One hundred years ago in 1919: New Zealand's birth reduction shock associated with an influenza pandemic

Nick Wilson, Nikki Turner, Michael G Baker

ABSTRACT

AIM: We aimed to conduct a preliminary analysis of any association between the 1918 influenza pandemic and its impact on birth rates in New Zealand.

METHODS: Official data covering the period 1910 to 1930 were sourced from multiple New Zealand Yearbooks. Estimates were made of the size of the natality impacts and estimates made of the potential causes.

RESULTS: In 1919 there were 3,756 fewer non-Māori and 239 fewer Māori births than the pre-pandemic year of 1917, with these representing reductions in birth rates per 1,000 population of 16.6% and 19.8% respectively. The birth rate reductions in the pandemic year of 1918 (relative to 1917) were less at 8.8% and 6.7% reductions respectively. We estimated the likely major driver of the natality deficit in 1919 was embryonic and fetal loss due to influenza infection in pregnancy. Smaller roles were plausibly played by adult deaths during the pandemic and reduced sexual activity associated with the social turbulence of the peak pandemic months.

CONCLUSIONS: The reduction in birth rates in New Zealand in 1918 and especially 1919 are consistent with international data associated with the 1918 influenza pandemic. The relatively higher natality loss for Māori for 1919 is also consistent with other epidemiological data on the unequal burden from this pandemic. Pandemic planning needs to consider ways to prevent such future burdens and associated inequalities. There is also a need to improve on the current low level of routine influenza vaccination in pregnancy so as to minimise fetal loss from seasonal influenza infection.

The influenza pandemic that caused an estimated 9,000 deaths in late 1918 in New Zealand is generally well documented.[1–3] While a fertility impact on the Māori population was suggested by Pool in 1973 (with an estimate of 12.2% of marriages in the 25–34 year age-group dissolved due to death of spouses[4]), the impact on natality in New Zealand from this pandemic has never been considered in any substantive way. We therefore aimed to conduct a preliminary analysis of this likely association given the 100-year historical point, its potential future relevance to pandemic planning, and its potential relevance to modern-day recommendations for pregnant women to be vaccinated against seasonal influenza.

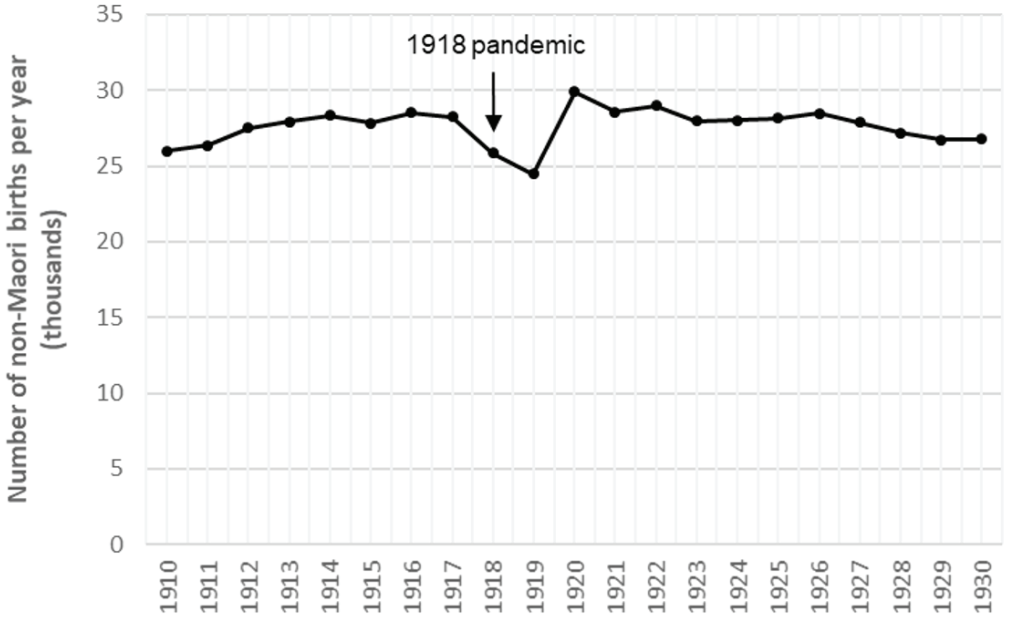
Methods

Official data covering the period 1910 to 1930 were sourced from multiple New Zealand Yearbooks,[5] including those published up to 1932. But due to limitations with the denominator data for the Māori population around this time period, we use modelled Statistics New Zealand estimates for calculating rates (specifically from Figure 2.2 in a Report[6]).

