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Pandemics, Famines, and Global Development

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Policy Brief

WorldTAP: Accessing knowledge, and technologies through information training, capacity building and networking

WorldTAP

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It is said that following pandemics, people want to forget and return to what they consider normal. There is evidence, however, that what has been normal for the last 225 years is three pandemics per century, in addition to multiple famines. This makes it important for society to prepare for a pandemic in the middle of the 21st Century in addition to significant food insecurity in some local regions. The lessons learned from the COVID-19 pandemic of 2019-2022 must become key aspects of global development designed to bring society and the planet to a more resilient and better state. In addition, it is important to have community, family, and individual-based historical information related to pandemics and famines. To assist in achieving this, the senior author (SA) has chosen to record his personal recollections as footnotes. *Pandemics, Famines, and Global Development* is designed to provide information valuable for planning to minimize negative impacts of future pandemics and famines.

Pandemics

Humans (*Homo sapiens*) originated in Africa several hundred thousand years ago. Following the retreat of glaciers, the societal structure of small hunting and gathering populations was replaced by agriculture and permanent communities. Increased population densities most likely resulted in increased risk to the intra-community and inter-community spread of infectious diseases. Throughout recorded history there have been more than a dozen major pandemics resulting in significant human mortality and societal disruption (Table 1). The first documented pandemic took place nearly 2.5 thousand years ago.

Table 1. Dates, causes, impacts, and duration of fifteen pandemics.

Pandemics[1]	Date	Cause	Mortality[2]	Duration
Peloponnesian War Plague	430 B.C.	Bacterium	100,000	3 years
Antonine Plague	235 B.C.	Virus	7,500,000	15 years
Cyprian Plague	252 A.D.	Unknown	5,000/day	190 years
Justinian Plague	541 A.D.	Bacterium	37,000,000	300 years
Leprosy Pandemic	1200 A.D.	Bacterium	Early death	300 years
Black Death Plague	1347 A.D.	Bacterium	37,000,000	5 years
Columbian Pandemic	1492 A.D.	Multiple	55,000,000	200 years
Cholera Pandemic	1817 A.D.[3]	Bacterium	8,750,000[4]	7 years
Bubonic Plague	1855 A.D.	Bacterium	12,000,000	75 years
Russian Flu Pandemic	1889 A.D.	Virus	1,500,000	3 years
Spanish Flu Pandemic	1918 A.D.	Virus	500,000,000[5]	2 years
Asian Flu Pandemic	1957 A.D.	Virus	1,000,000	2 years
AIDS Pandemic	1981 A.D.	Virus	51,000	1981 to present
SARS Pandemic	2003 A.D.	Virus	774	1 year
COVID-19 Pandemic	2019 A.D.	Virus	*ca* 6,000,000	2019 to present

[1]Key pandemic dates and mortality/duration are based on compilations from various online resources.
[2]Estimated human mortality.
[3]First of a pattern of three pandemics every 100 years during recent centuries.
[4]Estimated human mortality in India.
[5]Approximately 25% of global human population.

It is highly probable that pandemics caused by bacteria and viruses regulated human populations for thousands of years before the Peloponnesian War Plague. While current global human population density is approaching 8.0 billion, it did not reach 1.0 billion until slightly more than two centuries ago. A recent research paper provided molecular evidence that an ancient coronavirus existed in East Asia about 20,000 years ago. Another molecular study found the bacterial pathogen of Bubonic Plague associated with 2,000-year-old human bones.

The Peloponnesian War Plague (430-427 B.C.) was the earliest recorded pandemic. It took place in Greece during the war between Athens and Sparta. Wars and travel are commonly associated with pandemics. The Peloponnesian War Plague resulted in the death of an estimated 100,000 people in Greece. Based on symptoms, the disease is believed to have been Typhoid Fever. Pathogens that cause pandemics are never truly eradicated. They survive to cause individual illnesses and infectious diseases of regional significance.[3]

Bubonic Plague is an example of a recurring pandemic. This infectious disease is caused by a bacterium vectored (moved from a diseased to a healthy organism) by rat fleas. It resulted in the Justinian Pandemic, the Black Death Pandemic, the Great Plague of London, and the Third Plague Pandemic of 1855. During Soviet times, the USSR had a complete branch of government for plague management. The Bubonic Plague was brought to Italy in 1347 A.D. by individuals traveling by boat from the East. This is highly reminiscent of how COVID-19 was likely introduced into the U.S.A. as infected individuals arrived by air travel from infected locations. In 1994, there was an outbreak of Bubonic Plague in India due to local customs that prevented rat control. During the past century, about ten individuals died every year from Bubonic Plague contracted from rat fleas in the western mountainous regions of the U.S.A.

