The influenza pandemic of 1918–19 in two remote island nations: Iceland and New Zealand

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Abstract

Aim Nations varied in their experience of, and response to, the 1918-19 influenza pandemic. Island communities can provide unique opportunities to study the epidemiology of infectious diseases. We aimed to compare the epidemiology and public health response to this pandemic in two remote island nations, on opposite sides of the globe: Iceland and New Zealand (NZ).

Method Historical accounts in both nations were reviewed, along with recent analysis of the pandemic's impact and course.

Results Marked similarities were noted in epidemic timing, failure of border control, shape of epidemic curves, and delayed use of public health interventions. However, amongst the exposed European populations, Iceland experienced a significantly higher mortality rate (830 vs 550 per 100,000) compared to NZ (rate ratio: 1.5, 95%CI: 1.4-1.6). There is evidence that some public health measures in specific areas of both nations resulted in lower mortality rates. In particular, Iceland’s use of travel restrictions and ship quarantining, appeared to protect 36% of the population.

Conclusion The epidemiology of the 1918-19 influenza pandemic was fairly similar for the exposed European populations of Iceland and NZ. Nevertheless, major differences were the significantly higher overall mortality rate in Iceland and the success of Iceland’s use of travel restrictions.

Nations varied in their response to the 1918-19 influenza pandemic; however, certain epidemiological characteristics of this pandemic were similar in many locations. Similar characteristics of the pandemic included waves of varying intensity, with the second wave generally causing the highest mortality;1 excess mortality amongst young adults;2 lower socioeconomic status associated with increased mortality risk;2,3 and some evidence, although conflicting, that rurality may have been protective.4,5

Public health interventions included the use of quarantine, mass gathering restrictions, and closure of public facilities.1,6

Island communities provide unique opportunities to investigate the epidemiology of infectious diseases. In this study, we aimed to compare the epidemiological characteristics of the 1918-19 influenza pandemic in two relatively large and geographically remote island nations, from opposite sides of the globe: Iceland and New Zealand (NZ).
Additionally, both nations predominantly had European populations in 1918, had some public health infrastructure, have good historical documentation and well-defined population data for 1918 (size and location).

Both nations were exposed to the first wave of the pandemic strain mid-1918 via ships with infected passengers, as neither country implemented full maritime quarantine prior to exposure. Therefore, we also compared the epidemiology of the pandemic and public health responses in the two countries.

Method

Data on pandemic influenza deaths and population figures in 1918 from Iceland were obtained from previously published work by one of the authors, along with other accounts and records (including Statistics Iceland data: www.statice.is). NZ’s pandemic mortality and population data were retrieved from historical records, along with historical accounts and more recent analyses.

Unlike Iceland, NZ has an indigenous population (Māori). But for comparability in this analysis, only deaths amongst the NZ European population were used, due to both the disproportionate mortality amongst the indigenous population and the higher quality of European based records. This restriction has led to a slight underestimate of the overall NZ population pandemic burden.

Given the strong evidence for successful isolation of the eastern and northern populations of Iceland during the pandemic’s second wave, we calculated the pandemic mortality only in the ‘exposed’ population, assuming an equal age-distribution in all regions of the country.

Results

Timing, mortality and geographical spread—Iceland, the smaller of the two nations in both population and landmass, is estimated to have had 484 pandemic-attributable deaths during 1918. These deaths occurred exclusively in the southern and western parts of the country. In contrast, the 1918 pandemic spread to almost all areas of NZ, mainly via coastal shipping routes and along national railway lines.

An estimated 6,000+ deaths occurred amongst New Zealanders of European descent. Iceland had a higher mortality rate (830 vs 550 per 100,000) amongst individuals of European ethnicity in the exposed population. This difference was statistically significant (rate ratio: 1.5, 95%CI: 1.4-1.6). Estimates for NZ suggest that 30-50% of the population was affected with symptomatic illness from the pandemic, whilst estimates in Iceland suggest an attack rate of 66% and as high as 80-90%.

The first pandemic wave was experienced by both nations between July and October 1918, and was reportedly mild. However, the second wave, commencing in late October 1918, exacted the largest mortality burden. This wave peaked in three weeks at roughly the same time (mid-November 1918) for both Iceland and the North and South Islands of NZ (Figure 1).

Iceland did not experience a noticeable third wave in 1919 (it is unclear for NZ); however, there is some evidence that previously unexposed populations in Olafsvik and Dyrholahreppur, Iceland experienced a severe influenza outbreak in mid-1921, clinically identical to the 1918-19 pandemic (unpublished diary and personal communication by Þórður Tómasson, Curator of Skogar Museum).
Figure 1: Epidemic curve for pandemic influenza mortality for Europeans in Iceland and NZ, 1918

Age specific mortality, comparison between urban and rural areas—Both nations observed a “W-shaped” age distribution in mortality rates (Figure 2), characterised by relatively high pandemic mortality rates amongst young adults. However, the exposed Icelandic population experienced a higher rate per 100,000 in nearly all age-groups compared with NZ, most noticeably in the older population (60+ years).

Reykjavik (Iceland’s capital) had a noticeably higher overall mortality rate (1700 per 100,000) compared with the four major NZ cities (range: 390 to 790 per 100,000). Lower mortality rates were generally experienced in rural areas of NZ (705 per 100,000 in cities/towns compared to 330 per 100,000 in rural areas); similar to Iceland, with a noticeably lower mortality experienced in rural areas (523 per 100,000) compared to the urban environment of Reykjavik. Crowded living conditions in Iceland and lower socioeconomic status in NZ were cited as risk factors during 1918.
Effects of travel restrictions, quarantine and other interventions—Few areas in NZ achieved any form of partial or full quarantine. One NZ town (population: ~1000) is noted as enacting a successful form of quarantine, resulting in lower mortality compared with surrounding areas.