To put our findings into a broader demographic context we considered data on marriages and post-First World War troop movements back to New Zealand. As only annual marriage data were available, to give an idea of monthly marriage trends we

ISSN 1175-8716

Figure 1: Numbers of non-Māori births in New Zealand per year from 1910 to 1930.



ran queries of marriages from the national 'Births, Deaths and Marriages' database.[7] These queries used the common names (applied to the names of both brides and grooms) of: 'Smith', 'Wilson' and 'Brown'. A full copy of all the data in an Excel file is available on request.

Results

The number of births declined in both 1918 and 1919 for the non-Māori (essentially European) and Māori populations (Figures 1 and 2 show numbers, since we considered rates to be less reliable due to concerns with denominator accuracy for the Māori population). In 1919 there were 3,756 fewer non-Māori and 239 fewer Māori births than the pre-pandemic year of 1917. Similarly, the reductions in birth rates per 1,000 population in 1919 were by 16.6% and 19.8% respectively, relative to 1917. The birth rate reductions in 1918, relative to 1917, were less at 8.8% and 6.7% reductions respectively. In 1920 the birth rate had returned to near the 1917 level for non-Māori (ie, only 2.3% lower than in 1917), but declined further for Māori (21.9% lower, although it started to rise again in 1921; Figure 2 for numbers).

Figure 2: Numbers of Māori births in New Zealand per year from 1910 to 1930 (albeit with missing data for the first four years as registration of Māori births only became a legal requirement in March 1913 and probably rose initially due to improvements in the registration process).

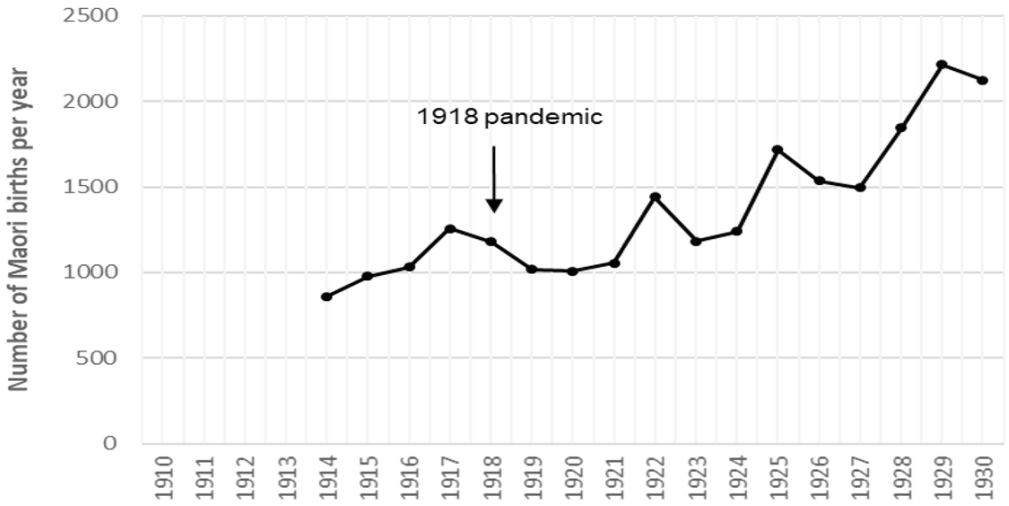
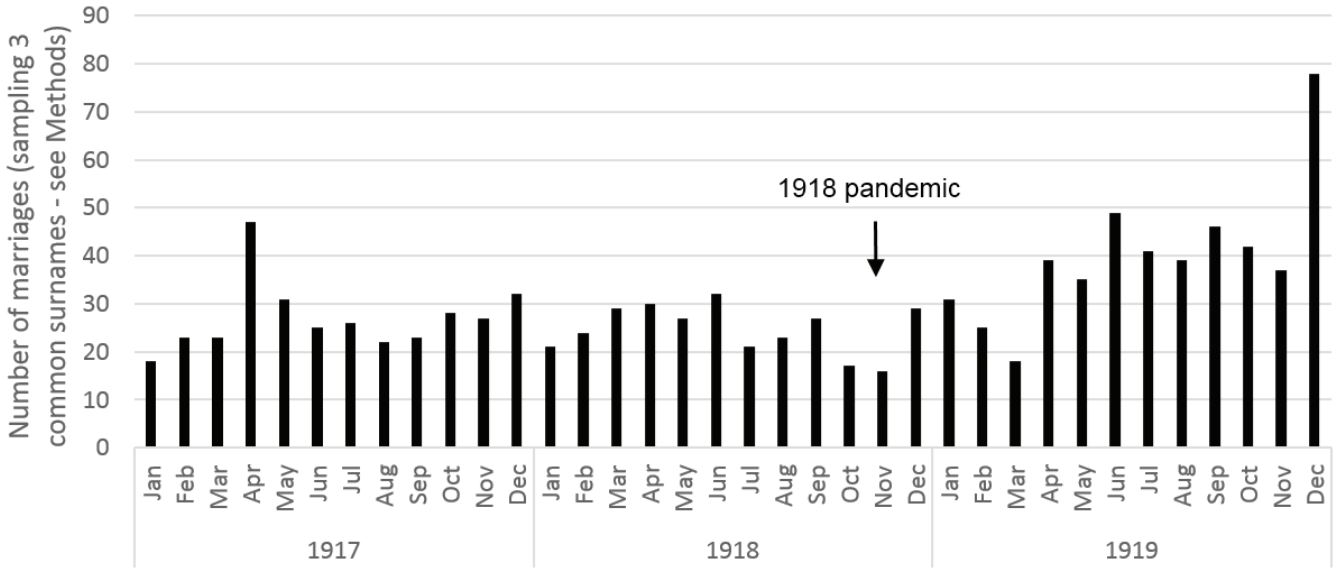


