Biocultural perspectives of pandemics and post-pandemic population health in Alaska

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Pandemics are recurring events through human history, so it is valuable to analyze and compare determinants, impacts, and consequences of different pandemics. Anthropological perspectives of pandemics recognize that modern population health is the product of biocultural evolution that is driven by human relationships with infectious pathogens that play out differently in locales with different cultural, environmental, and biological ecologies. Health and pandemic experiences in the Arctic are expected to be distinct from those of other regions of the world and should be closely investigated to better understand the dynamics and consequences of pandemics therein. In this paper, we focus on Alaska and its unique experiences with the 1918 influenza pandemic and the COVID-19 pandemic. Through review of these two pandemics, we show that there are similarities across time, such as how coastal communities were hit hardest and interior communities were more likely to escape, and that Alaska Native communities' ability to maintain agency over their community-centered responses resulted in better protection against novel outbreaks. Additionally, we characterize the ambient social conditions during each pandemic to explore critical relationships between biology, culture, behavior, and health. Finally, in an application of biocultural theory to pandemics, we review and engage with the emerging literature on the impacts of delayed healthcare during the COVID-19 pandemic and theorize about potential population health consequences of delayed care during COVID-19 in Alaska. Current data for Southeast Alaska show that the majority of people in the region experienced delays in healthcare in 2020-21, but more research is required to identify determinants of this phenomenon. Finally, we discuss how a biocultural perspective can help us understand the dynamics of pandemics and can help tailor pandemic preparedness plans that are appropriate for local social and cultural ecologies.

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Introduction

Pandemics are regularly occurring phenomena through human history, yet they are relatively understudied from social science perspectives when compared with epidemiological (Frost, 1919; Mills, 2004), demographic (Chandra et al., 2018; Noymer & Garenne, 2000), biomedical (Morens et al., 2008), virological (Nelson et al., 2008; Worobey et al., 2014), and historical (Budgell, 2018; Crosby, 1989) points of view (to name a few).[1] While there is no single standard definition of "pandemic" across fields (e.g., Doshi, 2011), pandemics are typically novel, acute, and rapidly transmitted infectious diseases that impact more than one country or continent relatively simultaneously (Dimka et al., 2022). A comprehensive understanding of pandemic dynamics and consequences in different geographic and sociocultural contexts requires engagement with the social sciences, especially those that integrate human behavior, culture, population biology, ecology, and historical context. An anthropological lens, particularly an integrative *biocultural* approach, provides a holistic framework that considers biological and social dynamics that occur at multiple time scales and geographic spaces to affect how humans experience acute infectious disease outbreaks. This approach also takes a comparative approach, a cornerstone of anthropology, in exploring human experiences within specific ecologies to shed light on both the common and idiosyncratic elements of different pandemics.

The Arctic remains one of the least studied regions in the world in terms of pandemic impacts and consequences. Because of its unique and diverse geological, ecological, and sociocultural characteristics, we cannot assume that pandemic experiences in the Arctic are equivalent to those of non-Arctic regions. The Arctic is under immense ecological pressure due to anthropogenic climate change and has been warming more rapidly than any other region of the planet for the last half century, including the tropics (Jacobs et al., 2021; Rantanen et al., 2022). This means that Arctic peoples will face a multitude of stressors on health in the coming years and decades, including novel pathogens (Mora et al., 2022). Thus, Arctic population health, as it is under acute stress from epidemics, pandemics, climate change, and emerging infectious diseases, deserves careful attention from holistic disciplines like anthropology so that public health and community authorities will be prepared for and can work to counteract these changes.

This paper discusses the historical, sociocultural, and ecological contexts of Alaska with respect to its experiences with two major pandemics, the 1918 influenza and COVID-19 pandemics, from a biocultural anthropological perspective. The goal of this discussion is to review current knowledge about each pandemic and compare their characteristics while emphasizing dynamics that are linked with the local physical and sociocultural ecology. Ultimately, we link these dynamics to show that while the proximate determinants of pandemics, such as the nature of a pandemic pathogen and the disease it causes (e.g., H1N1 influenza for the 1918 flu and SARS-CoV-2 for COVID-19), can and often will change, the ultimate determinants of outcomes, such as social inequalities and barriers to accessing medical care, show stability over time (van Doren, 2021).

After presenting what is known about the 1918 flu and COVID-19 in Alaska, we apply a biocultural framework to better understand how consequences of the COVID-19 pandemic can leave a lasting mark on the population health of Alaska. We review the current literature on delayed care and the

[1] The papers cited in this sentence are all in reference to the 1918 influenza pandemic, but diverse disciplinary perspectives explore other pandemics of differing etiologies, as well.

ways that failing to access or seek healthcare during the COVID-19 pandemic could have long-term impacts on population health through individual, social, and intergenerational pathways. Finally, we conclude with a discussion of how fields like public health can draw on existing social science knowledge and interventions to better prepare for a future that inevitably contains emerging infectious diseases and novel pathogens with pandemic potential. These pandemic preparedness plans must draw on our knowledge of the social and ecological drivers of pandemic impacts to better tailor preparation and responses to diverse populations that may be small, isolated, and have limited resources.

Biocultural anthropology, public health, and applications to Alaska

One of the most popular theoretical frameworks for studying human population health in recent years is the *biocultural* approach, which highlights how the biological and cultural elements of human nature perpetually co-evolve (Goodman & Leatherman, 1998; Wiley & Cullin, 2016). The biocultural approach further highlights how this co-evolution is not homogeneous across populations but plays out differently in distinct socioecologies. Lock (1993, 2017) characterizes these differences as *local biologies*, which are distinct characteristics of the physical body—and more broadly, the population—that are consequences of macrosocial socioeconomic and ecological forces. Not only can these local biologies be distinct between and among populations geographically, but they also show unique temporal dynamics (Lock, 2017; Hoke & McDade, 2014). Some prominent scholarship that utilizes biocultural approaches include: the investigation of how socially constructed race becomes embodied as health inequalities (Gravlee, 2009), how urban environments are stressors on human health (Schell, 1997), how stigma affects biology in marginalized populations (Brewis & Wutich, 2019), and how sex and gender dynamics affect health (DuBois et al., 2020).

