention funding and policy

The key pitfall of the current market-oriented medical approach – which is undoubtedly successful in secondary prevention (i.e. in early diagnosis and rational treatment) – is the rapidly growing financial demands of modern diagnostic techniques, medical liability and costly research and development for prescription pharmaceuticals. The unquestionable effectiveness is reflected in the significant extension of life expectancy in the Czech

Republic, especially during the past two decades, mainly as a result of the widespread application of modern methods of interventional cardiology and the introduction of broad-spectrum chemotherapy in routine clinical practice. As already mentioned, the current treatment modalities in terms of financial costs are always challenging; thus, efforts in primary prevention public health programming (such as the prevention of diseases before they occur in populations) are not useful for greater health impact – but why?

Healthcare economics is the economic aspects of healthcare, its planning and delivery (which includes government agencies and organizations in the public and private sector). In Europe, healthcare economic research helps drive where resources are placed in the healthcare sector in order to maximize best medical outcomes for patients at the lowest risk and best cost. Undoubtedly, investment in primary prevention is a good thing and is only needed more with the application of evidence-based medical practices in order to help formulate solid healthcare policy and finance. Primary prevention is a potential frontline of all illness healthcare expenditures for any government, hospital or directorate in charge of population health.

As a recent example, we may consider the Mexican or swine flu outbreak in spring 2009. As proven, the risk of death was similar to the previous 'seasonal flu' and depended strongly on the social situation and level of healthcare in a particular society. This can be very clearly demonstrated by the dramatically different levels associated with the incidence of mortality in Mexico and the US. In Mexico, 72 patients of 3,648 confirmed cases died in the initial phase of the epidemic, while 6 died in the US from a total of 5,469 laboratory-confirmed cases. Equity in medical care and access to medicine is an issue across borders.

The basic question of Roman law was *cui bono*, i.e. who benefits in this matter? There is abundant evidence that, in an emergency or epidemic situation, the need for rapid assistance and support is key to successful outcomes. And with any rapid and emergency response, there is a significant human and material cost associated with the logistics, staffing, expertise and medical supply to mitigate as much suffering as possible. When applying healthcare economic principles to an epidemic or outbreak, the government and/or the ministry will

spend any emergency resource or funds available to get the at-risk populations the needed medicines, medical staff and support to combat the outbreak.

However, as noted earlier in this section regarding the benefits and shortfalls of the precautionary principle, one may be worried about the poor or even counterproductive outcomes of exaggerated vaccination campaigns. Such superfluous campaigns may reduce vaccination compliance of a population across age groups and at-risk patient groups. This can be seen in much of the developing world, with poor compliance with vaccines for measles, mumps and rubella (the MMR vaccine) and even polio due to cultural or religious values that claim vaccines cause illness and other diseases or otherwise hurt the recipients.

No medical intervention is devoid of risk or sequel; vaccines are no different. The potential for flu-like symptoms and other minor medical side effects of vaccines are real; however, the potential of getting a life-threatening disease such as measles, mumps or rubella is also real for those children who do not receive the vaccine. This is observed in many developing countries that have seen a decrease in herd immunity for measles due to many parents and caregivers not allowing their children to get the vaccine within the first two years of life. There were measles outbreaks in sub-Saharan Africa, Asia and even at a college campus in North America.

The basic vaccine schedule for children, as dictated by WHO's Expanded Program for Immunization (EPI), is clear. Compliance with the EPI, however, is not 100% across populations (desired herd immunity target for many childhood illnesses is between 90% to 95%). The need to have large and comprehensive herd immunity for many childhood preventable illnesses is greatly apparent. However, the current epidemiologically desirable vaccination coverage in terms of common 'child' infections is well below these needed targets in many populations, leading to an easier spread of infection throughout the at-risk population. The paradox of the current global vaccine schedules, as directed by regional and local governments, is that the cost of the vaccine is cheaper than the cost of treatment. In sum, it is cheaper to vaccinate than to treat.

This cost–benefit analysis in vaccine implementation is not new to public health or in the drafting of public health policy and its debate. Public health officials consider vaccine expenditure money well spent for the betterment of health and society, whereas other stakeholders in the decision-making process may not see the direct cost–benefit so clearly. In contrast to curative medicine, both the cost–benefit structure of public health (i.e. costs now, benefits later) make economic analysis difficult – vaccines can save many lives but are greatly undervalued and unnoticed by the general public and policy makers.

In an effort to mitigate this chasm in the public health policy debate (i.e. between budgetary restraints and medical need), three economic concepts are applied to healthcare interventions in primary prevention: cost–benefit analysis, cost-effectiveness analysis and cost–utility analysis (Meltzer, 2011). Cost–benefit analysis includes all costs and benefits that would be included in a vaccination campaign; it is helpful in deciding the cost to vaccinate or to treat the disease once infected. Cost-effectiveness analysis takes into account the costs and savings that are associated with medical intervention, as it relates to lives saved or the number of people who do not get infected with a disease because they are vaccinated.

Lastly, cost–utility analysis assesses health outcomes in terms of survival and quality of life. The application of the above three economic principles is what drives health policy at many levels. The major shortcoming to such an analysis is that it saves money but not necessarily lives. It is easy to make the case that a vaccine campaign would not be effective enough to be paid for in a given community, but that does not evaluate the individual and the quality of life of anyone who gets a disease that was preventable through a vaccine. Unless otherwise noted, public health proponents usually endorse vaccination programs for endemic diseases preventable through vaccination with some level of efficiency.

Evidence-based medicine and primary prevention

Evidence-based medical practice is the integration of clinical experience and best available medical evidence to best serve patients (Sackett et al., 1996). The emphasis in clinical practice settings with evidence-based medicine is that clinical experience and the new data

made available through peer-reviewed literature and other double-blinded and advanced clinical research must be integrated in clinical decision making. This integration is the art of medicine.

In public health practice and public health policy formation and implementation, this is the same. Even in trying to prevent diseases, this uncompromisingly demanding requirement of contemporary evidence-based medicine applies to public health practice. Proposed projects and/or prevention programs must be based on the results of biomedical research and public health experience confirmed in clinical practice. It is an extremely demanding requirement but evidence-based medicines' aim and primary goal is to maximize medical outcomes and encourage best practices in medicine, public health practice and primary prevention. With advances in the biomedical, societal, economic and public policy fields, evidence-based practice in public health is a legitimate requirement.

Since the mid-20th century, many public health and medical professionals have paid heed to the negative impact of various environmental factors within the social environmental context. Put plainly, this research focus looks at attempts to draw causal relationships between the quality of the environment and related risk factors and that of their effects on public health – namely, climate change, water access, food security and rising sea levels.

In sum, evidence-based practice in public health and primary prevention must rely on solid data regarding the ecological integrity of the planet and how it affects public health across populations. The present evidence in the literature overwhelmingly supports the hypothesis that neglecting to respect ecological integrity and the resulting environmental degradation leads to deterioration in public health (Soskolne and Bertolini, 1999; Ladd and Soskolne, 2008). Primary prevention must focus on the impact of the degradation of the environment on human health and how human action leading to such degradation represents a serious danger for the right to health of unborn and future generations (Westra, 2006).

Steps forward: Primary prevention and public health

One of the strategic challenges of 21st-century medicine is the prevention of disease; primary prevention has a major contribution in reducing healthcare costs, maximizing healthcare outcomes with limited resources and, finally, improving quality of life now and for future generations. Public health policies' main contributions to human disease have been in the prevention and elimination of disease. Healthcare economic principles applied to public policy seek to engender a culture of maximizing healthcare outcomes through the most cost-effective program with the best community benefit. Finally, primary prevention in medicine will lead to a reduction in preventable disease onset and must be invested in with resource capital and political and policy-based support in order to minimize preventable harm and save lives. It is better to prevent illness and suffering than to treat it.

Primary prevention in public health is tantamount to the success and progress of societies across the globe. However, for short-term political and social goals made by politicians, it is difficult to receive significant funding for primary prevention plans and policy when benefits are poorly realized in the short term. An emphasis on primary prevention is needed for public health policy to succeed in the long term.

Economics of health

This last section and paper highlights the role of funding in global health policy and where certain shortcomings can lead to mortality and morbidity. The 2014 paper entitled "Vaccination: Public health prevention strategies in times of financial austerity" (published in *Advances in Research*) is a simple review of these issues faced by many fragile and stable countries. This paper briefly and anecdotally discusses the current reality and future requirements across nations to invest in public health prevention strategies so as to ensure global health.

Many novel public health campaigns have been under way and much of the research literature to date explores the myriad modalities that promote global health in the context of human and health security. We propose that a back-to-basics approach may benefit states

and health policy. In light of the long-term emergency that is financial austerity for many nation-states (with regional conflict displacing millions), prevention may be the best option for public health institutions to maximize medical outcomes. Disease prevention and the exploding NCD wave hitting both the developed and developing worlds are also commented on. This section makes the case for the prevention of disease and emphasizes the benefits of vaccination.

The financial crisis (created through global market manipulation and speculation) negatively impacts disease prevention strategies across global health and health security programming. Vaccination and the primary prevention of disease, which are methods aimed at the elimination of a disease before it infects, remain the most cost-effective and low-tech approaches to reaching global health security for billions of people. This is especially true in times of economic austerity and limited financial resources for ministries of health, governments and international aid programs. Our methods are a simple review of some of the challenges in treatment that developing nations face due to increasing disease burden, and how primary prevention may be a cheaper alternative.

A strategic challenge for 21st-century medicine is the prevention of illness and the promotion and maintenance of health among an increasingly vulnerable global population. Primary prevention is the best vehicle to achieve this. It is a major contributor to reducing healthcare costs, maximizing healthcare outcomes with limited resources, and improving quality of life. The main contribution of public health policy with respect to human health has been preventing and eliminating disease and premature mortality. Economic principles applied to public health policy seek to engender a culture of maximizing healthcare outcomes as cost-effectively as possible with the greatest community benefit.

For primary prevention regimes to effectively reduce preventable diseases and promote health, public health must be provided with adequate financial and physical resources, along with political and policy-based support, to meet the challenge. Both public healthcare and therapeutic medicine are complementary components required to maintain human health; thus, they should not have to compete for resources.

However, we are facing a resource and fiscal crunch and competition is inevitable. Even though the evidence is clear that primary prevention is the most cost-effective healthcare process in terms of ensuring population health, it is hard to compete with the dramatic and immediate effects of therapeutic medicine. This is especially so when policy makers and stakeholders focus almost exclusively on short-term political and social goals. The true economic benefits and health successes of primary prevention are hard to document when 'nothing happens' (for instance, when pandemics and major disease burdens are averted). A concerted emphasis on primary prevention is needed for all public health policy to succeed in the long-term in support of sustainable health.

Summary

This non-exhaustive section of the thesis unpacks how elements of primary prevention can be applied to public health policy in order to mitigate state failure and to promote health. The overriding principles of global health programming support the application of the evidence-based practice of prevention medicine to public health policy. In applying primary and secondary prevention to global health and affairs, it is postulated and backed up by the data above that better health outcomes for populations are generated. In the next section, we describe health risk in terms of migration in war and state failure.

Public health crisis: The need for primary prevention in failed and fragile states

A new 'normal' in global affairs may be erupting; there is a shift from large global powers to non-state actors and proxies committing violence through scaled conflict in a post-Westphalian world, generating significant global health policy challenges. The health security of populations is multifactorial and indirectly proportional to war, conflict and disaster. Preventing conflict and avoiding the health vacuum that occurs in war and violence may be best practices for policy makers. This chapter considers the approach of applying clinical primary prevention principles to global health policy.

The methodology for this topic included a brief policy review of current standards and practices in health security, fragile and failed states and prevention. It also included a definitions discussion. A short case study series is presented with best practices, including a risk and outcome review. Our findings were distinct and found that the global balance of power and order may be shifting through geopolitical transference and inadequate action by major global power brokers. Health security in at-risk nation-states may be decreasing as a result.

As discussed, small-scale conflict with large-scale violence threatens health security, and fragile and failed states may experience increased incidence and prevalence. Preventative policy as a means to resuscitate fragile and failed states and prevent further external and internal shocks may support health and promote a positive feedback loop of state stability and increased health security. In conclusion, the public health policy move to mitigate state failure and public health crisis in war and conflict through primary prevention may provide best practices and maximize health security for at-risk populations.

Introduction

Violence, trauma, war and conflict decrease health security for communities. However, identifying links and determining causation remains a major challenge in the literature. Empirical studies focusing on direct retrospective data of states and the health of populations may offer a novel approach to the war and health challenge. Aggregate research has shown that health security diminishes in war, conflict and failed and fragile states (Quinn, Zeleny and Bencko, 2015). This article discusses ways to reverse some of the decline and focuses on the case of failed and fragile states.

While there is no universally agreed-upon definition of state failure, fragility and collapse, some indices and criteria have been proposed by global institutions, governments and academics (Messer, 2005). Some of these overlap but do not align, feeding controversies over the meaning and exact parameters of state failure (Kraxberger, 2007; Patrick, 2007). For the purposes of this chapter, we define as 'failed' those states that have lost the ability to

provide the most basic of services to their constituencies, and 'fragile' as those that are on the brink of losing such an ability (Quinn et al., 2013; Quinn and Bencko, 2013). Such services include functioning infrastructure and institutions that are expected to provide primary health services and prevention programs, along with key infrastructure that engenders health for the population.

The health security of populations living in fragile states requires access to primary healthcare services that deliver disease and injury prevention, not just emergency care. Public health security is seen here as encompassing protection from environmental and behavioral health risks, basic protection against both communicable diseases and NCDs, and the provision of primary, secondary and tertiary prevention programs.

In clinical medicine, primary prevention stops the disease or injury before it occurs, secondary prevention reduces the impact of the disease or illness after the process has already begun, and tertiary prevention lessens the impact of a disease process already underway. Prevention programs reduce morbidity and mortality. Prevention of a disease saves lives, is immeasurably more cost-efficient compared with treatment, and defines current best practices in public health. This article advocates prevention as an approach to global health policy for populations of decreased health security in fragile and failed states.

Health security in failed and fragile states

The concept of health security is not consistently defined in the literature, its meaning being associated with human security, national and global public health security, and securing and promoting the health of individuals and communities (Aldis, 2008). Every one of these aspects is affected in failed and fragile settings. Fragile states experience a slow disappearance of state institutions and a reduction in the rule of law, which brings about a deteriorating human and health security environment, destabilizes surrounding countries, encourages corruption and disrupts economic practice (Naim, 2008; Quinn, Zeleny and Bencko, 2013; Zartman, 2005). Fragile and failed states have no safe, fair or legally regulated marketplace,

leading to black-market economies and illegal arbitrage becoming widespread for basic goods, including health service provision.