Figure 3: Numbers of marriages by month for 1917 to 1919 using a sample of three common surnames in the national 'Births, Deaths and Marriages' database given the absence of national-level data (see *Methods*).



Possible impacts of deaths of women and men in relevant age-ranges

The detailed analysis by Rice[1] reports that 2,217 non-Māori women aged 15–44 years died from the pandemic in 1918. Yearbook data from the 1916 census indicated that 53.0% of this age-group were married and had an annual fertility rate of 189.5 per 1,000 population. As a result of these sudden pandemic-related deaths among women in the fertile age-range an estimated 223 children would not have been born per year (ie, 2,217x53.0%x189.5/1,000). Furthermore, this demographic effect is equivalent to 5.9% of the missing births for non-Māori in 1919 (ie, 223/3,756), albeit a simplistic analysis that does not account for pregnant women probably being at increased risk of pandemic-associated death (see elsewhere[8] for evidence on this association).

Similar calculations are not so readily reproducible for married men given the unusual distribution of New Zealand men related to the First World War effort. That is, in November 1918, an estimated 22% of New Zealand men aged 20–49 years were still overseas (Table 1). Also other men were in military training camps in New Zealand, and in predominantly male populated mining towns as part of producing coal and scheelite for the war effort. Given such complexities, we simplistically assumed the same value as for women above at 5.9% of missing births being potentially due to the deaths of men who would otherwise have fathered children in 1919. Despite how New Zealand men were distributed geographically as per above, this estimate may be conservative since 1.9 times more non-Māori men aged 15–44 died in the pandemic than non-Māori women, with 1,372 extra male deaths.[1]

Table 1: Numbers of New Zealand military personnel overseas in 1918 and 1919* in relation to the First World War.

Location of NZ troops overseas	Situation on 11 November 1918 (day the war ended)		Estimated situation after 6 months (start of May 1919)	
	N	%**	N	%**
France & England	47,582	20.5%	20,600	8.9%
Egypt	4,541	2.0%	1,500	0.7%
Total	52,123	22.4%	22,100	9.5%

*Data from the 1919 Yearbook for numbers in 1918 and for the return rate that allowed the estimates for 1919 ie, based on the statement that: "An average of 4,500 men per month from the UK and France, and 500 men per month from Egypt, were returned to New Zealand from the date of the Armistice."
**The percentages use the New Zealand male population aged 20–49 years from the 1916 Census.