Famines

In addition to pandemics, famines have been common throughout history (Table 2). Famines result from pestilence, diseases, wars or abiotic factors such as drought. The Irish Potato Famine of 1842 is a widely known example of famine. The potato is native to South America and was introduced into Europe in the 1600s. A short 200 years later, potatoes had become the staple food of Ireland. The 1840s were a time of cool and wet weather. These factors created an ideal environment for serious outbreaks of the infectious disease known as Late Blight of Potato. In a similar manner, various preconditioning factors can increase the likelihood of humans contracting infectious diseases. Late Blight is caused by the fungus-like pathogen named *Phytophthora infestans*. It results in necrotic lesions on potato tubers which serve as infection sites for bacteria. The bacteria rot the tubers, making them unsuitable for human or animal consumption or even as an ingredient for vodka. The Irish Potato Famine resulted in major human mortality and large-scale immigration to the U.S.A.

A German scientist, Anton DeBerry, discovered that *P. infestans* was the cause of this infectious disease. The discovery serves as part of the foundational knowledge of modern medical science and technology that infectious diseases are caused by

Table 2. Nine general/local famines and approximate dates/duration.

Famines[1]	Approximate Dates
Northeast Africa Locust Famine	2020
North Korea Famine	1995-2014
Great Russian Famine	1931-1933
Irish Potato Famine	1845
Japanese Famine	1783
Italian Famine	1591
European Famine	1315
Roman Empire Famines	500 B.C.
Fertile Crescent Seven -Year Famines	2,000 - 8,000 B.C.

[1]Approximate dates based on compilations of on-line information.

[3] It was Typhoid Fever that sickened the great-grandfather of the senior author (SA) of *Pandemics, Famines, and Global Development* and the great-grandfather's brothers on their covered wagon return trip to Virginia from Kansas during the fall of 1873. One of the brothers died and it took the SA's great-grandfather all winter to recover.

specific types of bacteria, fungi, or nematodes, in addition to various types of chemical messengers such as viruses and prions. These organisms and chemical messengers are referred to as pathogens. A localized famine took place in Northeastern Africa in 2020-2021. It was the result of a combination of massive swarms of locusts destroying key crops, drought, and disruption of food production and distribution systems due to war. The impact of the 2022 Ukraine War on food security is currently unknown. Since Ukraine and Russia are major producers of the wheat required for flour and bread production, it is likely the war will have a significant negative impact on regional and possibly global food security.

Impacts, Mechanisms, and Variants

Pandemics impact human generations in different ways.[4,5,6,7,8] To understand pandemics caused by viruses or bacteria, it is essential to have an elementary understanding of chemistry and biology. For example, the virus that caused COVID-19 is a double-stranded ribonucleic acid (RNA) virus with 30,738 nucleotides. Its protein coat has unique spikes used to attach the virus to a host cell. Once inside a host cell, the virus sheds its protein-coat and the virus RNA instructs the metabolic processes of the host cell to produce new virus particles instead of continuing the cell's normal metabolic functions. This is done at the expense of the host, creating the detrimental physiological process known as an infectious disease.

Infectious diseases are expressed as various kinds of symptoms such as a fever, cough, potato tuber rot, or yellowing of leaves. The virulence (aggressiveness) of pathogens can change over time, based on their association with their biotic and abiotic environments. For COVID-19, this has resulted in Alpha, Beta, Delta, Lambda, and Omicron variants. When the SA estimated the number of possible, but not likely, variants, the number, single-spaced at ten-point-font, was 27 pages long.