When states experience fragility, failure or collapse, they cease to deliver basic human and health security or any level of public health. The government loses credibility and the state becomes questionable and illegitimate in the hearts and minds of its citizens (Rotberg, 2004; Messner, 2011). Fragile and failed states exhibit an increased propensity for conflict and violence and a decreased ability to provide basic public health infrastructure to prevent diseases, offer diagnosis, provide adequate disease surveillance and combat infectious diseases, leading to a significant decrease to health security (Ottaway, 2004; Frieden and Henning, 2009; Mallaby, 2012; Patrick, 2006).

Conflict and war have already been inextricably linked to the spread of disease and deterioration in health security (Ottaway, 2004; Helman, 1993; Lymon 1993). Conflict threatens health security, as it leads to an increase in infectious diseases, preventable trauma, malnourishment and mental health disorders (Quinn, Zeleny and Bencko, 2014). Preventing state failure and conflict, therefore, can lead (at least in part) to increased health security. Policy highlights underscore the patience of action (gradualism over short-lived gains and tailored responses that address specific state needs) rather than a panacea; informed policy can enhance effective governance through a variety of models attuned to local patterns and needs in advisory and supportive ways (Mazar, 2014). Taking note of existing studies on the consequences of conflict and state fragility on health security along with empirical studies would provide a better foundation for such informed and evidence-based policy.

Methods

Current understandings of defining and promoting health security as an approach to health security policy – along with key definitions of state failure and fragility and clinical prevention – are discussed in relation to the case studies of Ukraine and Syria and the challenge of a vaccine-preventable disease. We examine these two case studies to assess the

value of a policy of prevention, including its potential benefits and drawbacks to health security and state stability.

Case studies in policy research and public health practice offer evidence based on a specific set of variables and factors that can be tracked over a specific period of time with finite outcomes (Ulin, Robinson and Tolley, 2005). The use of polio as the main research instrument yields the pathological sequelae of current warfare and instability and its effects on public health. Polio is a vaccine-preventable disease and had greatly diminishing incidence and prevalence until the recent conflict and state instability in places like Afghanistan, Pakistan, states affected by the Arab Spring and, more recently, Ukraine. The use of polio as an indicator of health security in war has been accepted as a barometer of health systems (Garun et al., 2015; Obradovic et al., 2014).

Findings: *Cases 1 and 2*

Case 1: Ukraine

Background

Former Ukrainian president Yanukovych's refusal to sign an agreement that would bring Ukraine economically closer to the EU in November 2013 set off a political and social revolution. Following the unrest and the ousting of the president, the Crimean Peninsula was annexed violently by Russian forces. The two regions of Donetsk and Luhansk were invaded and propped up through Russian-backed separatists using violence; the body count was just under 10,000 in late 2015 (Manzi et al., 2015). There are currently areas within these Donetsk and Luhansk regions of Eastern Ukraine that are under Ukrainian government control and others that are not; Crimea is no longer under any Ukrainian control. Due to the conflict, basic services such as water, sanitation, hygiene, medical and primary health services, roads and infrastructure are not consistently accessible or safe in at-risk government-controlled areas or in many non-government-controlled areas. Social and political systems of Ukraine prior to the street protests calling for democratic reform were not well funded, but functioning at a basic level. Furthermore, healthcare systems in Donetsk and Luhansk (also referred to as 'Donbass') were performing very well for Ukraine. The revolution and conflict have destabilized these services, serving as a threat to the overall stability and legitimacy of the state.

Health system weakness

The revolution has posed significant challenges to Ukraine's healthcare system. Over five million people are at risk of violence and over one million are displaced and at risk. Pediatric and geriatric populations are most vulnerable to preventable illnesses. The Ukrainian health system was weak before the crisis and is now on the verge of collapse in areas affected by combat, areas with high IDP loads, and regions requiring surge capacity and resilience to the disruption of service delivery from the security crisis. About 30% to 70% of healthcare workers have fled the combat areas or died, healthcare provision has broken down and no supplies are available to replenish basic medical goods or vaccinations (Quinn, 2015).

Due to the recent law that limits Ukraine's support to the Donbass region, many people living there are deprived of primary healthcare services. Comprehensive reports about civilian casualties from fighting are still pending for 2016, but since the beginning of the conflict in mid-April 2014 and until 19 February 2015, at least 5,793 people (including 63 children) were killed and 14,595 (including 169 children) were wounded in the east of Ukraine (Eurdolian and Porter, 2015); these are conservative estimates from the HRMU and WHO based on available official data as of July 2015. The health system in Ukraine, in other words, has come under increasing strain due to a deteriorating situation of state fragility, political tensions and instability. This has had an effect on the delivery of primary prevention, which is discussed in the next section with a specific focus on the status of polio vaccination programs.

Primary prevention: The case of polio

As a result of political instability, financial deficit and an ineffective and possibly corrupt procurement system at the Ministry of Health in Ukraine, the government tender process for procurement of vaccines for 2014 has not been fully implemented. Regional stocks of vaccines have already been exhausted. The average vaccination coverage in the country for some diseases is well under 40% (Holt, 2015). In some regions and communities, most children have not been vaccinated at all since mid-2014. Given the large population displacement and the lowest immunization coverage in Europe, Ukraine remains at high risk of communicable disease outbreaks, especially among children. WHO predicted that outbreaks of polio and measles were likely throughout the summer of 2015. When positive cases of polio were identified with paralyzed children in late summer 2015, there was panic and the humanitarian response was in crisis mode.

In an effort to bolster these needed vaccines, Sanofi Pasteur has sent millions of oral polio vaccines for immediate use. However, the All-Ukrainian Council for Patients' Rights and Safety alleges that these vaccines are unsafe due to cold chain management – alleging the frozen vaccines were partially thawed while in air transit to Ukraine from the manufacturer. Although WHO says that the transport and refreezing were carried out in line with

international best practice, the complaint alleges that the process contradicts a set of Ukrainian guidelines that state the vaccines cannot be refrozen. The outcome of their use is pending as of the drafting of this paper. The at-risk pediatric population awaits bureaucratic decision making and possibly corrupt practices.

Discussion

This short case study reveals the consequences of state instability and possibly state failure, demonstrating how they deteriorate health systems and healthcare infrastructure, ultimately increasing morbidity and mortality from preventable diseases. Disruptions and shocks to public health infrastructure from state fragility and conflict not only have an effect on positive polio cases but also increase the threat and risk of other vaccine-preventable illnesses (both human and non-human transmission (i.e. tetanus)). These continue to impact a shaky public health infrastructure in a fragile state and beg a broader question regarding the relationship between the health security of populations and state stability.

Case 2: Syria

Background

In late 2010, the Arab Spring erupted in Tunisia, triggering regional upheaval and social and political revolutions spanning North Africa and the Middle East. As old regimes were challenged or overturned in Tunisia, Algeria, Egypt, Libya, Lebanon, Jordan, Morocco and Iran, Syria showed many signs of being next in line for democratic transition. As violence spread, multiple factions and groups took to the streets throughout the country and a civil war mushroomed into a major regional crisis. In the past four years of war, more than 250,000 people have died and more than 11 million have been displaced (UN, 2015).

There has been international concern over the suspected use of chemical weapons, barrel munitions and mass murder. There has been no official confirmation as to whether the Syrian state has carried out these attacks or how other fighters may have retaliated, but chemical weapons have been used and many have been killed (Pita and Domingo, 2014). The Syrian state meets the criteria not only of state failure but also Zartman's criteria of state collapse, where "the structure, authority (legitimate power), law, and political order have fallen apart and must be reconstituted in some form, old or new" (Zartman, 1995). It no longer controls core state functions, has little control over its territory and has been unable to provide basic services and protection for its population since 2011–2012. The Russian Federation has recently (October 2015) committed to support the Syrian state by propping up the Assad regime at all costs (Adamsky, 2015). However, based on the past five years of the Assad regime's policy focus on centralizing power, it is unclear if it would be able to make good on any state-based basic services, healthcare infrastructure provisions or other measures that promote health security at least in the near future.

Health system collapse

In mid-October, 2015, over 35,000 people became displaced in Hama as a result of a renewed government offensive supported by Russian airstrikes (ECHO, 2015). It is possible that external and internal shocks from ISIS/ISIL have fomented and exacerbated the crisis, leaving in its wake no access to any healthcare services for millions of people. The OCHA

and UNHCR estimate that "by mid-2014 10.8 million of Syria's population was affected by the conflict and in need of humanitarian assistance, including 6.5 million internally displaced persons" (UNHCR, 2015). The EC reports that "the long-lasting consequences of the conflict with shortages of qualified medical personnel and life-saving medicines, and the destruction of health infrastructure have left many [in Syria] without access to basic medical care. In effect, the Syrian healthcare apparatus is defunct and no longer providing for its people.

Medical facilities continue to be targeted by aerial bombardments, resulting in fatalities and destruction of facilities. Delivery of essential medical supplies and equipment, especially in opposition-controlled areas, is often blocked and the provision of aid to besieged and hard-to-reach areas is particularly difficult" (ECHO, 2015). With Russian-backed bombing campaigns against multiple targets in Syria and coalition-backed aerial bombing against ISIS/ISIL targets in Syria and Iraq, the delivery of humanitarian aid and basic health services remain under great threat.

Primary prevention: The case of polio

Political instability and conflict has disrupted the public health infrastructure in Syria, including pediatric access to primary healthcare, and has blocked routine vaccines for millions. Routine vaccines (e.g. polio, tetanus and measles, mumps and rubella) have not been administered to many communities and populations at risk. In late October 2013, over 10 cases of polio were confirmed, followed by another 14 in early 2014 and 20 for the rest of the year, with paralysis of one patient in late December 2014 (Garon, 2015). Prior to the current outbreak, Syria's last confirmed polio case was in 1999. Syria had remained polio-free until October 2013, when wild poliovirus was confirmed in Deir ez-Zor and Aleppo (WHO, 2015). The rapid growth in cases coincides with the continuing period of turmoil and violence, demonstrating a causal relationship between state failure and the lack of provision of primary healthcare and prevention, which has also become a source of health insecurity.

Discussion

The case studies of Ukraine and Syria demonstrate how different two situations can be while still falling within the same broad category of state fragility and failure. These two cases illustrate the relationship between political instability and the weakness or failure of health systems and the delivery of health services. It has already been documented that conflict increases strain on health services, but here we demonstrated that health services are also challenged by the inability of governments to exercise effective authority and control over the territory and population of their state.

While international responses to state fragility have been limited, they tend to focus on the delivery of emergency care. Conflict and state fragility, however, affect the infrastructure that enables the provision of routine health services. Here, polio immunization is taken as a research instrument explored through two case studies to illustrate how failure in the provision of routine health services in fragile state settings has long-term consequences. What empirical research has found in comparing these two current situations of internal conflict combined with state fragility is that the two similar situations have different outcomes. The incidence of polio in Syria is larger than that in Ukraine on a real number basis. We believe these differences are due to two main factors – the condition and strength of the health system prior to the situation of conflict and fragility, and the intensity of the conflict itself (which further hinders the provision of health services). A stronger Ukrainian health system prior to the conflict may have a higher compliance with vaccination and primary prevention programs, leading to a larger herd immunity effect, protecting more at-risk non-vaccinated individuals.

International responses to crisis and disasters should focus not only on emergency medical support, but also on the provision of routine primary prevention. In political terms, the international community should pursue the goal of preventing state failure and the resuscitation of failed states so as to engender an environment for transparent and accountable health-related institutions and maximize healthcare outcomes, thus directly benefitting the populations they serve. This can include: primary prevention in the form of

primary healthcare services to the pediatric population with basic and advanced vaccination programs; secondary prevention for NCDs in the form of screening for middle-aged and geriatric patients who may have diabetes, hypertension, cardiovascular disease, cancer and many others; and, finally, tertiary prevention, mitigating all of the above from causing further health status decline across all patient populations through medical care, education and lifestyle changes. Preventing war, conflict and violence will increase health security; these factors may also be affected by preventing state failure.

The prevention concepts listed above are not a policy of action that can be perverted to defend from invasion, control violence between states or stop more killing. Rather, a policy of prevention, rooted in best practices and evidence-based policy, must be a gradual process that stable states offer to fragile states through patient, long-term, mostly advisory and humanitarian aid relationships. Possible activities could include: direct economic assistance focused on local needs; training of civil staff, academic and governmental exchanges and other human-capacity development programs; military-to-military ties (M2M) that deconflict previous emphasis on destruction and instead shift it onto disaster risk reduction; and trade and investment policies that reduce exploitation. All of these measures reinforce the state and create an environment for improved healthcare provision. Early warning systems that focus on metrics associated with fragile and failed states should indicate states' status on the continuum of fragility and failure in order to assist and support donors from the public and private aid communities in prioritizing policy focus (Baliamoune-Lutz and McGillivary, 2008).

Limitations

This short case study approach to complex issues such as health security, global affairs and preventable illness is limited by the amount of data reviewed. Case studies for the preventable illness of polio in war and conflicted states may not be the best marker or indicator for the health of a population. Data related to population titers and seroconversion rates of selected preventable illnesses may prove to be a more robust and powerful study in relating state stability to health. Clearly, these topics are insufficiently studied and reported in

the literature. This question about the relationship between health security and state security is both fascinating and underexplored. Linkages between state and health and the question of causality (i.e. does it flow from state to individual, individual to state or is the process more complex?) are yet to be described or answered. More detailed relationships of health and state stability can better describe these potentially causal relationships.

Conclusion

Mitigating state failure and reviving fragile states must become a key policy objective for development and public health programming for states in crisis; fragile states are not preordained to state failure or absolute collapse. Failed states, conflict and health security are linked. Small-scale conflict and large-scale violence both threaten public health security. Health security can be gained, in part, through primary healthcare access and vaccination and prevention programs.

Country-specific approaches that encourage the rule of law and transparent and representative institutions, limit state-controlled violence and foster environmental integrity must comprise any political action. Such efforts are best delivered via concerted international efforts – including programs by intergovernmental institutions, the ICRC, humanitarian agencies, civil society organizations and other donors – rather than by means of sovereign states intervening militarily in other sovereign states. Preventing public health crisis in fragile and failed states through a policy of prevention ought to incorporate the provision of adequate food, sustainable shelter, water, sanitation, adequate vaccination programs and access to primary healthcare services (Davies and Gurr, 1998; Toole, Waldman and Zwi, 2006).

Failed or failing states are likely to present complex political and security situations, defined by a high degree of instability and the risk of violence. Since degrees of instability and state control over civil strife situations may vary, other ways need to be established to provide preventative health services in order to guarantee the right to health for all people.