Possible impact on sexual behaviour and subsequent conceptions

At this period in New Zealand's social development, marriage was fairly closely aligned with natality. That is in 1919 only 4.6% of births (1,132/24,483) were deemed "illegitimate" according to the 1920 Yearbook. Also, although there were substantive New Zealand troop movements (Table 1), the substantial post-war upturn in marriage did not clearly start until mid-1919 (Figure 3). At an annual level the number of non-Māori marriages in 1917 was 6,417 and this declined slightly in the pandemic year of 1918 (to n=6,227, a 3.0% decline), but then rose again in 1919 (n=9,519, a 33% increase on 1917 numbers) and surged further in 1920 (to n=12,175). The increase in marriages in 1919 was clearly not enough to counter the natality decline in this particular year. But reduced sexual activity among couples at the time the pandemic struck is a plausible contributor to some reduced natality in the subsequent year of 1919. This effect is likely because the peak pandemic months of November and December in 1918 caused substantive social disruption in New Zealand (eg, from illness affecting much of the population and people travelling to care for sick relatives and to attend funerals). This disruption in turn might logically have resulted in a decline in coital frequency for sexually active couples in these two peak pandemic months, along with spouses potentially avoiding close contact to prevent infecting each other. If such an overall decline in coital frequency was at a 50% level for these two peak pandemic months, then it might be assumed that this would average out to around 8% less sexual activity during the whole 12-month time period: end of March 1918 to the start of April 1919 (ie, (100%-[12-(2x50%)/12])=8.3%). This is the time period when conceptions would have occurred which subsequently generated births within the 1919 calendar year, all else being equal.

Possible impact of embryonic and fetal loss

To estimate the potential embryonic and fetal loss contribution (for loss in all three trimesters) to the reduced birth rate in 1919 relative to the 1917 year for non-Māori, we subtracted the two categories detailed above for parental death and reduced sexual activity. This gave the estimate of 79.9% of the missing births in 1919 relative to the 1917 year (ie, [100%-((5.9%x2)+8.3%)]=79.9%). This decline is equivalent to around 3,000 fewer births associated with embryonic and fetal loss among non-Māori in 1919 (3,756x79.9%=3,001).

Discussion

It is well established that influenza infection is associated with embryonic/fetal loss and that influenza vaccination in pregnancy reduces rates of stillbirths, eg, based on a systematic review.[9] Therefore, it seems very likely that the birth rate reductions we have described above for New Zealand in 1918 and 1919 reflect such losses, albeit with some smaller roles for adult deaths and reduced sexual activity. Such birth rate reductions associated with the 1918 pandemic have also been observed in other settings. For example, there was a 5–15% decline for the US and Scandinavia at 6–7 months post-pandemic[10] and a 43% reduction at 9–11 months after the peak of pandemic mortality for one county in Arizona, US.[8] Another US study[11] estimated a 10% drop 9–10 months after peak influenza mortality, which the authors ascribed to a reduction in conception during the period of intense pandemic activity. This was in addition to a birth rate reduction in the three months after peak mortality, which they associated with excess preterm births and stillbirths from influenza infections in the last trimester. Other work has also demonstrated post-pandemic birth rate reductions in Taiwan[12] and Sri Lanka.[13]

Our estimates for the natality impacts for 1919 may actually be underestimates of the extent of the loss when using 1917 as the comparison year for at least two reasons. Firstly men returning from war during late 1918 and 1919 brought with them an estimated 3,000 wives back to New Zealand from England according to the 1919 Yearbook (some of whom would have been pregnant and boosted the official 1919 birth rate in New Zealand). Secondly, the adult male population in New Zealand in late 1918 and 1919 would have risen above the 1917 level as men returned from the war zone (Table 1). Even though the marriage rate did

not seem to pick up until mid-1919 (Figure 3), some of these returning men would already have been married prior to going to war—and so a resumption of sexual activity and pregnancy of their partners would be expected soon after their return to New Zealand (and so potentially contributing to births in late 1919).

The larger natality shock for Māori in 1919 compared with non-Māori is consistent with Māori experiencing a disproportionately higher mortality burden from this pandemic (and in two subsequent pandemics[14]). This difference again highlights the importance of current efforts to eliminate poverty and ethnic inequalities in health in New Zealand, as well as more specific strategies to protect Māori health (eg, via eliminating tobacco, controlling the obesogenic environment and improving access to healthcare).