Biocultural approaches have been applied less often to the study of infectious disease dynamics and their role in shaping human biology, demography, culture, and behavior. One of the earliest applications of biocultural theory to the relationship between humans and pathogens was Livingstone's (1958) discussion of how the progression of agricultural development in West Africa led to closer and more frequent contact with mosquitoes that carry *Plasmodium falciparum*, the causal pathogen of malaria. Livingstone's explanation helped illuminate why the heterozygous genotype for sickle cell anemia, which protects against malaria disease, became prolific in this region (Allison, 1954). Other anthropologists have explored disease patterns in ancient contexts (Armelagos, 1969), the relationship between tuberculosis, demography, and cultural evolution (van Doren, 2022), syphilis in antiquity (Harper et al., 2011), the contexts and drivers of the spread of HIV (Goodreau et al., 2012), and in biocultural and ecosocial drivers of COVID-19 and other re-emerging diseases (Friedler, 2020). Dimka et al. (2022) argue for a more purposeful role of biocultural and biological anthropology in the study of infectious diseases, especially with respect to pandemic studies. Importantly, not all populations are regularly exposed to or are equally susceptible to the same infectious diseases, and the local environment is a critical component to which pathogens regularly circulate and how humans can adapt to the presence of those pathogens. Given the specific conditions faced by populations in the Arctic, we argue that scientists should study pandemics with unique characteristics of the Arctic in mind to help form public health recommendations that will most benefit Arctic populations.

Knowledge of pandemics in the Arctic can be considerably broadened through social science perspectives like the biocultural framework, due in part to its potential for interdisciplinary engagement. Zuckerman et al. (2022) discuss how the framework for biocultural anthropology exists within a loop of complementary frameworks, including ecosocial theory (e.g., Krieger, 1994), intersectionality (e.g., hooks, 1984), and syndemics (e.g., Singer & Clair, 2003). Ecosocial theory, popularized in the fields of public health and social epidemiology by Nancy Krieger (1994, 1999, 2001, 2005), was specifically operationalized to explain health inequalities, especially while elevating the importance of local environments as determinants of health and health inequalities. This perspective helps push back against assumptions that individual health outcomes are pre-determined and innate.

Similar to the interdisciplinary argument made by Zuckerman et al. (2022), van Doren (2022) explores how biocultural anthropology can be more purposefully integrated with theories of demography and epidemiology that investigate the role of infectious diseases in population health and demographic evolution. van Doren (2022) points out that the most prominent iterations of demographic and epidemiological transition theory (that is, explanations for how and why mortality and fertility change led to increases in life expectancy and apparent improvements in population health [Barrett et al., 1998; Harper & Armelagos, 2010; Kirk, 1996; Omran, 1971; Thompson, 1929]) were theorized in reference to Western European and some North American populations. In sum, the most referenced "standard" for how population health has shifted through millennia is substantially biased and does not adequately explain the nature of population health transitions on most of the planet (Defo, 2014; Mercer, 2018; Santosa et al., 2014).

The Arctic itself is, of course, not monolithic. Countries like Norway, Sweden, Finland, and Iceland may fit the traditional epidemiological transition model: the rise of the industrial revolution led to advances in sanitation procedure and the ability to support a growing population with advances in technology and infrastructure; infectious disease mortality fell and proportionate chronic disease mortality rose; and life expectancy increased while population size and density increased (McKeown, 1976; Omran, 1971). The U.S. also broadly fits this model (Omran, 1977). However, the U.S. is only an "Arctic nation" with the inclusion of Alaska. Most of Alaska is rural and sparsely populated, as is most of Northern Canada, Greenland, and Russia. Therefore, traditional models of population health and epidemiological transitions cannot adequately explain the realities of health over time in these regions. Large-scale observations of demographic and health shifts would not be appropriate for most spaces in the Arctic, and small-scale demographic analyses that consider how space and place determine life course experiences would be more appropriate, albeit much more complex in many cases (Raymer et al., 2018). As such, when health and population transitions are discussed in the context of the U.S., Alaska's inclusion in those discussions is erroneous, and its exclusion does not always result in more careful investigation of its population health within the context of being an Arctic space.

To integrate biocultural perspectives of pandemics with the study of population health—and thereby produce more bioculturally-informed, locally grounded public health recommendations—it is important to address one of the most long-standing debates in population health surrounding the social determinants of health (Lucyk & McLaren, 2017). Debates about the social determinants of health have centered on whether the ultimate drivers of health inequalities are more rooted in "neo-materialist" dynamics, that is, social structural forces such as poverty and neighborhood conditions that affected access to care; or, whether drivers are more often "psychosocial," for example, the effects of neighborhood safety on psychological stress, leading to stress-linked chronic disease. As with other dichotomies now widely accepted as false, such as nature versus nurture or genes versus environment, we argue that this distinction between neo-materialist and psychosocial pathways to health outcomes is indeed a false dichotomy. Instead, social structural forces are always acting in deeply integrated ways with psychosocial processes. For example, social inequalities are to some extent upheld and justified by cognitive biases, and the unequal distribution of resources leads to undeniably stressful experiences with proven health consequences via biological stress pathways.

For the purposes of studying pandemics through a biocultural lens, this means that we must stay attuned to the overt and subtle ways that larger social structural pathways can affect local pandemic experiences. For example, policies set at the state or federal level may be difficult to enforce or could even be counterproductive when applied to small communities with relatively large Indigenous populations. In turn, this may lead to distrust, confusion, and local division as well as challenges to mental health when Indigenous cultural and subsistence practices are derailed. However, vaccine resources given to local populations, when combined with local systems of collective interest, may make some Indigenous groups positive examples of vaccine uptake; in some cases, Indigenous groups have used this capacity to help vaccinate poor, largely white populations living near and among them.