CHAPTER 8: Healthcare migration and staffing: A global threat to health security

Introduction

Global health relies on healthcare staffing. Without adequate training, staffing and retraining, patient care sufferers and health security is reduced. However, economic incentives vary from state to state and medical training is a long and expensive process. Countries spend a lot of time, expertise and funding in order to train doctors across the globe; sadly, some of these doctors then take their credentials and, through the theory of arbitrage, or "arbitrage pricing theory", leave and start working in other nations for more pay. The void they leave in their wake can create an environment ripe for health insecurity for the community they leave. The paper and data reported here highlight the global healthcare staffing conundrum, with Iraq as the main case study that relates to war, conflict and disaster.

The aim of this chapter is to review the phenomena of Iraqi physician brain drain during a prolonged conflict from the Coalition invasion in 2003 to 2010. Personal interviews with migration experts, Iraqi doctors and policy makers, notes from Iraq field travel over the course of four years, peer-reviewed journals, website and policy reports, think tank data, governmental reports and publicly available sources were reviewed and assessed only from 2003 to 2010 to review the Iraqi brain drain phenomenon.

At the writing of this thesis, data related to those doctors who have fled Iraq due to the violence are inconclusive, fragmented and, in some instances, only anecdotal. Brain drain in Iraq remains a major barrier for healthcare access for Iraqis. The next stage of brain drain research in Iraq must be the quantitative and systematic review of the number of doctors working in Iraq, the number of Iraqi medical school graduates and standardized medical practice. Brain drain is a very complex phenomenon. Freedom of movement, travel, choice, and advancing one's own career and earnings are seen as fundamental rights in modern

society. Source countries are those with pools of highly qualified doctors offering low salaries while end-destination countries have fewer licensed native physicians to match their growing patient needs but plenty of resources and higher wages to attract the best trained doctors as needed – and in any volume to meet the demand. These end-destination countries receive the flow of migrating physicians in an imbalanced circuit flow (see Figure 2 and Figure 3 below).

Figure 2.

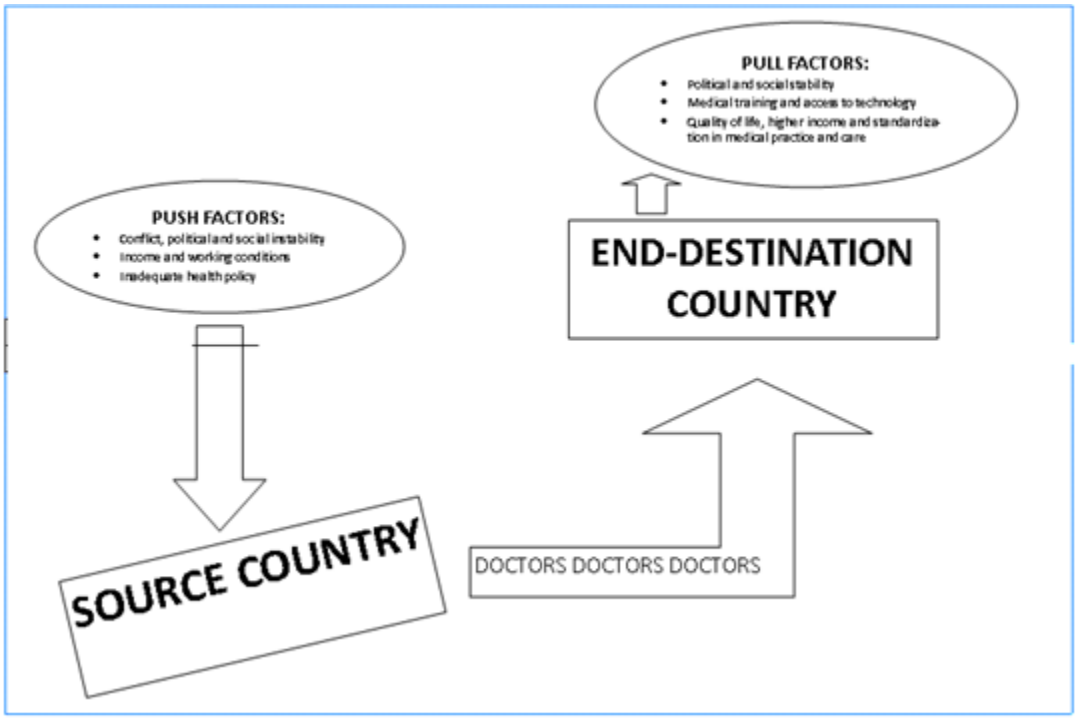
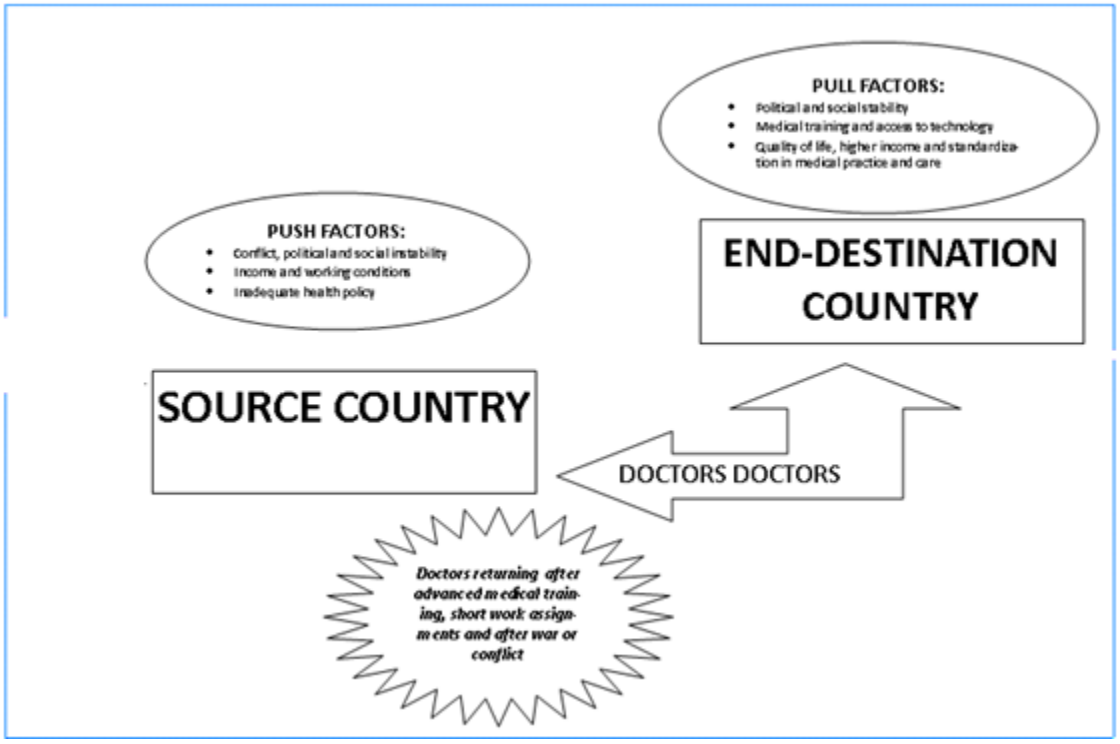


Figure 3.



Iraq has suffered an acute brain drain of doctors and other healthcare staff. Physicians faced violence and fled the country because of it; no data exists to estimate the loss or to monitor their return. This violence and instability in Iraq is slowly getting better, but true data on how many doctors fled and how many are returning is still insufficient and inconclusive. Iraq health policy efforts enable doctors to return to the much-needed medical labors throughout Iraq. These policy shifts can include sharing information flow of migration between source and destination countries, improving pay for doctors, standardizing medical procedure costs throughout the country and both directly and indirectly improving the working conditions, telemedicine provisions, allowances and stimulation of cross-cultural exchange programs and *de facto* rule of law.

Only recently (in the past one year) in Iraq have the ideas and content of rule of law through security been visible and under threat by ISIS/ISIL. For example, only recently have citizens begun to trust the police force as a means of security and safety and not as a militarized or

uniformed militia fighting on behalf of Sunni(a) or Shia camps. This very young and burgeoning sense of stability may offer hope for those physicians that wish to return home to practice medicine and aid in reconstruction and stability operations that encourage more health security for the population. This process of developing health security within cities and urban areas and a constant, viable and stable government will take many years and cannot be done without doctors working as the pillars of the community to offer health.

Summary

The brain drain of doctors from areas of conflict and instability has lead to a global healthcare pandemic. Stabilization of the situation regarding doctors in Iraq is paramount to the success of the Iraqi state. It could bring to a very fragile Iraqi society positive signals that there is a chance for peace and living in dignity in this fragile state. Healthcare staffing in fragile and failed states is at great risk of decreasing health security for many people in areas of prolonged conflict, war and disaster.

CHAPTER 9: Epidemiological and biostatistical methods, calculations and definitions applied to global health and prevention

Introduction

This thesis and subsequent published works have deployed both qualitative and quantitative methods. This chapter outlines certain calculations and definitions used throughout these publications, and how such methods fit within the framework of this research. The novel data gathered and calculated in these publications have their own methods section and use standard definitions. The purpose of this chapter is to better organize the epidemiological principles applied for the reader.

Compilation of all calculations applied to this PhD research project

The standard unit of study in epidemiology is the individual; however, this is not of value until data is added into a study population. The standard unit of disease within a population is the number of new cases of a disease that is diagnosed and the number of latent disease carriers or affected patients. Hallmarks of epidemiology are the incidence and prevalence of a disease. Incidence of a disease is the rate at which new cases occur in a population during a specified period. Prevalence of a disease is the proportion of a population considered as cases at a point in time.

Quantifying risk

Odds ratio (OR) is typically used in case-control studies – i.e. odds that the group with the disease (cases) was exposed to a risk factor (a/c) divided by the odds that the

group without the disease (controls) was exposed (b/d).

$$OR = (a/c) / (b/d) = ad/bc$$

Furthermore, relative risk (RR) is typically used in cohort studies – i.e. risk of developing disease in the exposed group divided by the risk in the unexposed group (e.g. if 21% of smokers develop lung cancer vs 1% of nonsmokers, RR = 21/1 = 21).

$$RR = [a/(a+b)] / [c/(c+d)]$$

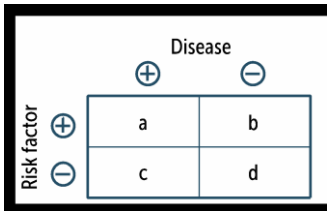
With this, it is equally important to calculate relative risk reduction (RRR) – i.e. the proportion of risk reduction attributable to the intervention as compared to a control. RRR = 1 – RR (e.g. if 2% of patients who receive a flu shot develop flu while 8% of unvaccinated patients develop the flu, then RR = 2/8 = 0.25 and RRR = 1 – RR = 0.75).

This is slightly different to that of attributable risk (AR), which is the proportion of risk reduction attributable to the intervention as compared to a control. RRR = 1 – RR (e.g. if 2% of patients who receive a flu shot develop flu while 8% of unvaccinated patients develop the flu, then RR = 2/8 = 0.25 and RRR = 1 – RR = 0.75).

$$AR = a / a+b - c/c+d$$

A concept very difficult to apply to our study methods in the publications seeking to associate risk of state failure with that of health security is absolute risk reduction (ARR). RRR is a measure calculated by dividing absolute risk reduction by the event control rate. ARR is the difference in risk (not the proportion) attributable to the intervention as compared to a control (e.g. if 8% of people who receive a placebo vaccine develop flu vs 2% of people who receive a flu vaccine, then ARR = 8% − 2% = 6% = .06).

Table 11. Two-by-two table (Risk Factor – Disease)



The table above is a classic representation of risk factor to disease. Some concepts of treatment and harm are directly related to these concepts. These concepts were only experimentally applied to the data for this thesis, but need to be discussed in order to be thorough when discussing treatment and harm. The number needed to treat (NNT) is the number of patients who need to be treated for one patient to benefit. This is calculated as 1/ARR. The number needed to harm (NNTH) is the number of patients who need to be exposed to a risk factor for one patient to be harmed. This is calculated as 1/AR.

Rate calculations: Outbreak investigation

This research and all publications associated with it do not include an outbreak investigation for communicable diseases. However, while deployed in many of these far-reaching remote areas of resource-poor and low-income countries, the author of this thesis did perform basic outbreak investigations. In Iraq and Kurdistan, there were cases of diarrheal illness, where cholera needed to be excluded without access to a laboratory for testing. In Timor-Leste, malaria, measles and Japanese encephalitis are endemic; however, outbreak investigations needed to be carried out for viral illnesses affecting the gastrointestinal and integumentary systems, as well as meningitis and encephalitis.

In these basic outbreak investigations, the following equations were considered and implemented:

Table 12. Basic outbreak investigation calculations		
Case fatality rate (CFR)	Corresponds to the percentage of cases that result in death	*Number of deaths/number of cases) x 100*
Weekly attack rate	Expressed as the number of cases per 100,000 people per week	*1. Divide 100,000 by the population of the area under study* *2. Multiply the result by the number of cases that occurred in a given week* That result is the *attack rate*, expressed as cases per 100,000 people per week
Weekly age-specific attack rate	Number of cases per 100,000 in one age group, per week	*1. Calculate the number of persons in the age group in the area under study* *2. Tally the number of cases in the age group for the chosen time period*

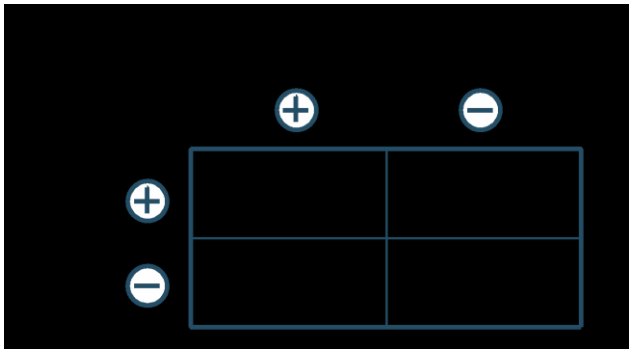
		3. Divide 100,000 by the number of persons in the age group *4. Multiply the result by the number of cases in that age group* The result is the *age-specific attack rate*, expressed as cases per 100,000 per week in a given age group.

The table above illustrates the calculations used for multiple investigations during the duration of this research.

Evaluation of diagnostic tests in medicine and epidemiology

The basic two-by-two table given above is also applied for tests used in epidemiology. For the purposes of this research thesis, the table below was implemented.

