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Preparing for Pandemic Influenza:

The Global 1918 Influenza Pandemic and the Role of World Historical Information

Abstract

The 1918 "Spanish Influenza" was one of the three most devastating epidemics known to humankind. Today it is taken as a model of possible future pandemics by health authorities in many countries. This study reviews and assesses the qualitative and quantitative studies of the 1918 pandemic. It shows that the qualitative studies, while wide-ranging, are neither consistent nor comprehensive at the global level. The quantitative studies, in turn, are limited to the national level and have yet to be combined into a picture of the global dynamics of the pandemic.

Existing studies have considered such issues as mortality waves (from one to three waves for each region of the epidemic), patterns of global diffusion, and the age profile of mortality (often noting high mortality among young adults). Nevertheless, studies of these factors need to be pursued in greater depth. Additional questions, identified by the authors as worthy of analysis, include lingering effects (such as impact on fertility), the relationship between population and mortality, and the relationship between climate and mortality.

It is argued that preparation for pandemic influenza is now a security issue, and that historical studies need to be organized on a more systematic and global level in order to prepare a thorough picture of the 1918 pandemic, in order to anticipate the possible character of any future infections. The study concludes with practical suggestions for creating a global picture of the pandemic from its unfolding in 1918 to its expiration in 1921.

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Preparing for Pandemic Influenza:

The Global 1918 Influenza Pandemic and the Role of World Historical Information

The 1918 "Spanish Influenza" is considered to be one of the three most devastating epidemics to affect humankind. Unlike the two other epidemics with which it is often categorized, the Plague of Justinian and the so-called "Black Death" (Walters 1978), the 1918 pandemic was global and affected every inhabited continent in the world. The estimated death toll of 50 million and its relative recency have made it the subject of numerous studies in spite of the difficulties of compiling reliable data on it from around the world. Epidemiologists and public health experts have recognized that a comprehensive study of the Spanish Influenza may reveal patterns that are of great value in planning for future global pandemics. The pandemic has also been the focus of substantial research in the social sciences, including studies of a historical or economic nature.

Pandemic influenza continues to pose a major risk to populations across the globe in the twenty-first century. Many national and sub-national public health authorities have developed comprehensive pandemic preparedness plans, which lay out strategies to mitigate the negative effects of a future pandemic if and when it should occur. Because the 1918 pandemic is considered to be a "worst case scenario," these plans are, more often than not, informed directly or indirectly by the experiences of 1918 (Moxnes and Christophersen 2008, p.1). As the U.S. Department of Health and Human Services' nearly 400-page Pandemic Influenza Plan explains, "Uncertainty about the magnitude of the next pandemic mandates planning for a severe pandemic such as occurred in 1918" (US DHHS 2005, p.5). In keeping with this logic, "[i]n an assessment from 2005 of national pandemic influenza preparedness plans from 21 countries in Europe, it was found that every country studied had been planning for a repetition of what happened in 1918" (Moxnes and Christophersen 2008).

A study of the impacts of the 1918 pandemic as a global phenomenon can provide important insights not obtainable through a narrower lens. Thus, as Patterson and Pyle write, "…there is a need for a modern global synthesis of data on the pandemic" (Patterson and Pyle 1991, p.5). A thorough understanding of the pandemic is vital to making modern pandemic preparedness plans as informed and effective as possible, and historical information can offer "valuable insights that are highly relevant to today's concerns – insights that in some cases can be obtained in no other way" (Morse 2007, p.7314). Because such a synthesis has not been conducted using the rich world-historical information that is today available to researchers, the aim of this paper is to illuminate some of the opportunities for such research, with a focus on some of the types of quantitative data that exist and are ready to be analyzed.

What we know about the 1918 pandemic

General overview. Starting in 1918, a highly virulent strain of influenza A spread around the globe in one of the deadliest pandemics in history, killing tens of millions. Several efforts have been made to characterize the pandemic globally, although local data often diverges from the global patterns identified in these efforts. The scope of this review is to outline the timing, features, and patterns of propagation and mortality identified by scholars.