Overall, this discussion points towards multiple directions in which social scientists, including anthropologists, can contribute to the understanding of pandemics in a diverse and unique space while simultaneously engaging with interdisciplinary theories and approaches. In the rest of this paper, we will focus on establishing the state of health in the Arctic, and what is known about how the 1918 influenza and COVID-19 pandemics progressed in Alaska within the context of Alaska as a diverse Arctic space. We will engage with specific ecological and sociocultural characteristics of Alaska as critical elements of how these two pandemics impacted its people. Finally, we will apply the current knowledge of past and ongoing pandemics to current pressing issues of population health and what this can teach us about how to pursue more holistic pandemic preparedness plans.

Health in the circumpolar north

The circumpolar north is a vast and diverse area with a population of about seven million people, including approximately 1.1 million Indigenous peoples in eight Arctic nations (U.S., Canada, the Kingdom of Denmark, inclusive of Kalaallit Nunaat [Greenland] and Faroe Islands, Iceland, Norway, Sweden, Finland, and Russia) (Young & Bjerregaard, 2019). The Arctic is under severe ecological pressures and is warming four times faster than the rest of the planet (Rantanen et al., 2022). Recent stressors, like the COVID-19 pandemic, have further challenged the health and well-being of Arctic populations. The health disparities of circumpolar nations are often overlooked, partly because most regions in the Arctic belong to high-income nations (Chatwood et al., 2012; Krümmel, 2009). Snodgrass (2013) aggregated research on health in Indigenous circumpolar populations compared to those of the high-income nations with which they are generally homogenized (Alaska's diverse Native population with the continental U.S., for example), and provides a thorough summary of primary measures of interest in population health. For example, life expectancy at birth varies greatly, but seems to be relatively high in Indigenous peoples of

Scandinavia and relatively low in Siberian peoples (Kozlov et al., 2007; Hassler et al., 2008). Meanwhile, cardiovascular disease has become increasingly more prevalent in all Indigenous circumpolar peoples except the Sami, who are Indigenous to Sápmi (northern Scandinavia) (Château-Degat et al., 2010; Snodgrass et al., 2005).

In this paper, we focus specifically on Alaska due to relative availability of research using historical data for comparison to contemporary experiences, as well as the desire to focus on one specific region for more detailed discussion rather than generalized discussion of the vast and complex circumpolar north. Alaska is geographically, socioculturally, and ecologically diverse, and has a large Indigenous population. Until 1930, Alaska's Native population was estimated to be over 50% of the total population of the territory, while today 18% of the total population is Native. However, the percentage of individuals who identified themselves as American Indian/Alaska Native (AI/AN) alone or in combination on the 2020 U.S. Census is considerably higher for some regions, especially the Bethel Census Area (88.5% AI/AN), the Northwest Arctic Borough (88.1% AI/AN), and the Kusilvak Census Area (96.9% AI/AN) (U.S. Census Bureau, 2020).

Alaska is the Native homeland of nearly half of the federally recognized AI/AN tribes in the U.S., and they can be meaningfully grouped into eight major (and broad) cultural areas: (1) Athabascan in the interior; (2) Tlingit, Haida, and Tsimshian of Southeast Alaska/North American Pacific Northwest; (3) Siberian Yup'ik of St. Lawrence Island in the Bering Sea; (4) Yup'ik, Cup'ik, and Yupiak of the central west coast; (5) Iñupiaq of the Arctic circle; (6) Alutiiq/Sugpiaq of Kodiak Island, Prince William Sound, and the southern Alaska Peninsula; (7) Unangan of the Aleutian Islands; and (8) Eyak of south central Alaska (Williams, 2009). While these eight broad cultural areas allow for some understanding and comparison, Alaska Native peoples maintain that there are too many cultural regions to number (Williams, 2009), and it is important to emphasize that each of the 229 tribes are complex, with internal differences tied to the land on which they have lived since time immemorial (Roderick, 2010). In this paper, we cannot adequately represent and discuss all facets of Alaska's diversity, its experiences with the 1918 influenza and COVID-19 pandemics, and the potential points of interest for post-population health. However, we seek to broadly acknowledge what is known about Alaska and its pandemic experiences and open the conversation for more researchers to engage with the dynamics of health, emerging infectious diseases, and historical context in Alaska, especially in ways that are of direct benefit to the knowledge and lived experiences of Alaska Native peoples.

Population health is best conceptualized as the product of many determinants, including ecological and sociocultural determinants (Krieger, 1994, 1999). Alaska is geographically large, with settlements few and far between, where weather is a constant threat to healthcare for rural Alaskans. In Alaska, one of the most important determinants of population health is healthcare *access* (Allhoff & Goleman, 2020). As stated by Allhoff & Goleman (2020): "It is not just that Alaska is sparsely populated, or that it is huge, it is that it is *both*" (emphasis added).

Overall, Alaska Native peoples have relatively good health compared to Indigenous peoples of other circumpolar nations (perhaps not as good in general as those in Scandinavia but measurably better than those in Northern Russia), and the main risks to health include dietary changes, low activity levels, high tobacco usage, pollution, and climate change (Snodgrass, 2013). The top seven causes of death in Alaska, excluding COVID-19, are: cancer, heart disease, injuries, cardiovascular disease, chronic obstructive pulmonary disease (COPD), suicide, diabetes, and cirrhosis (Alaska

Bureau of Vital Statistics, 2011). Systematic reviews from 2009 and 2011 show that for the top seven causes of death (plus three other important causes of death: influenza/pneumonia, sexually transmitted infections [including HIV], and tuberculosis), the common determinants are addiction, environmental exposure, diet/nutrition/exercise, social connectedness, access to clean water, climate change, access to quality healthcare, sexual and reproductive health, and occupational health and safety (Driscoll et al., 2013). Climate change has already caused significant economic and social upheavals in the Arctic (Parkinson & Evengard, 2009), and Indigenous peoples in the Arctic are at highest risk of severe negative outcomes of climate change due to the rapid transitions of the environment and their close relationship with the rapidly changing land (Hess et al., 2008). Many determinants of health are directly and indirectly linked to ongoing climate change in the Arctic, including consequences of severe weather, mental and social stress, loss of traditional lifestyle, newly emerging and re-emerging diseases, decreased access to safe water resources, and diet changes from loss of subsistence foods (Parkinson, 2008; Parkinson & Berner, 2009; Vors & Boyce, 2009).