Table 13. Two-by-two table (Test Outcomes)



This is the two-by-two table comparing test results with the actual presence of the disease. TP = true positive; FP = false positive; TN = true negative; FN = false negative. True

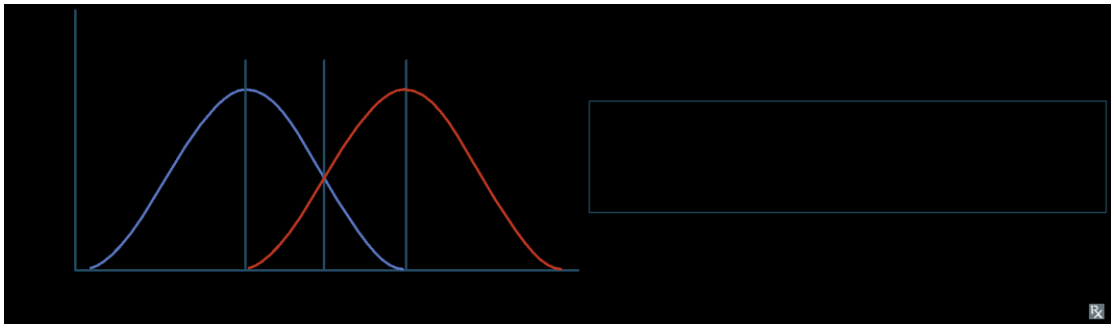
positives are reported as positive and are indeed positive; false positives are reported as positive and are actually NOT a positive result. True negatives are reported as negative and are indeed negative of having the disease; false negatives are reported as negative but the true results are actually positive (this is very dangerous for screening tests).

Sensitivity and specificity are fixed properties of a test (vs Positive Predictive Value (PPV) and Negative Predictive Value (NPV)). Sensitivity is the true positive rate – i.e. the proportion of all people with the disease who test positive, or the probability that a test detects the disease when the disease is present. Values approaching 100% are desirable for ruling out the disease and indicate a low false negative rate. High sensitivity tests are used for screening in diseases with low prevalence. A highly sensitive test, when negative, rules out disease. If sensitivity is 100%, TP / (TP + FN) = 1, FN = 0 and all negatives must be TNs.

Conversely, specificity-described true negative rate is the proportion of all people without the disease who test negative, or the probability that a test indicates non-disease when the disease is absent. Values approaching 100% are desirable for ruling out a disease and indicate a low false positive rate. A high specificity test is used for confirmation after a positive screening test. Thus, TN / (TN + FP) = 1 – false positive rate. Highly specific tests, when positive, help to rule IN a disease. If specificity is 100%, TN / (TN + FP) = 1, FP = 0 and all positives must be TPs.

The positive predictive value is the proportion of positive test results that are true positives. The probability that a person actually has the disease given a positive test result is TP / (TP + FP). PPV varies directly with prevalence or pretest probability: high pretest probability, equals high PPV. The negative predictive value is the proportion of negative test results that are true negatives. The probability that a person actually is disease-free given a negative test result is TN / (FN + TN). NPV varies inversely with prevalence or pretest probability: high pretest probability, equals low NPV.

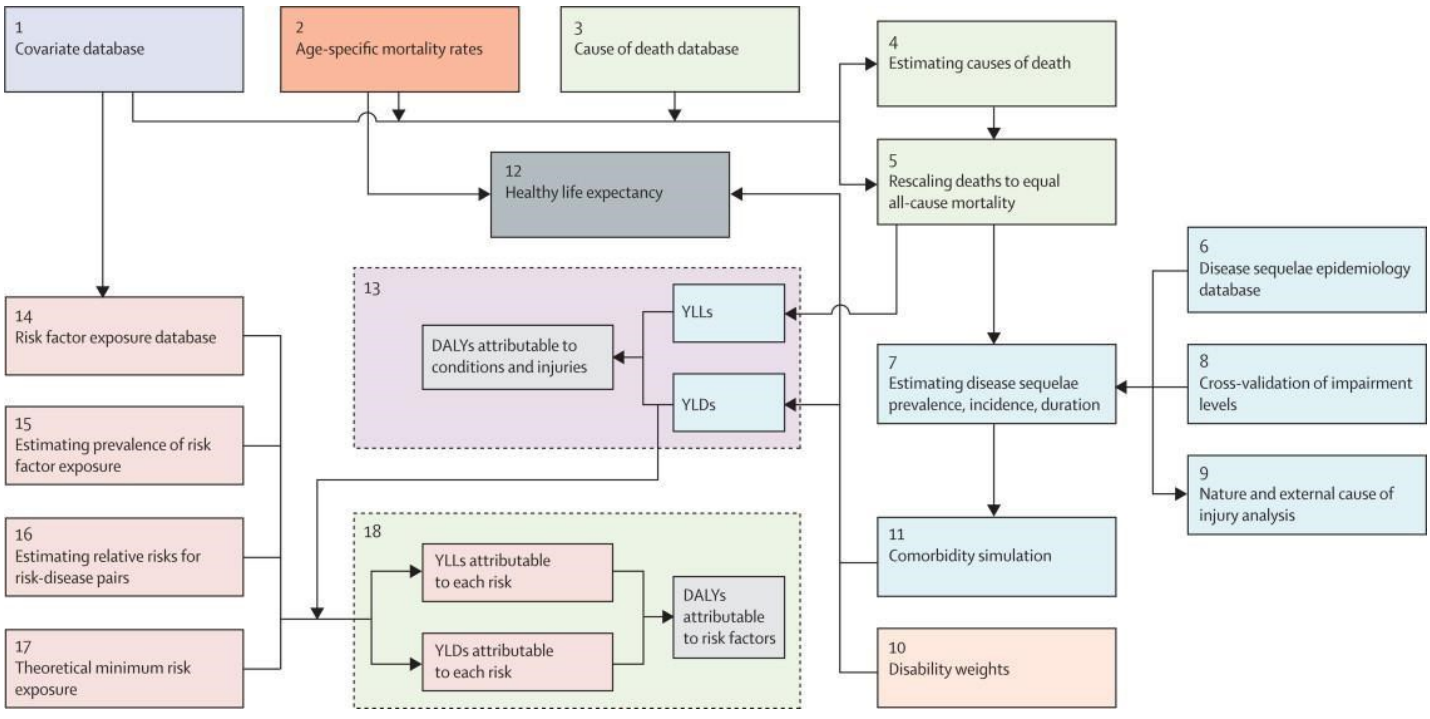
Figure 4.



Global burden of the disease

The below table illustrates the methodology used by the Institute for Health Metrics and Evaluation in their Global Disease Burden study (Daniels, Donilon and Bollyky, 2015). Please note that YLL = years of life lost; DALYs = disability-adjusted life year and YLD = years lost due to disease. This model was employed as an underlying schematic for some of the indices used in the publications of this PhD study and research projects. It is a comprehensive effort to measure epidemiological levels and trends of disease, injuries and risk factors globally.

Figure 5. Global burden of disease and its interrelations (adapted from the Global Burden of Disease study, 2010)



It should be noted that there is considerable reliance on the basic units of epidemiological study: incidence and prevalence, with rates being a close second. There have been many comments on rates in the literature when dealing with global health; data and rates are very helpful in dealing with resource allocation. Figure 5 above is controversial, as tying in so many variables related to disease, morbidity and mortality will have. However, the basic principles regarding study populations and disease are helpful and aid the conclusions of this research in estimating health security across communities and populations.

Results are usually presented in terms of disability-adjusted life years (DALYs), a time-based measure that combines years of life lost (YLLs) due to premature mortality and years lived with a disability (YLDs); these metrics were developed specifically to assess the burden of disease. This PhD research has not utilized the DALYs, YLLs and YLDs, as it did not relate to aspects of disaster and conflict medicine investigated.

CHAPTER 10: Summary and conclusion: Promoting a policy of prevention

"*Prevention is better than cure.*" – **Erasmus**

"*An ounce of prevention is worth a pound of cure.*" – **Benjamin Franklin**

Review and closing remarks

Based on the outcomes of this thesis, mitigating state failure and reviving fragile states must become key policy objectives for development and public health programming for states in crisis. Fragile states are not preordained to state failure or absolute collapse, and preventable morbidity and mortality of both NCDs and communicable diseases may affect the stability of the state. Failed states, conflict and health security are linked. Small-scale conflict and large-scale violence of non-state actors greatly threaten public health security. Health security of states can be gained and improved in part through primary healthcare access and prevention programs that target preventable illnesses.

Country-specific approaches that encourage the rule of law and transparent, accountable, sustainable and representative institutions, as well as limit state-controlled violence and foster environmental integrity through evidence-based policy, can encourage states towards further stability and improved health security. At the root of this, the provision of adequate food, sustainable shelter, water, sanitation, adequate vaccination and programs regarding the prevention of disease, as well as access to primary healthcare services, are core components.

This thesis has included multiple methodologies that address and attempt to unpack these many connected areas of state stability and their relationship to health. Highlighted and powerful methodologies, such as the aggregate research utilized, reviewed the indices and variables related to public health in countries that are in crisis. These fragile states are placed on a spectrum of fragility, where some could be marked as failed. One research instrument used, the FSI, measures the quality of national-level institutions; however, this may not capture all variables related to state fragility and health. An explanation is provided by the EFI and the EnFI in published research data related to this thesis project. The incidence of preventable infectious diseases has a new context in terms of the issues faced by states in providing an environment for health security.

To summarize, the qualitative and quantitative data suggests that, to improve health security in fragile and failed states, policy focus should seek to resuscitate fragile states and mitigate the loss of failed states. This may include preventing disease, preventing environmental degradation, encouraging economic and job security, and improving environmental conditions that affect health. It also suggests that empowering the population in terms of personal freedom and wealth greatly increases its resilience to counter the impacts of poor environmental conditions.

Failed or failing states are likely to present complex political and security situations now and in the future; they are defined by a high degree of instability and the risk of violence. Since degrees of instability and state control over civil strife situations may vary, alternate methods need to be established to provide preventative health services in order to guarantee the right to health to all people, especially in disaster and fragile or failed states. Prevention in medicine works and mitigates suffering when this concept is applied through evidence-based policy and decision making. The resuscitation of fragile states can lead to an improved health security situation for states in crisis and experiencing disaster. This thesis and the publications associated with it are only the beginning of this new field of study within epidemiology and global health.

Disclaimer and conflicts of interest

The PhD research, study and practice are completely that of the author (John Michael Quinn V) and his co-authors for each publication. The author has no affiliation with any governmental agency, domestic or foreign, of any kind. The views expressed in this PhD dissertation and thesis reflect only that of the author and may not reflect that of Charles University, the First Faculty of Medicine, the PhD consultant or mentor or any other collaborating institution or government.

During the research and writing of this PhD thesis, no war-fighting or offensive activities took place and no sides or alignments were considered or acted upon. There are no connections or associations with any government or foreign military that need to be disclosed. This thesis research and dissertation has been carried out with the sole motive of mitigating human suffering, bringing forward best medical practices and better describing patients caught in disaster, war, conflict and complex emergencies. The author holds no official political or social bias.

Epilogue: PCGH

Review

One of the legacy outcomes from this PhD research project has been the establishment of the PCGH (www.pcgh.lf1.cuni.cz). This is a "News in Medicine" eligible elective at Charles University in Prague, First Faculty of Medicine, and provides a venue for students to share their student experience in clinical medicine, relate to their patients and learn best practices created by the author of this thesis.

Description

The PCGH was established as a collaborative and interdepartmental research engine for scientific endeavors related to global health. The main research outcomes from the PCGH have been research articles, publications, book chapters, policy papers and assessments with key recommendations related to clinical and field research in global health. The main mission of the PCGH is to research, explore and describe global health trends, risk and problems and to propose opportunities and solutions through evidence-based research and best practices.

Project scope and mission statement

The PCGH's mission is to provide professional education, research and innovative public service in health promotion and the prevention and control of illness and injury by utilizing epidemiological, evidence-based and policy-driven best practices in medicine and public health. Our mission is to improve public health, improve the delivery of preventative medicine, promote individual well-being and eliminate health disparities globally.

Summary

The major outcome of the PCGH addresses new ideas and new global problems with evidence-based solutions. It is imperative that Charles University remains and re-emerges as a global leader in the public health debate; the PCGH can help bring these ideas to the

global discussion table. The PCGH is a regional center for the promotion of health and human security.

List of abbreviations

ACLS – Advanced cardiac life support

APC – Armored personnel carrier

APEC – Asia-Pacific Economic Cooperation

ATO – Anti-Terrorist Operation, also referred to as the theatre of military operations

CLS – Combat Lifesaver

CAMTS – Commission on Accreditation of Medical Transport Systems

CASEVAC – Casualty evacuation

CDC – Centers for Disease Control and Prevention

COB – Contingency Operating Base

CSH – Combat support hospital/combat surgical hospital

CSxxx – Composite score of the Failed States Index (with X= year described)

CT – Computed tomography

EC – European Commission

EU – European Union

eFAST – Extended focused assessment with sonography for trauma

ESA – Agricultural Development Economics Division

FAST – Focused assessment with sonography for trauma

FSIxxxx – Failed States Index (with X=year described)

FOB – Forward operating base

IFAK – Individual (improved) first aid kit

ICRC – International Committee of the Red Cross

ICU – Intensive care unit

IMF – International Monetary Fund

ITLS – International Trauma Life Support

MDG – Millennium Development Goals

MEDEVAC – Medical evacuation

MRI – Magnetic resonance imaging

MTF – Medical treatment facility

NATO – North Atlantic Treaty Organization

NCD – Non-communicable disease

OCHA – United Nations Office for the Coordination of Humanitarian Affairs

OSCE – Organization for Security Co-Operation in Europe

PCGH – Prague Center for Global Health

PDS = Post-traumatic Stress Diagnostic Scale

PHTLS – Prehospital emergency trauma life support

POC – Point of contact

PPE – Personal protective equipment

PTSD – Post-traumatic stress disorder

SBU – Security Service of Ukraine

SF – Special forces

USAID – United States Agency for International Development

WHO – World Health Organization

WP – White phosphorus

List of statistical symbols

X	A single element
N	Number of elements in a population
n	Number of elements in a sample
p	The probability of an event occurring. In reports of statistical significance, *p* is the probability that the result could have been obtained by chance – i.e. the probability that a type I error is being made.
q	The probability of an event not occurring; equal to (1 – *p*)
f	Frequency
C	Centile (or percentile) rank; *or* confidence level
Mo	Mode
Mdn	Median
μ	Population mean
$\bar{X}$	Sample mean
S	Sample standard deviation (SD)
z	The number of standard deviations by which a single element in a normally distributed population lies away from, the population mean; *or* the number of standard errors by which a random sample mean lies from the population mean

$\mu_{\bar{x}}$ The mean of the random sampling distribution of means

$\sigma_{\bar{x}}$ Standard error or standard error of the mean (standard deviation of the random sampling distribution of means) [*SEM* or *SE*]

$s_{\bar{x}}$ Estimated standard error (estimated standard error of the mean)

t The number of estimated standard errors by which a random sample mean lies from the population mean

df Degrees of freedom

α The criterion level at which the null hypothesis will be accepted or rejected; the probability of making a type I error

b Probability of making a type II error

c^2 Chi-square; a test of proportions

r Correlation coefficient

r^2 Coefficient of determination

b Regression coefficient; the slope of the regression line

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Appendix

Key published works (only those with Impact Factor):

Appendix A

Quinn, J., Rajaratnam, V., Zeleny, T., Kruszcynski, M., Marten, G. and Bencko, V. (2016) "Commentary: Expectations for global health program prioritization from a selection of international students studying at a European university", *Globalization and Health* (16 September 2016).