The 1918 influenza was unique in two ways. First, it had a case fatality rate that was ten times higher than those recorded for other influenza pandemics (Mills, Robins, and Lipsitch, 2004, 904-5). Second, the virus "was unusual in killing many young and healthy victims, unlike the annual ordinary influenza epidemics, which kill mostly small children and the elderly" (Moxnes and Christophersen, 2008, p.2). Scholars have made efforts to characterize the pandemic by estimating its virulence and death toll, examining the number and timing of waves of infection and mortality, and identifying general patterns of propagation and their determinants. As will be demonstrated, a key feature of this literature is its geographically focused and methodologically limited nature, which derives from the types of data used. Therefore, there is a need for geographically broad and methodologically diverse approaches to the study of the pandemic in order to understand it better. While literature on the pandemic is easily come by, global treatments of the topic are much rarer. Differences in location, available data, and methods of analyzing those data have led to varied conclusions about the nature of the pandemic, including but not restricted to the number and timing of waves of infection, patterns of propagation, and pandemic-associated morbidity and mortality. These studies have, almost without exception, focused on individual countries or administrative subdivisions within countries. As a consequence, the research community does not have a clear picture of how these phenomena manifested globally.

Death toll. While the current estimated death toll worldwide stands at 50 million, "a recurrent feature of the work carried out by historians on the pandemic over the last couple of decades has been the consistent upward revision of mortality figures" (Moxnes and Christophersen 2008, p.2). Thus, according to Johnson and Mueller (2002, p.115), the toll could have reached as much as 100 million, and it not clear that we will ever know for sure how many people fell victim to the disease. This uncertainty is due in large part to the challenges of working with global historical data. Many of the data available on the pandemic were collected locally and are incomplete for a variety of reasons, making global analysis difficult. It is commonly believed that deaths from the influenza were in some cases under-reported or underestimated (Davis 1951). Alternate estimates have been produced for a number of countries using census data but, even though equivalent data exist for other countries, they have not been analyzed to provide estimates of the death toll.

Mortality waves: their location, timing, and propagation. Although many standard reference sources cite the 1918 pandemic as having three distinct waves, in spring 1918, fall 1918, and early 1919 (Byerly 2005), this is not universally the case, even in global, aggregate examinations of the data. Patterson and Pyle (1991) examine the first and second wave because the third was assumed to be "a normal series of 'trailer' outbreaks" (p.4) rather than a full-fledged wave of its own. They cite the first wave as beginning in March 1918 and lasting into the summer, and the second lasting from late August 1918 into January 1919. A 2002 paper by Johnson and Mueller attempts to "update" the conclusions about mortality in the Patterson and Pyle paper. They begin from the premise that "the pandemic is recognized as having generally taken place in three waves" – spring and summer 1918, autumn 1918, and early 1919 (p.105). They add that in some areas there was activity in 1920 as well, though it was not universal and "it is debatable whether it should be considered a fourth wave of the pandemic or a new epidemic, possibly associated with a different strain of the virus" (Johnson and Mueller 2002, p. 107). Potter also recognizes three waves, though with slightly different timing and less specificity. The first wave was March-July 1918, and "many countries experienced second (1918-19) and third waves (1919-20)" (Potter 2001, p.576). He makes no mention of the possible fourth wave identified by Johnson and Mueller. In their 2006 paper, Taubenberger and Morens write that "the 1918 pandemic spread more or less simultaneously in 3 distinct waves during an ≈12-month period in 1918-19, in Europe, Asia, and North America," noting that "the first wave was best described in the United States in March 1918" (Taubenberger and Morens 2006, p.16). They characterize the two subsequent waves as following in "rapid succession" in fall and winter 1918-19 (Ibid.).

Most examinations of the pandemic cite the existence of three waves: spring or summer 1918, fall 1918, and early 1919. The first wave is identified as being comparatively weak with mortality rates roughly comparable to a typical seasonal influenza. The second wave accounts for the majority of the death toll. The third wave is somewhat more varied by location and usually receives little specific examination in global treatments of the data. However, this three-wave pattern varies somewhat, depending upon the study, and does not hold true in all localities. Furthermore, the data available from which estimates of death tolls and mortality rates are drawn are recognized to have a variety of deficiencies, particularly under-reporting and a lack of reliable baseline census data. These issues were exacerbated in Europe by the disruption caused by World War I. The war, which was located primarily in Europe and spurred investment in transportation infrastructure around the world (specifically railways and steamships) also influenced patterns and speed of propagation.