Additional stressors such as poverty, land dispossession, globalization, and sociocultural transitions challenged the adaptability of Arctic Indigenous peoples in the face of climate change (Ford, 2012). Even so, we cannot ignore the considerable adaptive flexibility of Indigenous Arctic peoples, and some scholarly work has been done specifically to center and elevate Alaska Native agency and traditional ecological knowledge to leverage their strengths to adapt to their changing ecologies and to future pandemic threats (Ford et al., 2014, 2015; Wexler et al., 2014).

The 1918 influenza and COVID-19 pandemics in Alaska

The 1918 influenza pandemic

The 1918 influenza pandemic is often considered a worst-case scenario for an infectious disease outbreak. It is sometimes referred to as the deadliest pandemic ever, with a death count ranging from 15-40 million on the low end and 50-100 million on the high end (Crosby, 1989; Johnson & Mueller, 2002; Patterson & Pyle, 1991; Spreeuwenberg et al., 2018). With an early 20th century global population of about 1.8 billion people, this amounted to approximately 2-2.5% mortality (Johnson & Mueller, 2002). Discrepancies in death counts stem from differences in methodological approach (estimating mortality indirectly versus counting existing death records) and missing data in much of the world that did not keep extensive demographic and/or vital records. Even so, there were few places the 1918 flu did not reach, and though its global spread is often attributed to movement of troops during World War I, even nations not directly involved in World War I suffered from the disease (Humphries, 2013; Oxford et al., 2002). Additionally, there are general characteristics of the pandemic that have been observed worldwide, independent of geographic location, demographic composition of the population, or sociocultural diversity.

The two characteristics of the 1918 flu most pertinent to the context of Alaska are (1) the age pattern of mortality, and (2) the disproportionate burden of pandemic influenza in Indigenous versus non-Indigenous populations. First, younger adults, typically aged 20-40, experienced unprecedented excess mortality during the 1918 flu, which is atypical for what could be expected for a seasonal influenza outbreak (Gagnon et al., 2013; Luk et al., 2001). This is one of the most widely observed yet poorly understood characteristics of the 1918 flu, since the ages at highest risk were the very young and very old. A detailed discussion of theories explaining this phenomenon are outside the scope of this paper, but the key takeaway is that people who died at the highest rates from the pandemic virus were those who were otherwise expected to be in their prime of life, working regularly to earn money and resources for their families, reproducing, and providing dependent care. Second, Indigenous peoples worldwide were observed to suffer disproportionately more from the 1918 flu than the settler populations in the same regions (Mamelund, 2003; Mamelund et al., 2013; Rice, 2018). While there are some limitations to understanding in the current body of observations on Indigenous versus non-Indigenous experiences with the 1918 flu (van Doren et al., 2023), the observation that Indigenous pandemic outcomes were generally worse seems robust.

Despite the relative wealth of information now available for populations worldwide about the 1918 flu, there have not been many extensive studies of the 1918 pandemic experience in Alaska. The flu likely came to Alaska via steamships delivering resources, and the first cases emerged in the southeast in October 1918. By the end of October there were over 200 cases in Ketchikan, and only 10 days later there were 336 cases and 7 dead, 250 cases in Hydaburg, and 98 cases in Alaska Native individuals in Sitka (Lauterat, 1986). It is difficult to say how many people total died during the flu in Alaska, but early estimates placed the number somewhere between 2000 and 3000 people, leaving 500 children orphaned and some localities totally abandoned (Lauterat, 1986). The governor of Alaska at the time, Thomas Riggs, stated in a hearing at the U.S. Capitol that about 90% of the deaths in the territory were in the Alaska Native population (Sisson et al., 1919), which is supported by the estimate that around 950 Alaska Native people died in Nome alone.

As for the distribution of deaths in other Alaska regions, Philip and Lackman (1962) provided the first consolidated account, while Mamelund et al. (2013) further summarized this report and integrated data from other historical and academic sources (e.g., Alaska Legislature, 1921; Lauterat, 1986; U.S. Senate, 1919) to provide a more thorough presentation of available data. Philip and Lackman's (1962) report provided an account of deaths in five major Alaska regions (Southeast, Southcentral, Yukon Delta, Seward Peninsula, and Southwest), and showed that the Southwest region (comprising Chogiung, Koggiun, and Naknek) suffered the highest mortality (35.4%) while the Seward Peninsula (comprising Nome, Teller, and Wales) had the second highest mortality (27.7%). Southcentral (9.3%), Yukon Delta (4.1%), and Southeast (1.7%) had relatively lower mortality, but even these percentages are high compared to mortality from influenza in non-pandemic years. An important observation of the distribution of deaths throughout the territory is the fact that coastal localities suffered the most from the pandemic; very few interior villages reported influenza deaths or cases. This may be due to reporting bias, but it can also be attributed to effective quarantine points in Shishmaref, Walla Walla, and Unalakleet, among other locations; villages around the Seward Peninsula that did not report any cases of influenza included Deering, Buckland, White Mountain, Koyuk, Elim, and Shaktoolik (Ganley, 1998). Fairbanks, Iditarod, and Yukon River were also protected by these quarantines (Sisson et al., 1919).[2]

Potentially one of the most important health conditions present in early 20th century Alaska (and for much of the rest of the 20th century) was the consistent and heavy burden of tuberculosis. The co-morbidity of pulmonary tuberculosis and influenza is severe; an existing infection with

[2] Specific names of localities discussed in this paragraph are used so that they match their original use in the references in which they are published. It is possible that locality names have changed over time. Please see the references (e.g., Ganley, 1998; Philip & Lackman, 1962; Sisson et al., 1919) for more detail, including labeled maps.

Mycobacterium tuberculosis, the bacteria that causes pulmonary tuberculosis, can accelerate the disease process of influenza and significantly increase the likelihood of death (Walaza et al., 2015, 2020). For populations in which there was a known tuberculosis burden prior to the 1918 flu, there have even been post-pandemic shifts in tuberculosis epidemiology due to selective effects during the pandemic (Noymer, 2009, 2011; van Doren & Sattenspiel, 2021). More specifically, those with active or latent tuberculosis infections were more likely to die during the 1918 influenza pandemic, leaving a smaller population of people infected with tuberculosis in post-pandemic years (Noymer, 2009). This phenomenon has not yet been explicitly investigated in the Alaskan context, but it is known that tuberculosis was present and prevalent, and was referred to as "The Scourge of Alaska" by Dr. Robert Fortuine in his classic book *Chills and Fever* (Fortuine, 1989).