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Globalization and Health

COMMENTARY Open Access

Commentary: expectations for global health program prioritization from a selection of international students studying at a European university

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Abstract

Background: Some university curricula struggle to present evidence-based promotion of global health principles and global health diplomacy within an undergraduate setting. The *de facto* global health paradigm has experienced significant stress and pressure from epidemics, war and violence, climate change and resource challenges. These stressors may lead to increased morbidity and mortality, in turn requiring medical professionals to play a larger role in global health action across borders.

Methods: In the academic year 2014-2015, an English-speaking international medical school promoted a global health forum with pre-course readings and a pre-attendance quiz. All students from the university were invited to attend and the event was not mandatory.

Results: The one-day-event culminated in expert speakers, discussions and a post-event questionnaire to gauge students' reactions and expectations as future physicians regarding the most pressing global health topics. Emphasis was also placed on what future doctors foresee as pressing issues in forthcoming global health policy and programming.

Summary: This paper is a brief commentary of the Global Health Forum in Prague 2014, and presents novel results from a post-event student questionnaire, with conclusions provided by students on innovative global health policy.

Keywords: Global health curricula, Global health diplomacy, Medical education, Medical students and staffing, Medical meetings

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Background

Headlines concerning beheadings by the Islamic State (ISIS) in the Middle East, rockets aimed at and incursions into the Holy Land, borderless morbidity and mortality caused by the Ebola virus and hybrid war in Ukraine illustrate the challenges that global health institutions face today. The scale of such crises may leave major response efforts scrambling in a bid to respond to violence and disease. Reduced resilience to these shocks and increasing crises challenges global health actors and stakeholders in their mandate to provide best practices for all [1, 2]. This challenge is exacerbated by the absence of no clear global health governance structures that can help cushion these shocks. Global institutional capacity may be stalled and best practices promoting evidenced-based policy may be lacking, leaving the venue of global health projects and programming at risk of fragility and failure [3].

Disease does not discriminate and knows no borders. The realities of the Ebola virus and more recently, the Zika virus, as well as potentially unknown threats, forces us to ask whether we are prepared for dealing with such threats. Although resources are scarce and funding minimal, it should be our collective responsibility and shared resolve internationally to adjust and form an appropriate global health infrastructure with the aim of recognizing, responding and managing crises, without ignoring current endemic problems.

Despite the uneasy abatement of the Ebola epidemic and short gains in other communicable diseases such as tuberculosis (TB) and malaria, and until recently, polio, many issues remain. The international community and global health policy makers have failed to provide an organized, systematic and sustainable response to recent catastrophic infectious disease outbreaks, complex emergencies of war and social unrest and worsening environmental degradation. If the global health community does not achieve a rapid and steep learning curve, these crisis events, as well as mortality rates, may increase and repeat logarithmically [4].

However, it must be noted that when the global health community and its seemingly disparate pool of actors are able to coalesce and focus on evidence-based strategies and policy, success has been achieved in the form of reducing morbidity and mortality. These advancements are not only the result of sound evidence-based policy, but also due to the presence of standardized global health curricula and education and training for health practitioners [5]. The purpose of the *Global Health Forum in Prague* is to support standardized curricula in global health and to instill awareness for future global health leaders.

Selected global health problems list

Ukraine

A humanitarian disaster is arising in Europe's backyard. According to WHO data, mid-summer 2016 saw more than two million displaced people, an estimated 9250 or more killed, over 27 000 wounded, a fully-packed civilian airliner detonated at 36 000 feet and the sovereign nation of Ukraine occupied by foreign tanks and foreign troops [6]. An immediate public health crisis concerning emergency medicines subsists, while access to vaccines such as those for polio and tetanus is absent; basic services such as water, hygiene, shelter and primary or emergency medical care is not available for those caught in the crossfire of an uncertain future, where tanks with unmarked troops keep advancing on poorly demarcated occupied zones.

Violent extremism: the Middle East

ISIS has infiltrated multiple countries and has murdered thousands through wanton acts of violence and torture defined as genocide by the UN. With this, women's health and empowerment have been decapitated and communities are barred access to primary and emergency healthcare services across borders.

ISIS is armed and possesses the financial and logistic support to continue killing, thus deteriorating the region into further health and security chaos. Escalation of violence in Syria and an increased Russian military presence and operations may be pushing almost 1 in 2 Syrians to flee to European soil. This is in addition to other fragile states in the Middle East and across the Sahel in Africa that are sending refugees and displaced peoples northward due to social and political unrest and instability. These stressors collectively exacerbate children's and women's health, intensify gender-based violence and exacerbate communicable and non-communicable disease (NCDs) [7]. ISIS highlights the requirement for global health governance and mandate, especially in ungoverned spaces and its relationship with state and non-state actors.

Ebola

Meanwhile, in West Africa, the well-documented Ebola virus has reared its head and has swiftly crossed borders, cultures and societies. The mechanisms that enabled such wild proliferation are currently under study, yet preliminary reports by the WHO and third parties reveal a slow and half-hearted global response to the crisis, possibly related to governance, persistent funding inadequacies, a dearth of well-trained medical staff and the conclusion that such an outbreak can happen again with very few safeguards in place and no lessons learned from previous experience [4, 8]. It should be noted that in the month of September 2015, newly confirmed cases of

the Ebola virus were still being reported in both Guinea and Sierra Leone, with associated fatalities [9]. And in April 2016 another case was confirmed in Liberia. The Ebola outbreak is not over and the spread of the Zika virus has not yet reached its full scale.

All of the above crises and emergency threats exist above and beyond the pre-existing crises of multidrug resistant tuberculosis (TB), malaria, diarrheal illness and the mortality of under-five-year-olds, HIV/AIDS, many neglected tropical diseases and the current proliferation of non-communicable diseases (NCDs) sweeping an overall unhealthy, smoking, sedentary global population with a poor diet in both least-developed and most developed countries alike [10].

However, it should be noted that global health infrastructure has had some success in collectively combating some of these global health concerns through solid leadership and transparent institutions. Indeed, some successes have managed to reduce certain diseases and social behaviors. For example, the establishment of the Millennium Development Goals (MDGs) set forth an agenda to prioritize and devote funding to very specific categories of global health threats.

The above endpoints and metrics have had varying degrees of success and as such, the new and revised Sustainable Development Goals (SDGs) will set a framework and path for sustainable development in multiple health and development streams for future generations, in effect bringing global health governance into a framework where actors and stakeholders can all be up to date about the same policy. The governance and focus of these metrics for the SDGs are still being drafted mid-2016. Despite these significant successes, however, many issues remain, and some old threats such as polio are once again finding their way back into at risk communities and populations.

The institution

Charles University, First Faculty of Medicine offers both undergraduate and graduate degree programs in English and in Czech. The Prague Center for Global Health is a research center based in the Institute of Hygiene and Epidemiology, which focuses on human and health security in conflict and post-conflict settings, and researches many of the above-mentioned global health concerns in Central Europe.

Methods

In an effort to focus on pressing global health topics, the Prague Center for Global Health held its second biennial Global Health Forum in Prague in 2014. The primary theme of the Global Health Forum 2014 was prevention in conflict areas, pandemics and the promotion of health security. Students were given pre-course readings and a pre-event quiz. Ethical approval was granted for the study by the Departmental Internal Review Board (IRB) of the Institute of Hygiene and Epidemiology, First Faculty of Medicine, Charles University. No reference numbers were given.

During the event, all participants submitted verbal consent for the results of the Forum and online quiz to be published, and also completed written informed consent as part of the survey when reporting their individual responses. On the day of the event, two hours were spent with speakers and professors reviewing key questions and topics from the readings prior to keynote presentations. Following the presentations, a videoconference with Dr. Greg Martin and full panel discussion with all speakers reviewed student questions and perspectives. Upon conclusion of the Forum, a post event questionnaire was sent via email to all participants and speakers (see "Questionnaire" details below.

Speakers

The speakers and topics of the invited presenters included:

- Melaura Myers, MD, medical resident – recorded video presentation: *Rural pediatric health in Tanzania*. This talk discussed the need for primary prevention in rural communities and specifically, the burden of disease in rural Tanzania and access to vaccines.
- Dr. Greg Martin, Editor in Chief at *Globalization and Health* – recorded video presentation: *Fragile and failed nation states and health*. This robust and highly effective recorded presentation put into practical terms the health challenges and barriers faced by those who reside in fragile and failed nations concerning infectious and noncommunicable diseases (NCD).
- Dr. Alena Šteflová, Head of the WHO Country Office (Czech Republic) at the World Health Organization: *Ebola and WHO*. This presentation discussed the extremely serious Ebola outbreak of 2014, the WHOs' response and budgetary commitments to the outbreak, as well as present and future challenges concerning global health security threats.
- Diplomat Elaine Kelley, US Department of State: *The Ebola outbreak and US response*. This presentation focused not only on the United States' commitment to global health, but also described how current programs like the President's Emergency Plan for AIDS Relief (PEPFAR) can be dovetailed into further global health programming for ensuring global health security.

- Prof. David McIntosh, Honoree senior lecturer at Imperial College London: *Abbreviated presentation on vaccine in conflict and disaster and rapid vaccine development*. This cutting-edge discussion on new vaccines, technologies and rapid access to tailored vaccines was cut short due to time constraints; however, the basics were highlighted.

Questionnaire

The questionnaire was offered through a paid Survey Monkey (surveymonkey.com) account supported by Mercy University Hospital (MUH) in Cork, Ireland, under Dr. Iohmar O'Sullivan, and is available at: http://www.surveymonkey.com/r/PRG_CUP_GHF_2014. All results, as well as individual responses, were compiled and reviewed for qualitative and quantitative measures using the surveymonkey.com software. The mix of questions was extremely broad and reflected the nature of global health, as well as the speakers' topics and the pre-course reading.

Student attendance and access

The Global Health Forum 2014 in Prague was interdisciplinary, apolitical, free of charge, free of private sponsorship and the organizers and supporters promoted no political or governmental agenda of any kind. All students in both the Czech and English language groups were invited to attend via posts on Facebook, LinkedIn, the official University Website and through word-of-mouth. Attendance was not mandatory; all student years across Charles University were invited to attend. In terms of ethical considerations, the students surveyed were not asked for their country of origin, country of residence or ethnic background. The main qualifiers were students' year of medical study and their reactions to the speakers and their topics.

Due to the social and political nature of the events to be discussed, diplomatic missions to the Czech Republic from Israel, Palestine, Ukraine and Russia were invited. Russia declined to participate in an official capacity and no other correspondence was received from any other country or their representatives.

Results

A total of 47 respondents completed the online questionnaire. The Global Health Forum in Prague 2014 was attended by 56 international undergraduate and graduate students from Charles University, Faculties of Medicine and across different years of study. General medical students made up the majority of attendees at 89 %; of these, 67 % were in the final two years of their medical degree with only 4 % first-year medical students in attendance. Postgraduate students represented 3 % of attendees. Of all the students in attendance, 7 % were dental students. No ethnic, country of origin or residence data were collected; anecdotally, the university's diverse student body comprises more than 60 nationalities and countries who will subsequently practice medicine and dentistry globally [11].

Among respondents, 37 % reported having an interest in global health, health policy or conflict medicine prior to the Forum. The majority (48 %) reported that they were "somewhat" interested, while 14 % of respondents were neutral, with no particular interest for or against global health. After attending the Global Health Forum, respondents reported an overall positive experience, with more than half of attendees expressing an increased interest in global health and health policy; 18 % of respondents expressed a new interest in these areas and 33 % expressed having a renewed interest in the field after attending and participation at the event.

Future medical practice

Overall, the Forum provided clarity to 33 % of students who felt that the Global Health Forum "would influence or change their future decision [regarding] specialty training or practice". According to the responses provided by dental students in attendance, they were least likely to be influenced by the Forum with regard to their future career goals. The added interest affected by the health forum was relevant to general medical student academic progression. Some students concluded in open-ended questions that the Forum should continue to be a resource for general medical students, and offer improvements in terms of addressing the relevance of global health issues to future medical and dental students.

Prevention medicine

When asked specifically, "[about] remote medicine in rural areas in Tanzania, do you find a connection between vaccine preventable illnesses like pneumococcal pneumonia and increased morbidity or mortality in rural and remote areas globally?", 68.18 % of respondents answered 'yes', 22.73 % responded, 'I don't know' and 9.09 % answered 'no.'

The open-ended question, "What strategy would you use to challenge cultural perceptions to vaccines in an era where anti-vaccine maxims are growing in popularity and herd immunity may be decreasing with negative effects?," elicited overwhelming responses with an emphasis on patient empowerment and education related to the benefits of vaccines and primary prevention. Some detailed and specific responses are listed below:

> *"More governmental involvement in school, educating students and kids about vaccines. Also reaching out to small ethnicities that might not speak the language of the country they live in."*

"One strategy that could be implemented is to bring to the first world countries attention of how preventable diseases and infections due to vaccines affect developing nations, and specific populations, that do not have access to such vaccine. This could provide a real life contrast to what could happen in first world countries if this "anti vaccine" trend continues. I think people related more to situations and topics if they can put a name and a face to certain issues. Also implementing some epidemiological study/research research study to find out why anti vaccinators have this preconception about vaccines and how the trend is growing in popularity in order to target these specific issues."

"I will educate my patients on the importance of vaccination, and give them examples of how dangerous it can be when parents don't vaccinate their kids. I will explain to them how herd immunity works, and what their responsibility is."

"Three vaccine delivery strategies: 1) school-based vaccination; 2) health-centre-based vaccination; and vaccination combined with other health interventions." [sic]

"Showing the data about the reemergence of preventable illness because of absence of vaccination and emphasizing the risk and complication of every disease and further increasing the education again regarding how to prevent the diseases."

Ebola

When asked, "In the setting of an epidemic of communicable disease such as Ebola, there is increasing pressure to produce 'vaccines on demand'. [N]ame three defining factors when it comes to stemming an epidemic of this nature", many student responses focused on quarantine and travel restrictions from endemic zones. Specific responses were longer and more detailed, and offered student-based insights into this pressing global health concern:

*"There are many defining factors when it comes to stemming an epidemic… I believe that socioeconomic issues are on the forefront of the EBOV (*Ebola Virus*) epidemic; such as was war, poverty, and poor health infrastructure:*

- *1. Poor health Infrastructure has definitely helped in the spreading of EBOV. If there was a more sophisticated health care system, I believe that speed of EBOV spread might have been diminished.*
- *2. War - the region of West Africa has been in civil unrest, this causes mass movement of people, refugee, and vulnerable people, allowing for both contracting EBOV and spread.*
- *3. Culture Issues - ranging from burial practices -(where certain groups of people do not believe in cremation - which is necessary procedure in the anti-epidemic protocol) to traditional medical practices and also fear of modern medicine and health care practice."*

"Mode of transmission, animal reservoir, political factors-international cooperation to prevent and treat disease."