Global diffusion patterns. Patterson and Pyle identify the first wave as beginning at Camp Funston, Kansas in early March 1918. They write that the virus then spread through the U.S. Midwest and southeastern states along troop transport routes and by April was affecting both military and civilian populations across the United States. In April the illness also "spread to France aboard American troop ships" (Patterson and Pyle 1991, p.7). The pandemic then moved outward from war-torn France, reaching Germany, Scandinavia, Britain, Indonesia, India, Australia, and New Zealand in June. According to the authors, the first wave did not strike Russia or Sub-Saharan Africa, while China was affected earlier than the rest of Asia probably due to rapid trans-Pacific transport from the United States (Patterson and Pyle 1991, p.8).

Johnson and Mueller do not consider the timing and propagation of the disease in their analysis of global mortality numbers. Potter, however, provides an overview of the geographic spread of the pandemic. He also identifies the origin to be the United States in March 1918, though he does not accept as fact that its precise origin was in Kansas. From focal points in the Midwest and southeast of the country, "infection spread outwards and then eastwards as young Americans were drawn to the army and naval training establishments of the American Expeditionary Force (AEF), and to the war in Europe" (Potter 2001, p.575).

The second wave appears to have originated in Europe according to both Patterson and Pyle and Potter, who identify the port of Brest in France as a key focal point with cases reported in August 1918. Both authors agree that from England and France the virus spread rapidly through Europe, with most of the cities in western and central Europe, including Russia, suffering epidemics in October (Patterson and Pyle 1991, p.10). They believe the United States to have been infected from the introduction point in Boston and ports on the Gulf and Pacific coasts. Patterson and Pyle note that "transmission in many places was greatly facilitated by wartime disruption and troop movements, and its pace was quickened by the vastly improved railroad networks that spanned continents, and by the steamships that connected them with unprecedented efficiency" (Patterson and Pyle 1991, p.10). In Canada, the virus appears to have propagated along the Trans-Canada railway. Africa, Latin America, and Asia also experienced multiple coastal points of introduction, though the Trans-Siberian railroad also played an important role in transmitting the virus to Northern Asia. "A vigorous quarantine protected Australia until January 1919, when the island continent was finally struck" (Patterson and Pyle 1991, p.11). Potter's assessment of propagation patterns, though less detailed, dates the arrival of the pandemic in Australia to January 1919 and in India to October 1918. This further aligns with Patterson and Pyle's analysis.

Additional patterns identified in existing global literature

There are two other notable mortality features in the 1918 pandemic. The first wave is not identified as having uncommonly high mortality rates, while the second wave stands out as extremely deadly. Mortality rates of the third wave are typically not discussed. A number of studies concur on the point that the first wave was "not exceptional" and that "overall, mortality rates were low in the spring wave, as in previous influenza pandemics" (Patterson and Pyle 1991, p.8). "In contrast, the events which were to follow remain unique to the history of influenza" (Potter 2001, p.575). Namely, the second "wave" (though Potter does not call it that) saw "a ten-fold increase in the death rate among cases" (Potter 2001, p.576). The second wave was unusual in another way as well: it took an extremely "heavy toll on the young adult population" (Johnson and Mueller 2002, p.106). "Influenza and pneumonia death rates for those 15–34 years of age in 1918–1919, for example, were >20 times higher than in previous years (35). Overall, nearly half of the influenza-related deaths in the 1918 pandemic were in young adults 20–40 years of age, a phenomenon unique to that pandemic year" (Taubenberger and Morens 2006, p.19). Only Patterson and Pyle do not specifically mention this phenomenon.

Mortality estimates. Mortality estimates for the 1918 pandemic have risen since they were first estimated. Patterson and Pyle estimated about 30 million deaths worldwide, while Johnson and Mueller raised that estimate to 50 million while acknowledging that, due to issues with the data, the number could in fact be as high as 100 million. Taubenberger and Morens cite this number in their paper, while Potter includes a total mortality figure of 40 to 50 million. All of these numbers are markedly higher than early estimates, which put the death toll at just over 20 million (Johnson and Mueller 2002, p.105).