The first systematic investigations of the prevalence of tuberculosis was not carried out until the mid-20th century (Comstock & Philip, 1961), but according to the first tuberculin survey, the prevalence of tuberculin reactors among Alaska Native children was 32% in the Aleutian Islands, 56% of the northwest coast and interior, and 75% in the Yukon-Kuskokwim Delta, with an estimated mortality rate for Alaska Natives of 501 deaths per 100,000 individuals in 1952 (compared with 1.8 deaths per 100,000 in the continental U.S. in the same year) (CDC, n.d.; Comstock & Philip, 1961). While the prevalence of tuberculosis during the exact years of the 1918 flu are currently unknown, it is reasonable to assume, based on these uncharacteristically high numbers for the mid-20th century, that the burden was heavy and likely was a strong determinant in how the people of Alaska experienced the 1918 influenza pandemic, especially since tuberculosis epidemiology is determined strongly by sociocultural and historical factors.

The COVID-19 pandemic

The COVID-19 pandemic is the most recent global infectious disease outbreak, and at the time of this writing, there have been nearly 770 million confirmed cases and over 6.9 million deaths; with a total global population of just over 8 billion people, this equals a 0.9% mortality rate worldwide (WHO, 2022), which is substantially lower than the 2-2.5% global mortality rate estimated for the 1918 flu. So far, there have been few research programs dedicated exclusively to the nature of the COVID-19 pandemic in Alaska, but general characteristics including cases, vaccinations, and deaths for each census area and borough have been well accounted for in the Alaska COVID-19 Information Hub (2022).

The first case of COVID-19 was identified in Ketchikan, Alaska in late spring 2020, but the epidemic curve was relatively delayed compared to the rest of the U.S. and other circumpolar nations (Petrov et al., 2020, 2021). By December 2020, vaccines were available in Juneau and were quickly distributed to Sitka, and then other rural island communities in Southeast Alaska as well as north to Anchorage and throughout the northern region of the state (McKinstry et al., 2020). By January 2021, Alaska had the highest per capita vaccination rate in the U.S. and was the first state to make COVID-19 vaccines available to everyone age 16+, in large part due to the extensive and tireless work of tribal health organizations, like the Alaska Native Tribal Health Consortium, and the thorough vaccination of the most remote villages (Berman, 2021). To date, there have been ~294,000 cases of COVID-19 in Alaska, and 1,449 deaths (0.5% mortality compared to 1.1% mortality for the whole U.S.) (Alaska COVID-19 Information Hub, 2022; WHO, 2022). The highest number of deaths per capita have occurred in Anchorage Municipality (187), Northwest Arctic Borough (184), and North Slope Borough (Utqiagvik) (142), and the largest number of cases have occurred in Denali Borough (71,388 cases per 100,000), Northwest Arctic Borough (68,351 cases per 100,000), and North Slope Borough (51,515 cases per 100,000) (Powell et al., 2022).

There have been many studies published that attempt to address inequalities observed in COVID-19 disease and mortality broadly, including but not limited to: critical evaluations of differences in risk in the spectra of sex and gender (Shattuck-Heidorn et al., 2021); different outcomes in socially constructed race categories, including Indigenous versus non-Indigenous populations (Holmes et al., 2020; Mackey et al., 2021); and pre-existing co-morbidities and disability (Gleason et al., 2021; Zhou et al., 2021). The observations of inequalities for all these examples, as well as others not mentioned, are mixed and context dependent. Of particular applicability to the experience of Alaska during COVID-19 is the pattern in unequal outcomes between Alaska Native and non-Alaska Native peoples. Alves et al. (2022) reviewed the global observations with available data on COVID-19 outcomes in Indigenous peoples compared to non-Indigenous people of the same regions and found mixed results: sometimes Indigenous outcomes were worse, sometimes Indigenous communities were well protected from negative pandemic outcomes. The results for Alaska simply stated that there were not much data available, but the trends leaned towards slightly worse pandemic outcomes in Alaska Native peoples (Alves et al., 2022). Recently, Petrov et al. (2023) identified Alaska Native peoples' agency over the pandemic response and sovereignty as a primary source of resilience, given Alaska Native peoples' COVID-19 outcomes were generally not as severe as non-Alaska Native COVID-19 outcomes.

In a qualitative analysis of interviews with Alaska Native individuals in rural Southeast Alaska island communities, van Doren et al. (2023) show that there was significant adaptive behavior and considerable resilience in the face of the new pandemic. Specifically, Alaska Native communities drew on historical knowledge of the 1918 flu, knowledge of subsistence gathering, and community-centered (rather than individualistic) protections to bolster their communities against COVID-19. Protections like the COVID-19 vaccines were considered the best way to "get back to normal" after spending most of the year isolating from one another in 2020. Even though communities throughout Alaska (not just in the southeast) occasionally expressed hesitancy about the vaccinations and opposition to *mandated* vaccines, they became widely accepted and well taken up throughout Alaska (Eichelberger et al., 2022; Hahn et al., 2022).

The results point towards an essential distinction between our current knowledge of the 1918 flu and COVID-19 pandemics: it is still somewhat unclear why Alaska Native communities seemingly suffered far more negative outcomes during the 1918 flu, but community-centered research that highlights the strengths of these communities during the COVID-19 pandemic shows ways that Alaska Native peoples are resilient in the face of novel pandemic threats. General epidemiological and demographic analyses, which make up a large proportion of 1918 flu knowledge of Indigenous peoples' experiences with the historical pandemic, do not necessarily capture the lived experience of the 1918 flu or the agency of Native communities in resisting pandemics. In this vein, we must also consider the substantial bias in perspective of pandemic experiences, as most of the written historical record in Alaska is written from the colonial perspectives of both the U.S. and Russia. Therefore, most, if not all, of Indigenous historical knowledge and memory of the 1918 flu in Alaska Native communities exists in the form of oral histories in their own languages. In this way, it is possible that settlers will never know the nuance of how Alaska Native communities experienced this historical event.