Iceland successfully introduced partial travel restrictions: a locally-initiated road patrol block on the main road leading to the northern part of the island, and a guard by a natural barrier of an unbridged glacial river, crossing the road to the eastern part. These measures were followed by ship quarantining which together, provided protection from the pandemic strain, sheltering 36% of the Icelandic population.

Interventions such as the closure of schools/shops and restrictions to mass gatherings differed between the countries. NZ’s response was varied, with social distancing policies between regions inconsistently implemented and introduced late during the pandemic period.

Conversely, Icelanders initiated more consistent interventions such as restrictions on mass gathering and closure of public facilities (notably publicly initiated), but most measures were delayed.

Community-based organisations in both nations contributed to the pandemic response, such as provision of food and supportive care. In post-pandemic years, changes to strengthen public health legislation were adopted in both NZ and Iceland.

Health services in both nations were stretched, with temporary/auxiliary hospitals created to deal with the pandemic cases. During 1918, Iceland had more doctors per head of population compared to NZ (80 vs 60 per 100,000), mainly due to one-third
of NZ doctors serving overseas as part of World War One. However, NZ did have an established nursing workforce (n=1,675), unlike Iceland.

Discussion

Influenza was a notifiable disease in Iceland before the pandemic, unlike NZ, which only initiated/implemented this requirement in the midst of the pandemic.

As both are relatively remote islands, requiring sea voyages of days to weeks to reach them in 1918, they had a potential geographic advantage compared with most other countries which have land borders. Yet, officials in both nations delayed in enacting responses or decided not to respond at all. In contrast, a few geographically isolated countries and areas did manage to exclude pandemic influenza in 1918-19, but only by very active border control policies.\textsuperscript{13}

The relatively high mortality amongst young adults for both nations is consistent with other studies in various populations during the 1918-19 influenza pandemic. This distinct vulnerability for individuals aged 20-40 years suggests that host factors may have played a role in determining mortality risk for this particular pandemic influenza strain, although results are conflicting.\textsuperscript{14} Of note is the high mortality rate experienced by the elderly in Iceland.

There is evidence from both nations that deprivation may have played a role in determining mortality risk from pandemic influenza. Deprivation has long been cited as a mortality risk for infectious diseases, so this result is not surprising. Conversely, rurality is suggested as a protective factor for pandemic-related mortality risk in both Iceland and NZ.

Previous research has hypothesised that less exposure to the 1918-19 pandemic strain (eg, remoteness reducing risk of exposure to infected people), differing health care access, or various other sociodemographic variables (eg, less crowding) may have contributed to the observed protective effect of rurality in some populations. However, the results are conflicting, and more research is required in this area.

We can only speculate as to the possible reasons for the higher mortality and estimated morbidity rate in Iceland, particularly given the arguably more effectively implemented public health interventions employed compared to NZ. One possibility is the impact of seasonality, since in late 1918 Iceland was entering its winter season, while NZ was just entering its warmer summer months.

The NZ population may have had some form of residual protective immunity having just passed through its seasonal influenza period. Seasonality could have impacted on transmission levels with Icelanders spending more time indoors in close proximity to others; as well as being exposed to additional respiratory stressors such as indoor air pollution from cooking and heating.

Furthermore it can be speculated that different levels of pneumococcal colonisation amongst Icelanders and New Zealanders may have played a role.\textsuperscript{15} Potential nutritional/dietary variations may also conceivably have caused differences in immune responses between the populations of these two nations.

It is worth mentioning the element of latitude differences (NZ is closer to the equator than Iceland), which may correlate with less sun exposure in Iceland. Both the time of
year and latitude could have resulted in lower vitamin D levels (resulting from less ultraviolet light exposure) among Icelanders.

Low vitamin D levels have been suggested as a risk factor for increased mortality during the 1918-19 pandemic in a US study.\textsuperscript{16} Also there is some (albeit incomplete) more modern evidence for low vitamin D contributing to influenza risk.\textsuperscript{17} It has also been suggested that “annual light/dark cycle and mediated by the pattern of melatonin secretion, might account for many heretofore unexplained features of infectious disease seasonality”.\textsuperscript{18}

Furthermore, the winter conditions in Iceland may have favoured the transmission of influenza virus (since cold and dry conditions favour transmission\textsuperscript{19}) and also reduced ultraviolet light levels may have favoured virus survival (given evidence for sensitivity to this light\textsuperscript{20}).

Given global air travel and the difficulty containing spread of the 2009 influenza pandemic, island nations probably cannot fully rely on border control for protection from future pandemics.\textsuperscript{21} Although very small islands might benefit from travel volume reduction,\textsuperscript{22} larger islands will need other interventions.

Iceland’s successful use of ‘protective sequestration’ and local ship quarantine, sheltering one-third of the population, add to previous evidence to suggest that such approaches are worth considering in places where travel movements can be easily controlled.\textsuperscript{23} Furthermore, the late outbreak of influenza (probably of the same pandemic strain) in Iceland in 1921, reinforces the importance of careful monitoring of previously unexposed populations after a pandemic.

In summary, the epidemiology of the 1918-19 influenza pandemic was fairly similar for the exposed European populations of Iceland and NZ. Nevertheless, major differences were the significantly higher overall mortality rate in Iceland compared to NZ and the success of Iceland’s use of protective sequestration and localised ship quarantining which protected 36% of the population.

Competing interests: Nil.

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