Challenges presented by available data. Issues with obtaining accurate data are a common theme in global studies of the pandemic, and are the primary reasons for varied mortality estimates. "It is generally accepted that recorded statistics of influenza morbidity and mortality are likely to be a significant understatement" (Johnson and Mueller 2002, p.108) due primarily to severe under-reporting or in some cases a lack of data altogether. Patterson and Pyle write that "Reporting was always incomplete. Official registration systems were disrupted by war in many European countries…Data from China, Latin American states, and the colonal areas of Africa and Asia are generally woefully inadequate, as one would expect from poor countries even today" (Patterson and Pyle 1991, p.13). A lack of regular census data in many areas further complicates calculating mortality rates as reliable population numbers are not available. Johnson and Mueller cite issues including nonregistration, missing records, misdiagnoses, and nonmedical certifications, as well as the fact that there are also "vast areas of the world for which we have no or little information, and often what information we do have is of dubious quality and contradictory" (Johnson and Mueller 2002, p.115).

Local variations in the timing and number of waves. Local data often deviate from the broad patterns of timing and number of waves identified above. For example, Chowell, Simonsen, et al (2014) identified four waves in Chile, beginning in October 1918 and lasting through 1921. Japan, on the other hand, experienced two subsequent waves, one from October 1918 to February 1919, and another a year later from October 1919 to February 1920 (Chandra and Yu 2015). Even within regions that appear to have well-identified patterns such as the United States, there are areas of considerable variation. In Michigan, for example, we have identified a severe but previously unrecognized wave in early 1920 that does not fit with the timeline put forward for most of the United States (in which the pandemic ended in 1919). Additionally, though Newfoundland experienced three waves during the pandemic, the timing varied from the description of the three waves globally. The first wave occurred in summer 1918, then there was a slightly delayed wave in fall 1918 to winter 1919, and finally a "late" wave in spring 1920 (Sattenspiel 2011). Table 1 provides an overview of the number and timing of waves in a diverse selection of locations across the world.

The value of studying the pandemic as a global phenomenon

Because the influenza pandemic of 1918 was a truly global phenomenon, its study at the global level presents a rare opportunity to observe the progression of an infectious disease in all its variations and across a wide range of conditions that are thought to enhance or retard its spread and virulence. To date, because most studies of the pandemic have been conducted at the national or sub-national level, the pandemic has been characterized in a specific manner. For example, in the case of Japan, we are told that the pandemic appeared in two waves, with the first wave occurring between October 1918 and February 1919, and the second wave between October 1919 and February 1920 (Chandra and Yu 2015, p.315). Yet a look at the experience of an array of countries demonstrates that, in fact, the pandemic took on very different shapes in different locations. While Patterson and Pyle have attempted to describe the pandemic across the globe, their focus is on European and North American data, recognizing three waves during the period of spring 1918 to spring 1919. They do not mention, for example, that Peru experienced an additional deadly wave in 1920 (Chowell, et al. 2011). In other words, there has been no comprehensive characterization of the pandemic globally in terms of numbers of waves, their relative severity, and their speed.

Impacts of the pandemic on populations. A second gap in the literature is the erratic nature of findings on the impacts of the pandemic on the populations it affected. Estimates of the numbers of people who died as the result of the pandemic vary widely across authors. The consensus estimate of 50 million fatalities, proposed by Johnson and Mueller, was, likewise, first proposed as part of a range of 50-100 million! Part of the reason for this uncertainty is the incomplete data available from which to compute these estimates. For example, record keeping in early twentieth-century China, with its large population, was sporadic, leaving a large gap in our knowledge about the toll in that demographically significant country. Yet many countries were collecting health and population data at the time and, as the publication of multiple recent papers has shown, many of the available data collections are only just being analyzed, with many more awaiting even preliminary study.