One parallel between the 1918 flu and COVID-19 pandemics in Alaska is the pattern of which communities suffered the most in terms of cases and mortality: coastal communities, especially those in the northern regions of Alaska, appear to have suffered the worst observed outcomes, while those in the interior seem to have suffered the least. This may seem counterintuitive on the surface, because if one of the essential determinants of maintaining health and treating ailments in remote Alaskan locations is access to care, then considerable distance from healthcare could have interfered with the ability of remote villages to endure the 1918 flu. However, the escape of many remote villages in Alaska during the 1918 flu is strongly tied to the movement of people and resources—or rather, the lack thereof—since quarantines were so essential in limiting the spread of the virus. Moving forward, pandemic preparedness plans must reflect on the characteristics of previous major pandemic events to integrate the methods that worked to reduce pathogen spread and mortality outcomes with the needs of idiosyncratic communities throughout Alaska. This work requires interdisciplinary cooperation between social scientists and public health practitioners to ensure that remote communities can continue to receive necessary resources safely (including vaccines), that remote communities can also access healthcare when needed for existing conditions and regularly circulating pathogens, and that larger cities in Alaska (e.g., Juneau, Anchorage) also have protective resources as main entry points to the state.

Population health futures: Delayed care and its consequences

The role of delayed care in holistic pandemic knowledge

Pandemics are disruptive epidemiological events that often have clear and substantial proximate impacts, but we must also consider the ways in which pandemics affect population health in the long term. Pandemic impacts do not end with those who died *during* the pandemic *from* the pandemic disease. Far more who are infected with a pandemic pathogen will survive than will not, and even people who may have never been infected or never progressed to active disease may be influenced indirectly via multiple possible pathways (van Doren & Brown, 2023). Here, we expand upon the current knowledge of how COVID-19 has impacted access to healthcare for other non-COVID conditions, and why this phenomenon is going to be important for understanding long-term impacts of pandemics.

Post-pandemic impacts are difficult to study, but current evidence shows that demographic, epidemiological, and even genetic consequences manifest in the surviving population. While an extensive discussion of these patterns is outside the scope of this paper, others have reviewed demographic evolution in response to the Black Death and 1918 flu (DeWitte & Wissler, 2021), observed improvements in life expectancy and respiratory-specific survivorship and mortality in post-pandemic periods (Kelmelis & DeWitte, 2021; Noymer, 2009; Noymer & Garenne, 2000; Saglanmak et al., 2011; van Doren & Kelmelis, 2022; van Doren & Sattenspiel, 2021), and hypothesized about high selective mortality during the Black Death and its consequences on allele frequencies that are protective against certain intracellular pathogens (Klunk et al., 2022; Moalem et al., 2002; Weinberg, 2008).

Importantly, much of what we know about post-pandemic health in any population comes from records of people who died, such as mortality records or skeletal material. This bias in the data limits our understanding of survivor health in post-pandemic populations. Some countries such as

Iceland (Cliff et al., 2009), Denmark (Saglanmak et al., 2011), and Norway (Mamelund et al., 2016) had well established methods of tracing cases in the early 20th century and could report on morbidity. However, this is the exception. We can better understand how pandemics affect population health by investigating how health changes in the surviving population, and one approach to this is through a closer look at the consequences of delayed care.

Over three years after the beginning of the COVID-19 pandemic in March 2020, the World Health Organization downgraded the COVID-19 pandemic from a public health emergency of international concern to an ongoing health issue (WHO, 2023). Now, we have some insight into how the COVID-19 pandemic has both directly and indirectly impacted not only epidemiological patterns, but also how people obtained medical care from 2020-22. From March to May 2020 in New York, over 24,000 deaths from all causes were found to be in excess of the baseline number of expected deaths for a typical three-month long non-pandemic period. It was suggested that these excess deaths could be attributed to social distancing, hospital burdens, and fear of exposure to the novel SARS-CoV-2 pathogen (Olson et al., 2020). From this initial observation, indications of changes in care-seeking behavior followed shortly: after this initial excess mortality burden was reported, the *Weekly Morbidity and Mortality Report* from June 12, 2020, reported that there was an observed 42% decrease in emergency room visits from March to April 2020 compared with the same weeks in 2019 (Hartnett et al., 2020). Research that has started to investigate the phenomenon of delayed care in more detail shows that up to one-third of adults experienced delayed care, and about 20% of those feel their health was negatively impacted by the delay, irrespective of the reason for delay or health condition (Zhong et al., 2022). However, Atherly et al. (2020) point out that there is still little known about the extent of delayed care or what kinds of services most patients needed but delayed. Importantly, delays in healthcare may impact people independently of whether they were ever infected with SARS-CoV-2 or ever suffered from COVID-19 disease.

Biocultural anthropologists are well positioned to study delayed care in the context of pandemics because it highlights how many different human behaviors—public health decisions, personal choices, and social norms—can have biodemographic consequences (van Doren & Brown, 2023). Biocultural theories and studies can help inform the concept that pandemics and other acute threats are possible inflection points in population health that may reverberate and be identifiable for long after the epidemic curve is over.

Observations of delayed care

There is an emerging body of literature investigating delayed care during the COVID-19 pandemic, but who delays care and why will be specific to a population's environment, ambient social conditions, trust in public health guidance, effectiveness of public health interventions, and more. Here, we briefly review some of the current literature on delayed care published since the beginning of the COVID-19 pandemic. We note that there are no purposeful investigations of this problem in any Arctic space worldwide, or Alaska specifically. With this in mind, we will highlight some key considerations for social scientists and public health practitioners moving forward to meet the challenges of this potential new public health burden in Alaska.