Since the Irish Potato Famine of the 1840s, numerous highly aggressive variants of *P. infestans* have evolved. During the past 30 years, the SA spent a significant amount of time dealing with highly aggressive variants of a plant pathogen known as the soybean cyst nematode (*Heterodera glycines*). Pathogen population dynamics, environmental selection pressures, genetic diversification, and human complacency are a few of the reasons for recurrence of pandemics. While readers of *Pandemics, Famines, and Global Development* most likely have little formal training in pathology or have not recently reviewed their high school chemistry, biology, and ecology, descriptions of the terms

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[4] The great-great-great grandson of the pioneer mentioned in Footnote 3 went hiking/camping in the Colorado Rockies in 2021. Prior to his departure, the SA reminded him to avoid rats and rat fleas, the primary host and insect vector for the Bubonic Plague pathogen.

[5] The father of the SA was born in Indian Territory. He was an eighteen-year-old living in Oklahoma, U.S.A. in 1918, the year of the Spanish Flu Pandemic. Although this pandemic resulted in an estimated 500 million human mortalities, the SA never heard his father mention the pandemic. The reasons for this likely include a focus on a series of other major events such as the end of World War I, the Dust Bowl, the Great Depression, and World War II, or a desire to move on and return to what was considered normal. In this case, the SA's father moved to New York City at a time many Oklahomans were migrating to California.

[6] The SA was an eighteen-year-old university freshman in 1957, the year of the Asian Flu Pandemic. While he clearly remembers large numbers of fellow students being sick, he did not contract the Asian Flu. Writing this article reminded him that one of his fraternity brothers died in the summer of 1958. The only thing the fraternity members were told was that the individual became ill.

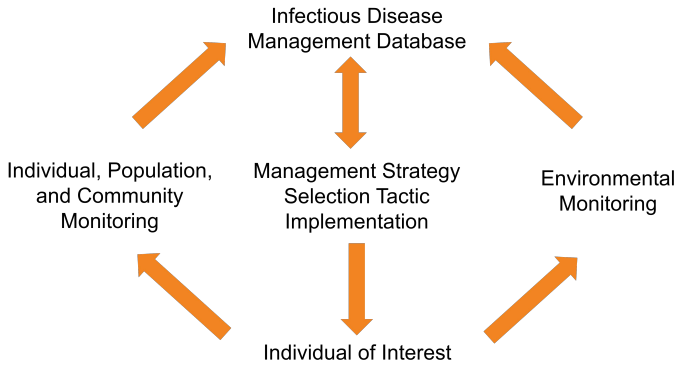
[7] The SA's oldest granddaughter was an eighteen-year-old college freshman in 2020, the beginning of the COVID-19 Pandemic. During the academic year she attended both in-person and virtual classes, was vaccinated and did not contract COVID-19. Her brother lived in a small house with four other individuals, all of which contracted COVID-19. Because of this exposure and other activities, he was tested several times in 2020 for COVID-19, with all negative results. In 2021, however, he had a mild case of COVID-19.

[8] In the summer of 2021, the SA witnessed his 10-year-old grandson immediately put on a mask when leaving an outdoor terrace to enter an indoor dining area. The grandson was not asked to put on his mask and the SA was totally unaware his grandson even had a mask in this pocket. The grandson attended in-person school in the 2020-2021 school year in fifteen unique outdoor shelters (one shelter per class) built in the summer of 2020. Even under Michigan winter conditions, the outdoor shelters were highly successful.

associated with infectious diseases are readily available online.

Since pandemics are complex non-linear systems, they cannot be controlled like linear systems (e.g., a Swiss watch or internal combustion engine). They must be managed using current information and the best available medical technology. The strategies (approaches) for managing pandemics include exclusion, avoidance, containment, local eradication, or implementation of a specific management tactic. Management tactics (actions/procedures) may include use of chemicals (vaccines/drugs), regulations, physical actions, introduction of beneficial organisms, and possible genetic modifications. To be successful, the strategies and tactics must be implemented in conjunction with a comprehensive and integrated infectious disease management model (IDMM). The key features of an IDMM include appropriate actions based on continuous monitoring (testing) and real-time use of a dynamic database system. During the spring semester of 2020, the undergraduate students in the SA's Michigan State University class entitled *Pests, Society and the Environment* converted an Integrated Pest Management (IPM) model into an IDMM (Figure 1).