"Economic and public health/medical perspectives play an important role in the policy process."

"Cooperation of major producers to receive the very expensive production costs. Mobilize and organize resources, doctors and medication, development of vaccines and health equipment. Treat the infected in hospitals and try to contain the infection and setup regimes in order to prevent increased spreading." [sic]

Financial response

When students were asked, "Do you think the funding efforts by the international community are sufficient [for] controlling the epidemic?", 4.76 % answered 'more than sufficient,' 47.63 % answered 'sufficient but can do with additional funding', 38.10 % said 'barely meeting the demand' and 9.52 % answered 'I have no idea.'

State fragility and health security

When asked about state fragility, i.e., "[D]oes state fragility or failure better enable the spread of pandemics and infectious disease?", 100 % of students replied, 'yes.' When asked, "Do you think sending military assets to a pandemic zone will benefit the relief effort and lead to eradication of the disease?" 60 % replied 'yes,' 10 % 'no' and 20 % replied 'these issues are not linked.'

Among the respondents, 10 % chose 'other', with one student stating: *"I do not think it's a question of yes or no… [It depends] on the type of epidemic and the population. On one hand, the "military assets" has the advantage of stopping the spread and local control but on the other hand there are ethical problems with it. I think that good education should combine always with military entrance."*

When asked, "Despite many pundits claiming US power is declining globally, no other single country

has proposed a comprehensive response plan to the epidemic (Ebola). Is the response by US forces and public health care adequate to stop the spread, 10 % of students said 'yes,' 45 % responded 'yes, but more can be done,' 30 % said 'no' and 15 answered 'no comment.'

Climate change

Some authors purport that environmental buffer systems have been pushed to their limit as a result of climate change and degradation, and that there may be a connection between these events and infectious disease [12]. When students were asked, "Based on this hypothesis, do you think there may be more or less infectious disease outbreaks as environmental degradation continues to be challenged?", 47.62 % responded, 'yes,' 19.05 % said 'no' and 33.33 % were 'unsure.'

Hybrid war in Ukraine

More than 9250 people have been killed in Ukraine since hostilities began in 2014 with the Crimean Peninsula being annexed by Russian forces. More than two million people have been displaced from their homes and cannot access basic healthcare, water or basic hygiene services. Based on this information, students were asked, "How can NATO and more economically developed countries address the Ukrainian humanitarian disaster to encourage global health?" Responses were open-ended and focused on sending more aid, placing more political and economic pressure on Russia in a bid to stop its support of violent attacks, and even, *"by eating Putin for breakfast."* Further specific responses by student participants that focused on global health policy by student participants included:

> *"Countries have put sanctions on Russia, which to an extent is a way of showing their disapproval with Russia's action. But sanctions also affect the citizens of Russia, who have not chosen to go to war in Ukraine. And if anything, may lead to financial instability in the homes of Russian families, and from their trickling down to the clear connection of financial and social instabilities linking to worse health. Although I do believe sanctions are necessary. I do think economically developed countries need to place greater emphasis on becoming more proactive on the ground, providing proper health facilities in war zones, having safe zones accessible to all the victims of war, having water zones be safe zones and also helping allocate displaced peoples and actively communicating with all political parties in trying to resolve this issue." [sic]*

> *"The main problem as I understood that the "Humanitarian aid" could not enter or reach to the places and people in Ukraine … The effort in this days to encourage global health should be focused on clean water, food and medical supplies to "prevent" a post-disaster effect of low hygiene situations etc…" [sic]*

> *"Boycotting Russia in order to inflict a bit of pain (financially) is a further possibility and sending a team to help rebuild the foundational in health; and it can be done not by sending professionals (which obviously not everyone wants to be benevolent) but maybe by sending students as part of the education of their course … construction engineering etc…" [sic]*

Discussion

Global health as a medical specialty or discipline is still new to clinical practice and medical study. Many international medical schools have not yet adopted much of the recommended curricula put forth by the Consortium of Universities for Global Health in an attempt to standardize the core concepts and key principles for promoting best practices based on the available evidence [13, 14]. As global events affect everyone and impact human and health security, the requirement for all physicians in training, dentists and ancillary medical personnel to understand the basics of global health should be a key policy point. Increasing not only the awareness off, but also the core principles of global health, can be a multiplier of public health interventions, humanitarian response and overall evidence-based policy formation and programming. Human resources for global health will experience significant strain going forward, especially in resource poor areas, which are often found in fragile and failed states. This expertise must be cultivated through educational processes [15].

According to respondent freehand results, the international students surveyed showed a desire to learn more about pressing global health threats via a standardized format or curriculum. A third of respondents stated that the topics and ideas presented at the Prague Forum would influence or change their specialty and practice. Thus, further global health courses, programs, field activities and possibly a master's program at Charles University should be developed and rooted in global health. Open-ended responses do speak for themselves of the diversity of students, student ideas about future global health programming and prioritization of global health threats.

Limitations

The questionnaire did not collect data on ethnic background, country of origin, country of residence or the

region or country that students planned to practice medicine or dentistry in upon graduation. By not capturing this data, the conclusions drawn about student responses related to the global health prioritization of key issues and their levels of interest in doing so may have been limited. The capacity building of state and regional institutions that promote health security can improve the response to public health crises. Future Global Health Forums may benefit from capturing more specific country or region statistics as it concerns clinical practice related to current global health issues.

Conclusion

The universal promotion of global health and global health diplomacy in the medical undergraduate setting is still in its infancy. The global health paradigm is currently experiencing a moment of prolonged shock from epidemics, war and violence, climate change and resource shortages. This crisis situation may lead to decreased health security for millions of people. Medical services personnel will be asked to fulfill a greater role in responding to these challenges at clinical and policy levels. The core knowledge that healthcare personnel acquire through their training may dictate resource allocation and the prioritization of future responses to such crises. Medical practice relates not only to clinical acumen, and also gains more responsibility in terms of the policy regarding the response to global health threats; as such, medical curricula should be expanded to include more information on global health teaching. The Global Health Forum 2014 in Prague provided a venue for gauging current students' thoughts and expectations as future physicians about the current most pressing global health topics. This brief commentary describes the results of a questionnaire completed by these students that addressed novel global health considerations.

Abbreviations

HIV/AIDS: Human Immunodeficiency virus/Acquired Immunodeficiency Syndrome; ISIS: Islamic State of Iraq and the Levant/Islamic State of Iraq and Syria; NATO: North Atlantic Treaty Organization; NCD: Noncommunicable disease; PCGH: Prague Center for Global Health; PEPFAR: President's Emergency Plan for AIDS Relief; TB: Tuberculosis; WHO: World Health Organization

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Availability of data and materials

The dataset(s) supporting the conclusions of this article are owned by the Prague Center for Global Health and can be made available upon official request.

Authors' contributions

JQ and VR are co-founders of the Prague Center for Global Health (PCGH) and the lead organizers of the Global Health Forum Prague, 2014. MK is a Global Health intern at the PCGH and assisted in collating data for this research. VL, TZ and VB supported the research in terms of designing, reviewing and drafting of the final manuscript. All authors read and approved the final manuscript.

Authors' information

JQ is cofounder of the Prague Center for Global Health. The views expressed here and by fellow co authors are that of the authors and may not necessarily reflect those of the the Institute of Hygiene and Epidemiology, the First Faculty of medicine or that of Charles University.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Consent for publication was received.

Ethics approval and consent to participate

Ethical approval was granted for the study by the Departmental Internal Review Board (IRB) of the Institute of Hygiene and Epidemiology, First Faculty of Medicine, Charles University. No reference numbers were given. Consent to participate was obtained verbally at the forum and before taking the survey for each response.

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Appendix B

Quinn, J., Zeleny, T. and Bencko, V. (2016) "Public Health Crisis in war and conflict: Health security in aggregate", *Central European Journal for Public Health* (in press winter Summer 2017).

CENTRAL EUROPEAN JOURNAL OF PUBLIC HEALTH

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Our ref. no. 4455

16 August 2016

Dear Sir,

The editorial board of the Central European Journal of Public Health has decided to accept your paper:

" John Quinn, Tomáš Zelený, Rammika Subramaniam, Vladimír Bencko: Public Health Crisis in war and conflict: health security in aggregate"

for publication in our Journal in volume 2017. The requested certificate is being posted as per your request.

Yours sincerely,

Prof. Milena Černá, MD, DSc.
Head, Editorial Board CEJPH

TITLE PAGE

4455 Public Health Crisis in war and conflict: health security in aggregate

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Summary
Objective: Public health status of populations is multifactorial and linked to war and conflict. Public health crisis can erupt when states go to war or are invaded; health security may be reduced for affected populations.
Methods: This study reviews in aggregate multiple indices of human security, human development and legitimacy of the state in order to describe the predictable global health portrait.
Results: Paradigm shift of large global powers to that non-state actors and proxies impact regional influence through scaled conflict and present major global health challenges for

policy makers. Small scale conflict with large-scale violence threatens health security for at risk populations.
Conclusion: The paper concludes that health security is directly proportional to state security.

Key Words: fragile and failed states, public health, non-communicable disease (NCD), infectious disease, global health and health security

Introduction

Health security is directly proportional to state sovereignty, legitimacy and mandate to provide health services (1, 2). Health security is negatively impacted across fragile and failed states while regional conflicts intensify and manifest globally (3). The connection between violence and health are difficult to study and many approach considerations have been applied with this research. This aggregate research through core measures of country status and multiple development indices in public health and health indicators provides rigorous information as to how much the general indices relate to tangible health security. We explain that by proxy, health security is implemented by incidence of preventable disease.

Aggregate research describes data combined from several measurements, such as those related to health security and multifaceted concepts of conflict and health. Based on this aggregate research model and at the individual level of health, it is observed that health behaviours and outcomes have multi-level determinants and can be predictable (4, 5). The perspective of multi-level analysis acknowledges the importance of both individual and environmental variables in determining health behaviours and outcomes at the level of the indivisible unit and conceptualizing multiple levels of organization relevant to a particular research question and the individual (6).

Material and Methods

This research model implements aggregate analysis with spread data constructing a model by merging disease (cholera, tuberculosis, malaria and measles) into a single variable: "agreg," which is a simple sum of cumulative incidence. Incidence can be described as a rather rough variable to implement in such an analysis as attributes of disease used in the aggregate analysis are extremely diverse. These ailments affect different populations globally and are widely dissimilar in general but are preventable.

Statistically however, generality is not lost due to disease burden; public health infrastructure and prevention programs aimed at mitigating these diseases when following best practices are similar in nature. For example, measles, cholera and TB are preventable through vaccination, albeit with varying seroconversion and efficacy rates, and malaria is preventable through primary prevention measures (chemoprophylaxis, mosquito bed nets and sprays, prompt diagnosis and initiation of effective therapy). Diagnosis of these diseases can be performed clinically or through bedside diagnostic procedures. However, these diseases can

be difficult and expensive for poorly resourced public health infrastructures to prevent and treat.

Finally, measles, cholera, tuberculosis and malaria are endemic in much of the resource poor and developing world; these regions are where fragile and failed states originate and thrive. Thus, an argument that populations are or would be indifferent about getting these diseases is rejected. This variable is the proxy for health security, as a high risk of exposure to deadly infectious diseases is a prime example of inadequate health security and the variable itself is not interdependent with other variables (indices implemented with this research do not have incidence of infectious diseases included), which allows for clear statistical analysis.

The multiple indices used in this analysis involve high-level data composed of a multitude and combination of individual data. By combining multiple indices with data sets for economic, health, social and behavioural, political, security and overall health status, this aggregate research concludes on human health trends in the data that indicate health status – the health security environment or portrait. The indices used are listed in table 1:

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table 1

Failed States Index (FSI)

The US Fund for Peace publishes the annual Failed States Index (FSI) listing those countries who are failed states or in great risk of failure. There are multiple metrics that rely on key social, political and economic indicators that compose this index. The reason for inclusion of this index into the aggregate analysis is that the included diseases are preventable through vaccination programs promoted by state health ministries and departments, as well as, through basic public health and hygiene measures (clean water, access to night-time mosquito nets or repellents, immunization and educational programs etc) based upon health security infrastructure promoted by organized, transparent and properly funded state governmental health institutions.

Humanitarian aid programs are great but can be very inconsistent, have difficult successes that are not reproducible and are under donor strain given global social, political and environmental complex emergencies; oftentimes, strong state institutions may have been a better alternative when possible that just sending short lived aid (7, 8). The assumption and expectation in using the FSI for this aggregate analysis is that states in the absence of or decreased exposure to conflict and war will be stronger states, will not be fragile or failing states and will promote health security for the population (correlating with an assumed lower incidence of measles, cholera, tuberculosis and malaria).

State Fragility Index (SFi)

The State Fragility Index (SFi) combines scores measuring two essential qualities of state performance: effectiveness and legitimacy. These two quality indices combine scores on distinct measures of the key performance dimensions of security, governance, economics,

and social development. The SFi utilizes a set of eight indicators in order to measure state fragility in previous years and examines changes in each indicator over time (9). The SFi helps look at state fragility overall.

Public integrity index (PII)
Public integrity index (PII) is a more focused index which captures on the quality of state-granted institutions in the given country. The difference between this index and the rest is that this one is not focused on the population per se, but solely rates the quality of institutions that are provided within the country (10). In terms of this paper this is almost a key index, because it is very focused and comes from a different methodology, which allows it to function as a control to the other, global in nature, indices.

Political instability index (PI)
This index defines political instability as the propensity of a government collapse (11), upon which is originally estimated a model in which political instability and economic growth are jointly determined. In our paper, we continue upon the index as it connects the economic nature of states with its stability. It our analysis, the index functions as second control, which is more focused and does therefore counter-balance the otherwise global indices.

Human Security Index (HSI)
The Human Security Index (HSI) covers 232 countries and societies, and is not intended to become an annual index for publication but rather is a result of over 25 years of indicator development. Steady advances in characterizing different aspects of the human condition have resulted in indicators, covering increasing numbers of countries, on a wide variety of subjects; the HSI is an attempt to create an index on people-centric Human Security (12). Components of the HSI include data from the Economic Fabric Index (EFI), Environmental Fabric Index (EnFI) and the Social Fabric Index (SFI). In sum, the HSI can be considered as an index of 30+ leading economic, environmental, and social indicators related to health and state stability (12).