First, it is critical to understand why delayed care occurred. There has not been a systematically derived characterization for reasons why people delayed care, but van Doren and Brown (2023) outlined a possible scheme: (1) public health mandates like social distancing guidelines, shutdowns, and pauses of non-emergent procedures prevented people from accessing medical institutions

(Ashkenazy et al., 2021; Atherly et al., 2020; Beran et al., 2020; Gupta et al., 2021); (2) hospitals and clinics overburdened with COVID-19 cases additionally prevented patients from accessing healthcare, even for emergent conditions (characterized as *involuntary care disruption* [Callison & Ward, 2021]) (Blay et al., 2021; Lei & Maust, 2022; Wilson et al., 2021); and (3) personal risk assessments leading to the choice not to enter institutions that could put them at risk of exposure to COVID-19 at any point (Beran et al., 2020; Caston et al., 2021; Clodfelder et al., 2022; Doncarli et al., 2021; Lusambili et al., 2020; Nab et al., 2021). Underlying motivations for or determinants of delayed care rest on various human behaviors and layered decision-making processes, which is important information even for more biologically oriented population health researchers. Importantly, each of these reasons for delayed care may intersect with one another and with other sociocultural factors, leading to a much more complex picture of how and why delayed care has become so prevalent during the COVID-19 pandemic.

Second, it is important to understand which health conditions were most affected by delayed care. The initial research published that investigates the health conditions for which delayed care was common covers a broad range of conditions. Most prominently, at least in the early phases of the pandemic, dramatic reductions in presentations of myocardial infarction (MI) were observed; in June 2020 in Denver, Colorado, over 18% of patients refused emergency transportation during an MI and 22% of MI patients died in the hospital compared to only 4% during the same period in the previous year (Clodfelder et al., 2022). Others observed that there was as much as a 60% drop in cardiology visits, 50% reduction in blood pressure evaluations, and millions of cardiac rehabilitation sessions were canceled overnight (Duffy et al., 2021). Overall, the total number of emergency room visits dropped around 30-42% from 2019 to 2020 (Hartnett et al., 2020; Igal et al., 2021). Lange et al. (2020) point out that the data collected on emergency room visits represents an important stress test for the state of life-threatening conditions that could result in permanent disabilities in the surviving population, so even during a pandemic, it is ideal neither for patients to skip visits, nor for population health researchers after the fact.

Cancer has also been studied in terms of delayed care. The observations and consequences of delayed cancer care are diverse and complex and are dependent on the type of cancer and progression of the disease. Overall, in 2020 there were drastic reductions in chemotherapy, immunotherapy, and new cancer diagnoses (de Joode et al., 2020), as well as home care services for progressed cases (Jeba et al., 2022). For breast cancer patients in the U.S., younger patients who had larger households and childcare responsibilities were significantly more likely to delay appointments (Li et al., 2021), which to some extent speaks to the ways domestic responsibilities—especially the elevated responsibilities of women during the COVID-19 pandemic (Power, 2020)—impeded on the ability to access healthcare, as well.

Other conditions that have been investigated, albeit sparingly, include diabetes, sexual and reproductive health, and other (non-COVID) infectious diseases. One of the only analyses of the consequences of delayed care on other infectious diseases was in the context of dengue fever in the Philippines. The study found that the determinants of care delays included financial constraints associated with illness and disease, location and transportation relative to care-providers, and hospital capacity, which were all important factors in administration of care to patients (Lisgay et al., 2021). Recent observations of diabetes have shown that there has been a recent increase in cases of diabetic ketoacidosis in people of all ages, suggesting that delayed care-seeking for diabetes may have caused more rapid diabetes progression (Ambati et al., 2022). Finally, many of the conditions discussed above are also known to be exacerbated when co-morbid with COVID-19, especially cardiovascular disease (Bansal, 2020; Clerkin et al., 2020; Nishiga et al., 2020), cancer (Al-Quteimat & Amer, 2020), and kidney disease (Durvasula et al., 2020; Khouchlaa & Bouyahya, 2020).

In Alaska, one of the most pressing concerns for emergent, infectious, and chronic diseases—in addition to wellbeing, in general—is the ability to access healthcare. Most of Alaska is rural, and most of its rural locations are also remote, that is, a distance that cannot be traversed in a single day of travel, or across rivers that freeze over for months of the year (Allhoff & Goleman, 2020). A report from the Arctic Council (2020) has indicated that there has been some delay in regular healthcare administration during the COVID-19 pandemic. The report acknowledged that delayed care during the pandemic is only one facet of a complex web of health determinants, and that people are broadly battling higher risk from pandemic influenza due to underlying health conditions, tuberculosis, difficulty accessing healthcare due to geographic isolation and travel complications, and some lack of infrastructure (Arctic Council, 2020). Further, delays in or absence of transportation to health centers has led to further health complications and preventable death, and the delay of non-emergency visits will worsen in places in which ischemic heart disease, cancer, chronic respiratory disease, and mental health issues are already present (Arctic Council, 2020).

The authors of this paper have collected two waves of survey data from hundreds of respondents around Southeast Alaska from spring 2020 and winter 2020-21 to explore the way Southeast Alaskans perceived risks related to COVID-19, prepared for the pandemic to reach Alaska, and then subsequently modified their behaviors to protect themselves and their communities from the pandemic. In the winter 2020-21 wave of the survey, there was a specific question regarding to what extent respondents delayed seeking healthcare since the beginning of the COVID-19 pandemic. The results of this question are presented in Table 1, with the responses stratified by whether the response came from a person in a large town (Juneau, Sitka, or Ketchikan) or a small town (Angoon, Craig, Elfin Cove, Gustavus, Haines, Hoonah, Klawock, Petersburg, Skagway, Wrangell, Yakutat, or other small localities). Results are additionally stratified by whether the respondent self-identified as Alaska Native or non-Alaska Native on the survey. Without statistical analyses, *most* people who responded to the survey in winter 2020-21 had, to some extent, experienced delayed care for one reason or another: for Alaska Native respondents, 81% in large towns and 75% in small towns said they experienced delays in care, while 82% and 85% of non-Alaska Native respondents said they experienced delays in care in large and small towns, respectively. To this point, this small set of results (relating only to Southeast Alaskan communities) comprise most of our knowledge of delayed care in Alaska; therefore, much more work needs to be done to understand to what extent Alaskans experienced delayed care during the COVID-19 pandemic, to detangle reasons why care was delayed, and to prepare for post-pandemic medical and public health burdens of the consequences of delayed care.