Figure 1. Five-component closed loop conceptual infectious disease management model developed by the 2019 spring semester students enrolled in ENT 205H (Pests, Society and the Environment).



The conceptual five-component closed loop IDMM system model includes individual, population and community health monitoring in addition to evaluation of other key biotic and abiotic aspects of the ecosystem. Pandemic management using IDMM must be implemented at the community level in a continuous real-time mode, using sound database information as the basis for selection of appropriate pandemic management strategies and tactics. The three fundamental tools for pandemic management include: 1) education (a difficult, but essential process); 2) facilitation (making the strategies and tactics readily available); and 3) persuasion (rewards referred to as a carrot or punishment known as the stick).

One thing that is certain is that the future will be different than the present or the past. Scientists are engaged in testing alternate hypotheses. Based on human population increase during the past 500 years, it is projected that global human population may increase to at least 10 billion by 2050. Could an alternate hypothesis for this be a reduction to 3.0 billion, the approximate global population in 1960, three years after the Asian Flu Pandemic? For successful pandemic management, it is essential to evaluate the potential impacts of available management strategies and tactics under a series of alternate futures. The alternate futures should range from an optimal high quality of human life for all on both a community and global basis, to an alternate future associated with a return to the *Dark Ages*.

It is interesting to note that in both the nineteenth and twentieth centuries there were three key pandemics. In each case, the first pandemic was early in the century, the second about mid-century and the third in the final quarter of the century. The first major pandemic of the twenty-first century, COVID-19, was right on schedule. Will the next twenty-first century pandemic take place shortly after mid-century? If so, will it be caused by a bacterium or a virus, or some other type of chemical messenger such as a currently unknown prion?

Lessons Learned: Global Development

Approximately six million innocent lives have been lost globally during the COVID-19 Pandemic and more are likely to be lost during the coming months and years as new variants emerge. COVID-19 has affected every sector of global and local community-economies including education, health, agriculture, businesses, travel, and tourism among many others. In addition to the many lessons learned during the COVID-19 Pandemic, there has been misinformation spread through social media, causing unnecessary fear and even panic at the local community level. In some nations, the public health crisis created by the pandemic has been used as a political tool. It has been observed that during the Pandemic, there have been disparities in the health care available to various ethnic and socio-economic groups.

Therefore, some groups have been impacted more by COVID-19 than others. There has also been disparity among nations and local communities on how COVID-19 was managed. The disparities include education, availability of vaccines, and nature of personal protective equipment/programs, in addition to the persuasive attributes of rewards or possible punishment.

Six of the key lessons learned during the COVID-19 Pandemic include:

- Need for improved public health infrastructure in rural and urban communities,
- Importance of community-based local food systems and food supply chains,
- Power of digital tools for education, communicating, and networking,
- Variant-specific vaccines,
- Telehealth systems, and
- Community-based innovations in education.

Preparing for the Future

In 2022, humans live in local communities in a highly interconnected global world. The unexpected public health crisis created by COVID-19 demonstrated the urgent need for local and global cooperation and collaboration. Global collaboration is essential for better preparedness for future pandemics and public health emergencies. No one country or community can do it alone. In an interconnected world, global issues require global solutions. To be successful, however, the solutions must be implemented at the community development level and designed to bring communities to fuller or better states. To achieve this, there is a need for global cooperation, comprehensive monitoring, resource sharing, innovative research, technology development (vaccines, oxygen tanks, internet, etc.), policy advocacy, positive awareness campaigns, education, and local human capacity development. This must be designed to ensure that humankind's communities are adequately prepared for the changes and challenges associated with future pandemics and famines.

It has been observed that the public health infrastructure and facilities in rural and urban communities are weak, especially in developing countries. Supplies of medical technologies and equipment such as oxygen tanks and medical equipment were in short supply during critical phases of the COVID-19 Pandemic. This was very alarming in communities throughout India and other developing nations. Public health infrastructure needs to be improved in both rural and urban communities. It must include easy access to health care in resource-poor areas.

Food is a basic need of every human being. The pandemic-related lockdowns disrupted food supply systems in developing countries, causing increased food insecurity among poor communities. Building resilient community-based food production and efficient supply systems are essential for addressing the public health issues of the future. Community food systems must be designed to promote self-sufficiency, self-reliance, and food security in times of uncertainties and emergencies.