A second strand of research on the demographic impacts is in the area of overall population effects. In addition to mortality impacts, it has been established that the pandemic also impacted fertility. Yet even in this area there is some controversy, with Bloom-Feshbach et al (2011) demonstrating that biological factors played a dominant role in the USA and Nordic regions, Mamelund (2012) questioning those findings, and Chandra and Yu (2015) showing that behavioral factors may also have been important in the cases of Japan and Taiwan.

A third important demographic variable, migration, has not been studied at all. Yet it is likely that the pandemic greatly affected the mobility of populations. This could have happened in one or both of two ways -- reduced mobility as people sought to protect themselves from the virus by self-quarantine, or increased mobility as people fled areas of severe infection in search of safer places. We know little about these impacts, yet social distancing, of which both of the above phenomena are examples, has been proposed as a method of halting the spread of epidemics such as influenza. Did different populations respond differently and, if so, was one or the other method more effective? Studies that shed light on this could be of great interest and use to the global public health community.

Tied to the above variables is a fourth important demographic phenomenon. Where it existed, the institution of marriage in its various forms and the impacts of the epidemic on patterns of marriage is another interesting topic. Did people postpone marriage during or after the pandemic? To the extent that the virus disproportionately killed people who were "marriageable," how did this impact populations and the institution of marriage itself?

Lingering impacts on health. As noted, studying the pandemic as a global rather than local or even national phenomenon can be an important way to understand the pandemic because of the variations it may demonstrate in the manifestation of the epidemic itself. In addition, the study of factors that are thought to affect pandemic influenza at the global level can shed light on the factors that enhance or block the spread of the disease in ways that local or national studies cannot.

For example, variations in temperature and humidity have been shown to affect the reproduction and transmissibility of the virus in the laboratory. Optimal conditions for the reproduction and spread of the influenza virus, for example, have been shown to be 5 degrees Celsius and dry conditions (Lowen et al 2007). Yet studies of the association between temperature and humidity and the virulence and spread of influenza outside the laboratory are very rare. Compiling a large dataset showing temperatures, humidity, prevalence, and mortality from the disease can provide us with a clear picture of when different countries should be vigilant about the spread of influenza. Given that daily data on weather are now widely and instantaneously available, agencies like the CDC in the USA could use such data to generate alerts about possible flare-ups during the annual flu season.

A second example of using world-historical information to study the pandemic is to identify the multiple waves of the pandemic, whether there were "echo" effects of the wave that oscillated across the globe, the conditions under which these waves reverberated across the globe, and how these patterns are connected with the complex interplay of factors thought to promote the spread of influenza. We know, for example, that different countries experienced different wave patterns. For instance, Table 1 demonstrates that Japan and Taiwan experienced similar wave patterns, because Taiwan at the time was a Japanese colony. In some cases, therefore, colonial structures and the corresponding linkages they engendered can explain similarity in wave patterns. Yet we still lack studies on how and when waves moved across these structures, whether the pandemic was a continuous phenomenon of flare-ups and subsidence, whether the pandemic was steadily nurtured by reservoirs of the virus, or whether the waves can be thought of as discrete, unconnected phenomena.

Country	**Timing of Wave I**	**Timing of Wave II**	**Timing of Wave III**
Global	Spring 1918	Fall 1918	Early 1919
United States	Spring/summer 1918	Fall 1918	Early 1919
Michigan		Sept. 1918 to Jan 1919	Jan. 1920 to April 1920
Europe (broadly)	Summer 1918	Fall 1918	Winter to spring 1919
England & Wales	June to Aug. 1918	Oct. to Dec. 1918	Feb. to April 1919

Chile	Oct. 1918 to Feb. 1919	July 1919 to Feb. 1920	June 1921 to Dec. 1921
India	Spring/Summer 1918	Fall/winter 1918	
Sri Lanka	Summer 1918	Fall 1918	Spring 1919
Japan		Oct. 1918 to Feb. 1919	Oct. 1919 to Feb. 1920
Taiwan	June 1918 to Sep. 1918	Oct. 1918 to Dec. 1918	Dec. 1919 to Feb. 1920
Newfoundland	Summer 1918	Fall 1918 to winter 1919	Spring 1920

Table 1: Some estimates of the timing of the various waves of the global influenza pandemic[1]

A third example of the use of world historical data to study the pandemic relates to human factors. There is a literature that examines the association between population density and virulence and speed of transmission (see Nishiura and Chowell 2008, for example). Among the hypotheses that have been tested is the notion that, the more densely a population is packed, the easier and more likely it is that the virus will have an opportunity to spread. Yet, surprisingly, this literature is inconclusive as to the role of population density in facilitating transmission. Does this have something to do with the fact that the most densely populated parts of the world benefited from warmer climate and/or better nutritional opportunities for populations, thereby weakening the impacts of the virus?