The observations presented here, and those presented by the Arctic Council (2020), strongly underlie the idea of the indirect impacts on population health introduced above. Moving forward, public health emergency responses to—and preparedness plans for—pandemics should not forget to invest energy and careful thought into how pre-existing population health conditions and idiosyncratic ecological barriers could influence the outcomes of a pandemic, and potential outcomes for long into the future. This may be true whether the pandemic pathogen is introduced or becomes epidemic at any given time within a population. Most of the articles cited throughout this discussion of delayed care were from a biomedical, clinical, or epidemiological perspective (only a couple were qualitative and patient-centered). Moving forward, social scientists and public health practitioners should work together, using a holistic perspective to understand and address the complex determinants and potential consequences of delayed care during a pandemic event in a region like Alaska, especially for conditions like cardiovascular disease, diabetes, and cancer, which charge interest on the body if they go untreated and are uncontrolled. We outline more specific pathways forward below.

Table 1. Distribution of responses to the question: Did you delay seeking healthcare for any reason since the beginning of the COVID-19 pandemic? Answers obtained during a pulse survey throughout Southeast Alaska to investigate risk perception of and preparation for COVID-19 in winter 2020-2021. Results here are stratified by Alaska Native vs. non-Alaska Native respondents, and whether the respondent comes from a large or small town in Southeast Alaska.

	Alaska Native respondents				**Non-Alaska Native respondents**			
	Large		**Small**		**Large**		**Small**	
Response	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**
Not at all	7	19	3	25	52	18	5	15
To some extent	11	31	3	25	127	44	8	24
Certainly	18	50	6	50	107	37	20	61
% of respondents who delayed care "to some extent" or "certainly"		***81***		***75***		***82***		***85***

Conclusions: Integration for holistic pandemic preparedness

Reflection upon the historical experiences of Alaska during the 1918 flu can be useful context for the modern experience with COVID-19, and more importantly, for developing preparedness plans for the inevitable future epidemic challenges. From a social science perspective, some essential conclusions can be made: there are complex determinants for how Alaska Native peoples experience pandemics versus non-Alaska Native people; human behaviors that mitigate the spread of the pathogen (e.g., quarantines) work very well in Alaska; and when Alaska Native communities have agency over emergency pandemic responses that are grounded in traditional ecological knowledge, the response can be effective in mitigating an otherwise potentially detrimental pandemic wave. These commonalities across a century are important to draw upon as strengths of the socioculturally diverse and geographically disparate Alaskan population and should be carefully considered as we move into a post-pandemic period.

Research on pandemic effects, responses, and resilience in Alaska communities will inherently involve rural and remote communities, including those populated mostly or entirely by Alaska Native peoples who rely on hunting, fishing, and gathering for subsistence. Due to their relative geographic isolation and the ecological diversity across Alaska, these communities vary dramatically in local organization and governance and the way they connect with the land, both factors that are vitally important in pandemic vulnerability (including biological vectors and pathways for transmission), resilience, and response. As a result, assumptions and research practices used in the lower 48 states, especially those established in large urban communities, cannot be simply exported and transplanted to the unique Alaskan context.

Instead, biocultural research on COVID-19 and other pandemics must follow the principles of community-embedded co-design (Parsons et al., 2016). This allows local knowledge to co-lead the research process as an equal partner, which increases not only the accuracy and relevance of research but also local buy-in by Indigenous peoples and other communities. Ideally, community-centered approaches would begin with the Indigenous communities identifying areas of need for the basis of the research to yield the most benefit from the knowledge created through their leadership and collaboration. Incorporation of traditional ecological knowledge will help pandemic research programs stay attuned to ecological diversity and the diversity of mental models used by communities to understand and adapt to pandemics (Southwell et al., 2020). Importantly, such research programs require iterative, participatory design. This comes at a cost; such research is often ill-matched to current, biomedically-based ethical review panels (Goodyear-Smith et al., 2015), and research co-design takes careful, long-term work in communities to establish rapport and engage in non-traditional methods for data collection and mutual understanding—that is, co-production of knowledge (Armitage et al., 2011; Latulippe & Klenk, 2020). Additionally, this relationship requires a re-framing of how Western scientists conceptualize Indigenous knowledge, which is too often not considered scientific or rigorous despite many millennia of observation, iteration, refinement, precision, and communication. That is, Indigenous knowledge should never be treated as inferior to Western science in the process of knowledge co-production. We believe the process of such an approach is worth the effort; "one size fits all" pandemic policies can lead to confusion, resistance, loss of trust, and unintended negative consequences.

Other researchers in the Arctic have also written on the importance of the value of this co-production approach: while not referring to the framework as "biocultural" specifically, Cueva et al. (2020) put forth a similar and useful framework to more accurately represent health challenges in circumpolar spaces and highlight a participatory community-based approach to better understand the individual, family, social, cultural, historical, and environmental contexts of communities in the circumpolar north. The need for this framework comes from their observation that most research dedicated to health of circumpolar communities is most focused on (a) epidemiology and inequalities; and (b) resilience and survival-oriented characteristics (Cueva et al., 2020). We are encouraged by the move towards more holistic knowledge creation and understanding of the Arctic and emphasize that these community-centered approaches have much to contribute to pandemic preparedness through purposeful intersections with not only public health, but other areas of research such as disease ecology (Archie et al., 2009; Young et al., 2017), One Health (Rock et al., 2009), and climate change (Jacobs et al., 2021; Wu et al., 2022).

Because co-design and co-production are newer approaches and create tension with established, top-down methods of research, this approach is in its formative stages. However, research that does *not* follow these principles is often rejected or perceived negatively, especially by Indigenous communities (Zurba et al., 2022). Co-design and co-production are especially important for research that may involve biological data collection or biological inferences, given the rocky history of such research involving Indigenous peoples. Based on our review, a biocultural approach to pandemics in Alaska that takes local context seriously has much to promise and will aid our understanding of the long-term consequences of pandemics as well as future pandemic preparedness.

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