Modern information and communication technology/tools (ICTs) were used widely during the COVID-19 Pandemic for education, general communication, and linking communities on a global basis. Various platforms such as Zoom and Microsoft Teams were adopted for virtual classes, meetings, workshops, businesses, and governmental operations. These tools proved to be cost effective in connecting people with each other without the need for travel. ICTs have also been helpful in day-to-day communication and networking for families, businesses, and communities. Despite public health challenges, the global community has responded and continued working. Depending on the nature of the work, people can work from almost anywhere using internet-based digital platforms. Although not the best and the most effective option for everyone, schools and colleges have continued their programs virtually. These technologies facilitated development of innovative ways to offer educational programs. Modern digital tools provide options for local education and learning opportunities on a global basis. Local teachers and professors have developed community-based online course content that can now be extended to the global community in a free or cost-effective way, making community classrooms global. During the COVID-19 Pandemic, social distancing guidelines and rules made it difficult to have in-person visits to doctors. In this scenario, virtual telehealth services became very helpful in getting appropriate advice and consultations from doctors and medical professionals.

Through the concerted efforts of the health industry, safe and effective vaccines were developed within 12 months of the onset of the COVID-19 Pandemic. There has, however, been significant disparity in the

production, distribution and availability of vaccines in various parts of the world. Developed countries have large stocks of vaccines while developing countries in Africa and Asia struggle to have adequate doses for their populations. On the one hand, in some developed countries, a large segment of the population is not willing to be vaccinated and there are large reserves. On the other hand, developing countries are not able to access vaccines to meet their demand. Capacities of developing countries need to be enhanced in local production, storage, and distribution of vaccines for community development.

Pathogens such as viruses, bacteria, nematodes, and prions do not discriminate by economic status, race, or nationality. The COVID-19 virus and other bacterial/viral pathogens will continue to evolve new variants. The global community will need to follow public health guidelines and learn to live with and optimally manage ever-changing pathogens. Vaccinations are critical to protect one's health. It may be that individuals will need to get vaccinations every year like regular flu vaccines to protect their health from evolving variants of COVID-19 virus and other pathogens.

COVID-19 has demonstrated the importance of friends and families to mental health. This is a key element of the process of development, bringing communities to a fuller or better state. Stress due to uncertainties, isolation, and loss of lives caused by the pandemic of 2019-2021 had detrimental impacts on the mental health of individuals, families, and communities. Individuals lost their businesses or jobs from economic stress. Some cases resulted in suicide. Social and economic support systems at the community level need to be created to provide the necessary moral and economic support to disadvantaged and resource-poor families.

Human beings are social animals and connectivity amongst people is imperative. Individuals, families, and communities were isolated during the COVID-19 Pandemic and have gone through major mental stress and loneliness. People have realized the importance of social connections among friends, families, and colleagues to provide moral support in times of uncertainty.

COVID-19 resulted in significant changes in human living environments. Cities are changing, resulting in an increased demand for housing in smaller communities with lower costs of living. During the pandemic, businesses and organizations allowed employees to work remotely from home. This has been convenient for some individuals and has saved time and commuting costs. With the availability of the internet, people can work and communicate effectively from anywhere. With the cost of housing rising in cities and not affordable for everyone, the demand for housing in local communities has grown. Families have moved or are considering moving to smaller communities with more space and affordable housing costs.

While pandemics require global responses and global solutions, implementation must be at the community level. Managing and reducing the impacts of pandemics hinges on rapid, effective, coordinated, and sustained responses and cooperation among stakeholders at all levels. While global and local communities must continue to address the challenges and issues related to the COVID-19 Pandemic, they also need to be ready to face future pandemics. A global platform named ***Alliance for Pandemic Preparedness and Response*** (https://aparweb.org/) has been launched to foster networking and global cooperation. Michigan State University is an active member and partner in this important endeavor.[9]

[9] The SA feels certain that his children and grandchildren will remember their experiences associated with COVID-19. He sincerely hopes that the lessons learned by their generation will significantly enhance society's ability to prevent or successfully deal with future pandemics on both a community and global development basis.