Nutrition is another factor that has been raised in evaluating the nature of the pandemic. It is thought that better-nourished people should be more capable of fighting the virus. Yet the anecdotal evidence suggests that a key mechanism for mortality was, in fact, the mounting of a severe immune response to the virus, hence it disproportionately affected people in the prime of life. Simultaneous variations in nutritional status, weather, population density, and other important variables may be greater in data at the global level than at the national or sub-national level. Such variations will empower the researcher to more carefully parse the individual effects of each of these variables.

Gaps in existing research

Scarcity of statistical studies of the pandemic as a global event. As has been noted above, there is a scarcity of statistical studies of the pandemic as a global event. While a number of academic and popular books have been written on the pandemic, these are, without exception, qualitative in nature, and do not explore the available quantitative data in a systematic manner (see, for example, Barry 2004, Kolata 2001). While they provide rich contextual material about the event, they do not analyze demographic and health data to produce certain types of historical knowledge about the pandemic that might be of great interest to historians and epidemiologists alike.

This point can be illustrated by a quick survey of the kinds of quantitative studies that have been published. These are, without exception, local, sub-national, or national in nature, and produce insights into such characteristics of the pandemic as its impact on population size (i.e., via the mechanisms of altered fertility and mortality), its effects on different population segments (i.e., age groups and gender), the nature of its transmission both individual (i.e., reproduction number) and aggregate (i.e., epidemic velocity), cross-morbidity and mortality and immunity effects, and long-term impacts on individual and population health. The absence of global or even transregional datasets containing the kinds of data used in these analyses has precluded analyses of these phenomena at the supra-national level. As the topical diversity and geographic breadth of these studies illustrate, however, data on these topics were being collected and published at the time of the pandemic. As a result of the development of resources such as HathiTrust, a vast repository of scanned books and reports published at the time of the pandemic --- not under copyright protection---is widely available to scholars today.

Types of datasets available for analysis. In some instances, individual-level data have been used to study aspects of the pandemic (Chowell et al 2012, for example). However, individual-level data are typically highly localized and the studies are, consequently, restricted to very limited geographies. A second type of data includes population-level health-specific data that focus on influenza or on related conditions such as bronchopneumonia or "respiratory diseases." These data, which are usually reported for sub-national administrative entities (districts for colonial India, residencies for colonial Indonesia, prefectures for imperial Japan, counties for the USA) are most commonly available in the publications of public health departments (or their precursors). Their existence depends on the presence of consolidated administrative structures which, while present in many countries, were absent or non-functional in other countries that were in political turmoil or otherwise under-resourced at the time of the pandemic. Thus the four aforementioned examples of research on the pandemic represent consolidated European colonies or independent countries with well-developed data-collecting structures. The third type of data, aggregate census data, permits quantitative analysis of the pandemic even though censuses do not provide information directly connected to health. However, by providing snapshots of population size at regular intervals, they enable the study of the impact of the pandemic by comparing population sizes before and after the event using pre- and post-pandemic trajectories and analyzing population deficits.

These varied resources also offer data at varying frequencies. Thus, the individual observations are often cross-sectional in nature (i.e., one observation per individual), the health reports usually provide monthly or annual (and in rare cases weekly) counts of morbidity and mortality for villages, towns, or larger subnational units, and the censuses are usually decennial (or in some cases quinquennial) in frequency. These varying frequencies lend themselves to different types of analyses, each with its own strengths. The cross-sectional data allow us to study individual-level phenomena. However, because we do not have information about the same individual over time, it is difficult to determine the degree to which individual-level confounders may color the analysis. The weekly, monthly, or annual aggregated data tend to follow the same entity (location) over time, allowing us to parse out confounders that are specific to a location. However, because these data represent population aggregates, we lose the individual quality of the data, and must interpret findings from such data carefully, recognizing the kinds of ecological and other biases that can creep into such analyses. The same problem applies to the use of aggregate census data.