Economic Fabric Index (EFI)
The Economic Fabric Index uses Gross Domestic Product (GDP) per capita, adjusted for pricing; purchasing power parity (PPP, a theoretical exchange rate as opposed to the real one. Purchasing power parity attempts to eliminate the fluctuations in observed exchange rates by recalculating the exchange rate using a standard basket of goods, thus making comparisons of prices across different countries much more accurate in terms of real value), equality of income distribution (income and finance distribution); and Financial-Economic Governance, which is described as the risk of hardship through unsustainable trade or debt, or from catastrophic health care governance disaster. The EFI is implemented in this aggregate analysis for economic status of the population and is the reason not to include GDP per capita alone, as it is of much bigger interest when combined with other main economic factors, especially income distribution, than as a standalone variable. Economic security is directly linked to health security.

Environmental Fabric Index (EnFI)
Environmental Fabric Index (EnFI) uses environmental vulnerability, environmental protection (access to clean water, etc.), policies and deliverables and overall environmental sustainability in a population. The Environmental Fabric Index blends risk of environmental disasters, environmentally healthy living conditions, environmental sustainability and governance (13). This index basically ranks the studied countries in terms of the results of state action in the area of environment and directly connected factors. Environmental Fabric Index is the main variable that contains environmental information for the HSI.

Social Fabric Index (SFI)
The Social Fabric Index (SFI) lists health education and information empowerment, protection of, and benefits from, diversity and peacefulness governance, including protection from official or illegal corrupt practices and food security (12). In its essence, SFI ranks the country in terms of those social factors, which are a direct result of state activities. This is very powerful as the information in this combined index is much more valuable as it captures a descriptive side of society.

Literacy Rate (LR)
Literacy rate is the percentage of people who are literate in a given country. The importance of this factor is indirect – it is expected that a more literate population would be able to inform itself better about the prevention of disease (especially measles, cholera, tuberculosis and malaria), as well as, educate itself about health promotion in general for the family unit, and would be able to demand health security promotion and measures in the form of policy from state institutions and empowerment. An illiterate population increases public health risk and may be linked to poor health security status and state fragility.

Life Expectancy at birth
This variable serves for comparison of results. The comparison of results as to how much do the indexes explain the incidence of preventable lethal diseases and how much they explain the actual life expectancy. In global health, policy and resources are devoted to reducing the incidence, duration and severity of major diseases that cause morbidity but not always that of mortality, and to reducing their negative impact on human life (14). Infant mortality and ensuring political crisis is not proposed to be linked, however, infant mortality is a better indicator for democracies prone to failure than it is for less democratic states, as well as, an indication of maternal health security (15, 16); it is important to capture both fatal and non-fatal health outcomes in a summary measure of average levels of population health. Healthy life expectancy (HALE) at birth adds up expectation of life for different health states, adjusted for severity distribution making it sensitive to changes over time or differences between countries in the severity distribution of healthy states (17).

Preventable Illness and Infectious Disease

Conflict and war are inextricably linked to human disease and deterioration in health security (1, 2, 18, 19, 20). Many infectious disease are preventable through vaccination, simple prevention measures and basic access to standardized primary health care. Measles, cholera and tuberculosis (TB) have been selected as leading infectious diseases to find linkages to that of health security reduction in conflict areas. Routine measles vaccination for children, combined with mass immunization campaigns in countries with low routine coverage, is a key public health strategy to reduce global measles deaths (21,22). More than 20 million people are affected by measles each year (21). The cholera disease burden is estimated at 3 to 5 million with cases and 100,000–120,000 deaths due to cholera every year and approximately 80 percent of cases can be successfully treated with oral rehydration salts and even prevented via vaccine (14). Areas with low sanitation and no potable water due to war and conflict are at increased risk of cholera. It is estimated that approximately 1/3 of the world's population are infected with TB, that there are 8 to 9 million new cases of TB and nearly 2 million deaths each year from TB (22). Globally, malaria is the most important parasitic disease that threatens health security as annually.

Results

The analysis of the data is done through a two (2) stage least squares (2SLS) method where it is instrumented by the Failed States Index (FSI) and by the Social Fabric Index (SFI). The reason is that the FSI is rather a general observation index and thus it is expected it to be correlated by any variable that is not put into the equation making it in the residual. For SFI however, it is very highly correlated with FSI and is a rather restricted index, so to assume that its correlation with non-included variables is non-existent or at least very small as their relationship would be highly indirect. For most variables, observations for different years are not identified; the only data available are in a cross-sectional format. In order to counter heteroscedasticity, White robust residuals are implemented.

For the 2SLS estimation, first the FSI is estimated by the SFI. The results are in table 2:

Table 2 in here

To answer the initial question, the most natural testing method is a simple linear regression in form of:

 (equation 1)

This trivial method gives FSI as a significant (p-value < 0.001) variable for explaining the incidence of preventable infectious diseases. But, the overall explanatory power seems rather limited as the coefficient of determination is only 0.10. In order to get a more practical answer, an extended model is implemented. The model takes the following form:

$$agreg = \beta_0 + \beta_1 * IVFSI + \beta_2 * PI + \beta_3 * GI + \beta_4 * EFI + \beta_5 * EnFI + \varepsilon$$

(equation 2)

Instead of the Human Security Index (HSI), the main three parts are used – the Economic Fabric Index (EFI), Environmental Fabric Index (EnFI) and Social Fabric Index (SFI).

Social Fabric Index is, however, already being used for FSI instrumenting, so it isn't used in the estimation by itself. The model estimation results are the following table:

Table 3 in here

The explanatory power of the model has improved significantly to 0.2253. While that is still not high, given the size and variance of the examined sample, it is not insignificant. What is more intriguing, are the specific results themselves – FSI and Political instability index (PII) turned out to be completely insignificant with respect to the dependent variable, while the Public Integrity Index (PII) takes over as the main explanatory variable.

The Economic Fabric Index (EFI) and Environmental Fabric Index (EnFI) are also fairly significant, but surprisingly at a rather lower level, yet their coefficients have a level higher coefficient compared to the other variables, suggesting their potential impact may be much higher. This means that the Failed States Index (FSI) on a global scale is rather unable to explain incidence of infectious diseases, which may be against conventional expectations. The model also provides a prompt explanation – the FSI does contain mostly government stability themed components.

With the political instability index by itself being irrelevant, the FSI takes over the insignificance as well. The problem is much more technical than social, as the results suggest what truly matters is the ability to take actions through strong, transparent and accountable institutions through evidenced based policy implementation, for as long as the institutions necessary for such a move exist and are operational, the remainder of the public sector status of the state is irrelevant. The higher magnitude factors are population income and environmental conditions, the former is the obvious indicator of whether people can prevent the contamination by infectious diseases by themselves while the latter is a good indicator of likelihood of contracting the disease given the environmental condition. So, while the external conflict or in general political instability may have an adverse effect on the creation of necessary policy institutions, it's the institutions themselves and fundamental factors (economic and environmental conditions) that play the major role in infectious disease prevention, and possibly in ensuring health security for populations.

The main issue of the previous model is that health security is not only the incidence of preventable infectious diseases, but includes many other factors. Thus, these results reflect only a part of the portrait. So, in order to solidify these results, the same model is made but with a wider dependent variable, one which includes health security and, unfortunately, many more variables. The average result of the smaller and larger model should then be a more accurate result than that of any single of those models. For the dependent variable life expectancy (LE) is used. The model calculation is seen below:

$$le = \beta_0 + \beta_1 * IVFSI + \beta_2 * PI + \beta_3 * GI + \beta_4 * EFI + \beta_5 * EnFI + \beta_6 * agreg + \varepsilon$$

(equation 3)

And the results of its estimation are the following:

Table 4 in here

The results are quite different from the previous case. The Failed State Index (FSI) and is very significant in this model with life expectancy decreasing in increasing values of FSI, much as would be predicted. Public integrity index (PII) have remained around the top of the explanatory variables as it is still highly significant. The Environmental (EnFI) and Economic (EFI) fabric Indices no longer share the same importance – the Economic Fabric Index plays almost six times as much impactful in scale as the environmental fabric index, which has lost importance in this model and has become barely significant.

As for scale, since FSI is approximately 100 times larger in units than the EFI and EnFI, it has about the same effect on life expectancy as the level of income, only in the opposite direction. Economic situation of a country or population has then about twice as much impact as these other variables. Finally, the coefficient of determination is up to 0.6907, which is more than double that of the previous model. That suggests that there is much less unexplained variance than in the previous case, which is both expected and important as it should be the case that aggregate variables (in our case the indices) are better at explaining other aggregate variables than concrete ones.

Comparing the results of both models, they fit perfectly. For the economic and environmental fabric indexes, we made a case for health security to be well instrumented by incidence of preventable infectious diseases. Their switching roles when it comes to diseases and life expectancy is perfectly logical, because life expectancy requires significantly more factors which are influenced by an individual's income than prevention of infectious disease. Furthermore, life expectancy has more factors involved that are more important than the environment alone. Avoiding mosquitoes and other infectious but preventable illness from birth in sub-Saharan Africa is extremely difficult, but an individual can extend his life through healthy lifestyle, including access to nutritious and abundant food, and when having access to quality primary health care and disease prevention in general – this is the environment that engenders health security.

Conclusion

This aggregate research has reviewed indices and variables related to public health in countries that are in crisis and thus fragile, to the point where some could be marked as failed states. The FSI used to measure the quality of national level institutions (FSI) does not capture all variables related to state fragility and health. An explanation is provided by the economic and environmental fabric indexes. They both have a very large impact on the incidence of preventable infectious diseases and give a new context to the issues faced by the state in providing an environment for health security.

The matter is split into two levels – the primary cause and the resolution of effects. The primary cause seems to be the quality of the environment, which greatly reduces the incidence of preventable infectious diseases. In parallel, there is a nationwide issue of improving the quality of the environment that is rather impossible at a level of an individual. Environmental policy is difficult to tackle even in terms of a single state as the environment is rather global in nature, resulting in poor health effects from a bad environment being transborder. On the other hand, what is capable of mitigating the problems caused by poor environment is personal wealth (which is captured by the economic fabric index as its main component is income per capita); indeed, economic security can and in significant amount of cases does dictate health security.

To summarize, the data suggest that to improve health security in fragile and failed states, policy focus should seek to resuscitate fragile states, mitigate the loss of failed states, provide health security in the form of prevention, prevent environmental degradation, engender economic security, improving environmental conditions that affect health. It also suggests that empowering the population in terms of personal freedom and wealth greatly increases the ability of a population to counter the impacts of poor environmental conditions by itself.

Limitations

The Failed State Index (FSI) is contested as a good aggregate to review the listed variables. Some opponent researchers describe the index as deficient, stating the index to be counterproductive to states as diverse as Colombia, Malawi, Somalia, Iraq, Haiti, and Tajikistan with data in aggregate. The main points of contention with the FSI relate to the inability to distinguish capacity gaps, security gaps, and legitimacy gaps that states experience; and that these gaps often do not coincide in a given country, and that the logical responses to each of the three gaps diverge in significant ways (23). Lastly, HIV/AIDS status and associated data were not directly used in this analysis as health indicators due to the disproportionate geographical representation and disease burden.

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Conflict of Interest: The authors have no disclaimers or conflicts of interest to declare.

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Legend:
Tables

Appendix C

Quinn, J., Zeleny, T., Stoeva, P. and Bencko, V. (2016) "Public health crisis: The need for primary prevention in failed and fragile states", *Central European Journal for Public Health* (in press Summer 2017).

CENTRAL EUROPEAN JOURNAL OF PUBLIC HEALTH

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Our ref. no. 4671

16 August 2016

Dear Sir,

The editorial board of the Central European Journal of Public Health has decided to accept your paper:

" John Quinn, Preslava Stoeva, Tomáš Zelený, Toozy Nanda, Alžběta Tomanová, Vladimir Bencko: Public health crisis: the need for primary prevention in failed and fragile states"

for publication in our Journal in volume 2017. The requested certificate is being posted as per your request.

Yours sincerely,

Prof. Milena Černá, MD, DSc.
Head, Editorial Board CEJPH

for

TITLE PAGE
4671 Public health crisis: the need for primary prevention in failed and fragile states

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Summary
Aim: A new 'normal' in global affairs may be erupting from large global powers to that of non-state actors and proxies committing violence through scaled conflict in a post-Westphalian world generating significant global health policy challenges. Health security of populations are multifactorial and indirectly proportional to war, conflict and disaster. Preventing conflict and avoiding the health vacuum that occurs in war and violence may be best practices for policy makers. This paper considers an approach of applying clinical primary prevention principles to global health policy.
Methodology: Brief policy review of current standards and practices in health security, fragile and failed states and prevention; and definitions discussion. A short case study series are presented with best practices, with risk and outcome review.
Findings: The global balance of power and order may be shifting through geopolitical transference and inadequate action by major global power brokers. Health security in at risk nation-states may be decreasing as a result.
Discussion: Small scale conflict with large-scale violence threatens health security and may experience increased incidence and prevalence in fragile and failed states. Preventative policy to resuscitate fragile and failed states and prevent further external and internal shocks may support health and promote a positive feedback loop of further state stability and increased health security.
Conclusion: Public health policy shift to mitigate state failure and public health crisis in war and conflict through the basis of primary prevention may provide best practices and maximize health security for at risk populations.
Key Words: fragile and failed states, infectious disease, non-communicable disease (NCD), primary prevention, evidenced based policy and health security

Introduction

Violence, trauma, war and conflict decrease the health security for communities. However, identifying links and determining causation remains a major challenge in the literature. Empirical studies focusing on direct retrospective data of states and the health of populations may offer a novel approach to the war and health challenge. Aggregate research has shown that health security diminishes in war, conflict, failed and fragile states (1). This article discusses ways to reverse some of the decline and focuses on the case of failed and fragile states.

While there is no universally agreed definition of state failure, fragility and collapse, some indices and criteria have been proposed by global institutions, governments and academics (2). Some of these overlap but do not align, feeding controversies over the meaning and exact parameters of state failure (3, 4). For the purposes of this article, we define as failed those states that have lost the ability to provide the most basic of services to their constituencies, and fragile as those on the brink of losing such ability (5, 6). Such services include functioning infrastructure and institutions that are expected to provide primary health services, prevention programs along with key infrastructure that engenders health for the population.

The health security of populations living in fragile states requires provision of access to primary healthcare services that deliver disease and injury prevention, not just emergency care. Public health security is seen here as encompassing protection from environmental and behavioral health risks, basic protection against both communicable and noncommunicable disease, as well as the provision of primary, secondary and tertiary prevention programmes.

In clinical medicine, primary prevention stops disease or injury before it starts; secondary prevention reduces the impact of disease or illness after the process has already begun; and tertiary prevention lessens the impact of a disease process already underway. Prevention programs reduce morbidity and mortality. Prevention of disease saves lives, is immeasurably more cost efficient compared with treatment, and defines current best practices in public health. This article advocates prevention as an approach to global health policy for populations of decreased health security in fragile and failed state settings.

Health Security in failed and fragile states

The concept of health security is not consistently defined in the literature, its meaning being associated with human security, national and global public health security, securing and promoting the health of individuals and communities (7). Every one of these aspects is affected in failed and fragile settings. Fragile states experience a slow disappearance of state institutions and reduction in the rule of law, which brings about a deteriorating human and health security environment, destabilizes surrounding countries and encourages corruption and disrupts economic practice (8, 9, 10). Fragile and failed states have no safe, fair or legally regulated marketplace, leading to black-market economies and illegal arbitrage becoming widespread for basic goods, including health service provision.

When states experience fragility, failure or collapse, they cease to deliver basic human and health security or any level of public health. The government loses credibility, and the state becomes questionable and illegitimate in the hearts and minds of its citizens (11, 12). Fragile and failed states exhibit an increased propensity for conflict and violence, and a decreased ability to provide basic public health infrastructure to prevent, diagnose, provide adequate disease surveillance and combat infectious disease – leading to a significant decrease to health security (13, 14, 15, 16). Figure 1 summarizes the contributing factors to state failure and the potential link to public health crisis.

Figure 1 here

Conflict and war have already been inextricably linked to the spread of disease and deterioration in health security (13, 17, 18). Conflict threatens health security as it leads to an increase in infectious disease, preventable trauma, malnourishment and mental health disorders (9, 19, 20). Preventing state failure and conflict, therefore, can lead at least in part to increased health security. Policy highlights underscore patience of action - gradualism over

short lived gaines, and tailored responses that address specific state needs - not a panacea; but informed policy can enhance effective governance through a variety of models attuned to local patterns and needs, in advisory and supportive ways (21). Taking into account existing studies of the consequences of conflict and state fragility on health security, along with empirical studies would provide a better foundation for such informed and evidenced based policy.

Methods

Current understandings of defining and promoting health security, along with key definitions of state failure and fragility, as well as clinical prevention, as an approach to health security policy are discussed in relation to the case studies of Ukraine and Syria and the challenge of a vaccine preventable disease. We implement these two case studies to assess the value of a policy of prevention, its potential benefits and drawbacks to health security and state stability.

Case studies in policy research and public health practice offer evidence, based on a specific set of variables and factors that can be tracked over a specific period of time with finite outcomes (22). The use of polio as the main research instrument yields the pathological sequelae of current warfare and instability and its effects on public health. Polio is vaccine preventable and had a greatly diminishing incidence and prevalence until recent conflict and state instability in places like Afghanistan, Pakistan, states affected by the Arab spring and more recently Ukraine. The use of Polio as an indicator of health security in war in recent research has been accepted as a barometer of health systems (23, 24).

Findings

Case 1: Ukraine

Background

Former Ukrainian president Yanukovich's refusal to sign an agreement bringing Ukraine economically closer to the EU in November 2013 set off a political and social revolution. Following the unrest and the ousting of the president, the Crimean Peninsula was annexed violently by Russian forces. The two Regions of Donetsk and Luhansk were invaded and propped up through Russian backed separatists through *de facto* control of violence and body count just under 10,000 in late 2015 (25). There are currently areas within these the Donetsk and Luhansk regions of Eastern Ukraine that are under Ukrainian government control and others that are not; Crimea is no longer under any Ukrainian control. Due to the conflict, basic services such as water, sanitation, hygiene, medical and primary health services, roads and infrastructure are not consistently accessible or safe in at-risk government controlled areas or for many non-government controlled areas. Social and political systems of Ukraine prior to street protests calling for democratic reform were not well funded, but functioning at a basic level. Furthermore, healthcare systems in Donetsk and Luhansk (also referred to as 'Donbass') were performing very well for Ukraine. The revolution and conflict have destabilised these services, serving as a threat to the overall stability and legitimacy of the state.

Health System weakness
The revolution has posed significant challenges to Ukraine's health care system. Over 5 million people are at risk of violence, over 1 million displaced and the at risk. Pediatric and geriatric populations are most vulnerable to preventable illness. The Ukrainian health system was weak before the crisis and is now on the verge of collapse in areas affected by combat, areas with high Internally Displaced Peoples (IDP) loads, and regions requiring surge capacity and resilience to disruption of service delivery from the security crisis. About 30 to 70% of healthcare workers have fled the combat areas or died, healthcare provision has broken down and no supplies are available to replenish basic medical goods or vaccinations (26).

Due to the recent law that limits Ukraine's support to the Donbas region, many people living there are deprived of primary healthcare services. Comprehensive reports about civilian casualties from fighting are still pending for 2016 reporting, but since the beginning of the conflict in mid-April 2014 and until 19 February 2015, at least 5,793 people (including 63 children) were killed and 14,595 (including 169 children) were wounded in the east of Ukraine (27). The health system in Ukraine, in other words, has come under increasing strain within a deteriorating situation of state fragility, political tensions and instability. This has had an effect on the delivery of primary prevention, which is discussed in the next section, with a specific focus on the status of polio vaccination programmes.

Primary prevention - the case of polio
As a result of political instability, financial deficit, an ineffective and possibly corrupt procurement system at the Ministry of Health in Ukraine, the government tender process for procurement of vaccines for 2014 has not been fully implemented. Regional stocks of vaccines have already been exhausted. The average vaccination coverage in the country for some diseases is well under 40% (28). In some regions and communities most children have not been vaccinated at all since mid 2014. Given the large population displacement and the lowest immunization coverage in Europe, Ukraine remains at high risk of communicable disease outbreaks, especially among children. WHO predicted that outbreaks of polio and measles were likely throughout the summer of 2015. When in late summer 2015 positive cases of polio were identified with paralysed children, panic and humanitarian response were in crisis mode.

In an effort to bolster these needed vaccines, Sanofi-Pasteur has sent millions of Oral Polio vaccines for immediate use. However, the Ukrainian Council for Patient's Rights and Safety alleges these vaccines are unsafe due to cold chain management - alleging the frozen vaccines were partially thawed while in air transit to Ukraine from the manufacturer. Although the World Health Organisation (WHO) says the transport and refreezing were carried out in line with international best practice, the complaint alleges that the process contradicts a set of Ukrainian guidelines that state the vaccines cannot be refrozen. The outcome of their use is

pending as of drafting of this paper. The at risk pediatric population awaits bureaucratic decision making and possibly corrupt practices.

Discussion

This short case study reveals the consequences of state instability and possibly state failure, demonstrating how it deteriorates health systems and healthcare infrastructure ultimately increasing morbidity and mortality from preventable diseases. Disruptions and shocks to public health infrastructure from state fragility and conflict have an effect not only on positive polio cases but increase the threat and risk of other vaccine preventable illness (both human and non-human transmission (i.e. tetanus)). These continue to impact a shaky public health infrastructure in a fragile state and beg a broader question about the relationship between the health security of populations and state stability.

Case 2: Syria

Background

In late 2010, the Arab Spring erupted in Tunisia triggering a regional upheaval, social and political revolutions spanning North Africa and the Middle East. As old regimes were challenged or overturned in Tunisia, Algeria, Egypt, Libya, Lebanon, Jordan, Morocco and Iran, Syria showed many signs of being next in line for democratic transition. As violence spread, multiple factions and groups took to the streets throughout the country and a civil war mushroomed into a major regional crisis. In the past 4 years of war, more than 250,000 people have died and more than 11 million have been displaced (29).

There has been international concern over the suspected use of chemical weapons, barrel munitions, and mass murder. There has been no official confirmation as to whether the Syrian state has carried out these attacks, or how other fighters may have retaliated but chemical weapons have been used and many have been killed (30). The Syrian state meets the criteria not only of state failure but also Zartman's criteria of state collapse where 'the structure, authority (legitimate power), law, and political order have fallen apart and must be reconstituted in some form, old or new' (31). It no longer controls core state functions, has little control over its territory, and has been unable to provide basic services and protection for its population since 2011-2012. The Russian Federation has recently (October 2015) committed to support the Syrian state by propping-up the Assad Regime at all costs (32). However, based on the past 5 years of the Assad's policy focus of centralizing power, it is unclear if it would be able to make good on any state based basic services, healthcare infrastructure provisions or other measures that promote health security at least in the near future.

Health System collapse

In mid October, 2015, over 35,000 people became displaced in Hama as a result of a renewed government offensive supported by Russian airstrikes (33). It is possible that external and internal shocks from the Islamic State in Iraq and the Levant (ISIS/ISIL) have fomented and exacerbated the crisis, leaving in its wake no access to any healthcare services for millions of people. The UN Office for Coordination of Humanitarian Affairs (OCHA)

and UNHCR estimated that 'by mid-2014 10.8 million of Syria's population was affected by the conflict and in need of humanitarian assistance, including 6.5 million internally displaced persons' (34). The European Commission reports that 'the long-lasting consequences of the conflict with shortages of qualified medical personnel and life-saving medicines, and the destruction of health infrastructure have left many [in Syria] without access to basic medical care. In effect, the Syrian healthcare apparatus is defunct and no longer providing for its people.

Medical facilities continue to be targeted by aerial bombardments, resulting in fatalities and destruction of facilities. Delivery of essential medical supplies and equipment, especially in opposition-controlled areas, is often blocked and the provision of aid to besieged and hard-to-reach areas is particularly difficult' (33). With Russian backed bombing campaigns against multiple targets in Syria, coalition-backed aerial bombing against ISIS/ISIL targets in Syria and Iraq, the delivery of humanitarian aid and basic health services remain under great threat.

Primary prevention - the case of polio

Political instability and conflict has disrupted the public health infrastructure in Syria, including pediatric access to primary healthcare and has blocked routine vaccines for millions. Routine vaccines (e.g. polio, tetanus and measles, mumps and rubella and others) have not been administered to many communities and populations at risk. In late October 2013 over 10 cases of polio were confirmed, followed by another 14 in early 2014 and 20 for the rest of the year, with paralysis of one patient in late December 2014 (23). Prior to the current outbreak, Syria's last confirmed polio case was in 1999. Syria had remained polio-free until October 2013 when wild poliovirus was confirmed in Deir ez-Zor and Aleppo (35). The rapid growth in cases coincides with the continuing period of turmoil and violence, demonstrating a causal relationship between state failure and the lack of provision of primary health care and prevention, which has also become a source of health insecurity.

Discussion

The case studies of Ukraine and Syria demonstrate how different two situations can be while still falling in the same broad category of state fragility and failure. These two cases illustrate the relationship between political instability and the weakness or failure of health systems and the delivery of health services. It has already been documented that conflict increases the strain on health services, but here we demonstrated that the latter are also challenged by the inability of governments to exercise effective authority and control over the territory and population of their state.

While international responses to state fragility have been limited, they have tended to focus on the delivery of emergency care. Conflict and state fragility, however, affect the infrastructure that enables the provision of routine health services. Polio immunisation is taken here as a research instrument through two case studies to illustrate how failure in the provision of routine health services in fragile state settings has long term consequences. What empirical research has found in comparing these two current situations of internal

conflict combined with state fragility, is that two similar situations have had different outcomes. The incidence of polio in Syria is larger than that in Ukraine on a real number basis. We believe these differences are due to two main factors - the condition and strength of the health system prior to the situation of conflict and fragility and to the intensity of the conflict itself, which further hinders health services provision. A stronger Ukrainian health system prior to conflict may have a higher compliance to vaccination and primary prevention programs leading to a larger herd immunity effect, protecting more at risk non-vaccinated individuals.

International responses to crisis and disasters should focus not only on emergency medical support, but also on the provision of routine primary prevention. In political terms, the international community should pursue the goal of preventing state failure and the resuscitation of failed states, so as to engender an environment for transparent and accountable health related institutions and maximize health care outcomes - directly benefitting the populations they serve. This can include primary prevention in the form of primary healthcare services to the pediatric population with basic and advanced vaccination programs; secondary prevention for non-communicable diseases in the form of screening for middle aged and geriatric patients that may have diabetes, hypertension, cardiovascular disease, cancer and many others; and finally tertiary prevention, mitigating all of the above from causing further health status decline across all patient populations through medical care, education and lifestyle changes. Preventing war, conflict and violence will increase health security; these factors may also be affected by preventing state failure.

The prevention concepts listed above are not a policy of action that can be perverted to defend invasion, control of violence from one state to another or more killing. Rather, a policy of prevention, rooted in best practices and evidence-based policy, must be a gradual process that stable states offer to fragile states through patient, long-term, mostly advisory and humanitarian aid relationships. Possibly based on such activities as direct economic assistance focused to local needs; training of civil staff, academic and governmental exchanges, and other human-capacity development programs; military-to-military ties (M2M) that deconflict previous emphasis on destruction and instead on disaster risk reduction; trade and investment policies that reduce exploitation - all reinforcing the state and creating an environment for improved healthcare provision. Early warning systems that focus on metrics associated with fragile and failed states should indicate states' status on the continuum of fragility and failure in order to assist and support donors, from the public and private aid community in prioritizing policy focus (36).

Limitations

This short case study approach to complex issues such as health security, global affairs and preventable illness is limited by the amount of data reviewed. Case studies for preventable illness of polio in war and conflicted states may not be the best marker or indicator for health of a population. Data related to population titres and seroconversion rates of selected preventable illness may prove to be a more robust and powerful study in relating state

stability to health. Clearly, these topics are insufficiently studied and reported in the literature. This question about the relationship between health security and state security is both fascinating and underexplored. Linkages of state and health and the question of causality, (i.e. does it flow from state to individual, individual to state or is the process more complex?) are yet to be described or answered. More detailed relationships of health and state stability can better describe these potentially causal relationships.

Conclusion

Mitigating state failure and reviving fragile states must become a key policy objective for development and public health programming for states in crisis – fragile states are not preordained to state failure or absolute collapse. Failed states, conflict and health security are linked. Small scale conflict and large scale violence both threaten public health security. Health security can be gained in part through primary health care access and vaccination and prevention programmes.

Country-specific approaches to encourage the rule of law, transparent and representative institutions, to limit state controlled violence, and foster environmental integrity must comprise any political action. Such efforts are best delivered via concerted international efforts - including programmes by intergovernmental institutions, the International Committee of the Red Cross (ICRC), humanitarian agencies, civil society organisations and other donors - rather than by means of sovereign states intervening militarily in other sovereign states. Preventing public health crisis in fragile and failed states through a policy of prevention ought to incorporate the provision of adequate food, sustainable shelter, water, sanitation, adequate vaccination programs and access to primary healthcare services (37, 38).

Failed or failing states are likely to present complex political and security situations, defined by a high degree of instability and risk of violence. Since degrees of instability and state control over civil strife situations may vary, other ways need to be established to provide preventative health services in order to guarantee the right to health to all people.

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Figures

Figure 1. Contributing factors to state failure and the potential link to health security and public health crisis

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