The existence of an evidently vast array of sub-national data on the influenza pandemic presents significant opportunities for research. There appears to have been no systematic effort to date to compile these data into a single resource that fills in geographic and topical gaps, and that can be used to study the phenomena described above at the global level. As a starting point, there is a need for an inventory of the known sets of data on the pandemic and their features and content. There also needs to be a parallel and ongoing process of discovery of new materials. It should not be difficult to compile a list of all the public health reports worldwide that were published during the time of the pandemic and to do an inventory of the kinds of information they contain, statistical or otherwise.

Influenza as a security consideration. There are significant modern uses for global research on the 1918 influenza pandemic. Pandemic influenza is known to be a major threat to human health globally – so much so that it has recently been reframed as a security threat due to the magnitude of potential economic, social, and political impacts (Kamradt-Scott and McInnes 2012).

Some of this disruption will be due to infection rates and mortality, and some due to the impacts of policy measures including school closings and restrictions on public gathering taken to slow the spread of the virus. "The direct and indirect health costs alone (not including disruptions in trade and other costs to business and industry) have been estimated to approach $181 billion for a moderate pandemic" (DHHS 2005, p.16). The total cost of the pandemic would exceed this estimate, which does not account for the substantial temporary workforce reduction that will result from individuals falling ill, missing work to take care of family members, or avoiding work due to fear of becoming ill. Basic services such as grocery stores and banking could be impacted, compounding the effect of closing key institutions such as schools and bringing daily activity to a standstill.

Furthermore, "the emergence of a new pandemic influenza subtype is expected," and "there is no scientific basis for the assumption that a new pandemic influenza virus cannot be worse than the Spanish flu virus" (Mills, Robins and Lipsitch 2004, p.904). Since the 'resurgence' of H5N1 avian flu cases in humans in the early 2000s, countries have been working to develop pandemic preparedness plans. Modern pandemic planning such as this draws heavily on data gathered from past pandemics, and such planning is vital to allow governments at all levels to respond effectively to the next influenza pandemic, thereby reducing the negative impacts.

It is due to the scope of these potential impacts, and the likelihood of the emergence of a virus capable of causing them, that pandemic influenza has been deemed a security threat and is now being treated as one by many governments in terms of planning and preparedness. In planning for future pandemic influenza outbreaks, data from previous experiences are key. Historical data can offer researchers unique insights into how such scenarios may unfold. Because the 1918 pandemic is often regarded as a "worst case scenario" when analyzing pandemic influenza, it has formed the basis of a great deal of modern pandemic preparedness planning and thus deserves as thorough a study as possible.

Conclusion

The 1918 influenza pandemic has primarily been studied as a local or national event; there remains a need to combine these data and study it as a single global event with multiple waves. A project of this nature would involve the identification, compilation and digitization of the existing data followed by analysis to generate answers to the many questions identified in this paper and others of interest to historians, epidemiologists and the health policy community. While such a global study should be feasible, we must recognize the challenges inherent in such a project. These include heterogeneity of the data, differences in local experiences, and the absence of data in large and demographically important regions such as Africa, China, and Russia. Nonetheless, an examination of the 1918-1920 pandemic as a global event would provide a fuller understanding of the pandemic, informing pandemic planning and thus benefiting national security and global health in our increasingly interconnected world.

NOTES

[1] Table 1 references: For Chile see Chowell et al 2014; for England and Wales see Chowell et al 2007; for Europe see Patterson and Pyle 1991, Taubenberger and Morens 2006, and Chowell et al 2007; for India see Chandra and Kassens-Noor 2014; for Japan see Chandra and Yu 2015; for Michigan see Chandra and Christensen 2017; for Newfoundland see Sattenspeil 2011; for Sri Lanka see Chandra and Sarathchandra 2014; for Taiwan see Chandra and Yu 2015; and for United States see Patterson and Pyle 1991 and Moxnes and Christophersen 2008.

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