After the initial post-pandemic natality decline for Māori, the data also suggests further sudden dips in 1923 and 1926 (Figure 2). We have no definitive explanation for these subsequent dips, except to note that declines in births have been reported for subsequent waves of the 1918 pandemic elsewhere (ie, in 1920 in the US[11]).

It should be noted that our analysis is still fairly preliminary and if more research was undertaken then epidemiological modelling and time-series analyses could be performed (ideally using more fine-grained data that could arise from collating individual birth registrations or tracking cohorts of couples and returning soldiers). This analysis could then more accurately estimate the relative roles of embryonic/fetal loss along with uncertainty distributions. Such knowledge could then better inform planning around future influenza pandemics. This response includes the potential need to prioritise protection of pregnant women from infection via: protective sequestration, use of any scarce pandemic vaccines or antivirals, or prioritised access to ventilators in hospital ICUs. Such knowledge could also inform the design of current day informational materials to promote the routine use of influenza vaccination by pregnant women against seasonal influenza in New Zealand. The World Health Organization gives a high priority to vaccinating pregnant women and New Zealand has fully funded influenza vaccination for pregnant women since 2010. While the current rate of influenza vaccination in pregnancy in New Zealand is not accurately established, it is thought to be low, eg, one unpublished analysis suggested it was under 30% in 2016 (Howe A, New Zealand Influenza Symposium, February 2019, Wellington). Mechanisms to improve this low current coverage need to be explored, along with efforts to maximise uptake by population groups with the highest needs: particularly Māori, Pasifika and low-income New Zealanders.

Competing interests:
Dr Turner is the Director of the Immunisation Advisory Centre (IMAC). IMAC runs annual national influenza symposia. These symposia accept small amounts of funding through private industry sponsorship. This funding is provided in the form of educational grants that are not targeted for any specific topic within the symposia (www.immune.org.nz/funding).

Author information:
Nick Wilson, Department of Public Health, University of Otago, Wellington; Nikki Turner, Department of General Practice and Primary Care, University of Auckland, Auckland; Michael G Baker, Department of Public Health, University of Otago, Wellington.

Corresponding author:
Professor Nick Wilson, Department of Public Health, University of Otago, Wellington.
nick.wilson@otago.ac.nz

URL:
http://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2019/vol-132-no-1507-13-dec-2019/8075

REFERENCES:

1. Rice G. Black November: The 1918 Influenza Pandemic in New Zealand. Christchurch: Canterbury University Press, 2005.
2. Rice GW. Black Flu 1918: The Story of New Zealand's Worst Public Health Disaster. Christchurch: Canterbury University Press, 2017.
3. Summers JA, Baker M, Wilson N. New Zealand's experience of the 1918–19 influenza pandemic: a systematic review after 100 years. N Z Med J 2018; 131:54–69.
4. Pool DI. The effects of the 1918 pandemic of influenza on the Maori population of New Zealand. Bull Hist Med 1973; 47:273–81.
5. Statistics New Zealand. Yearbook collection: 1893–2012. Wellington: Statistics New Zealand. http://archive.stats.govt.nz/browse_for_stats/snapshots-of-nz/digital-yearbook-collection.aspx
6. Statistics New Zealand. A History of Survival in New Zealand: Cohort Life Tables 1876–2004. Wellington: Statistics New Zealand, (with online tables at: http://www.stats.govt.nz/browse_for_stats/health/life_expectancy/cohort-life-tables.aspx), 2006.
7. Department of Internal Affairs. Marriages Search; Births, Deaths & Marriages Online. http://www.bdmhistoricalrecords.dia.govt.nz/search/search?path=%2FqueryEntry.m%3Ftype%3Dmarriages
8. Dahal S, Mizumoto K, Bolin B, Viboud C, Chowell G. Natality decline and spatial variation in excess death rates during the 1918–1920 influenza pandemic in Arizona, United States. Am J Epidemiol 2018; 187:2577–84.
9. Zhang C, Wang X, Liu D, Zhang L, Sun X. A systematic review and meta-analysis of fetal outcomes following the administration of influenza A/H1N1 vaccination during pregnancy. Int J Gynaecol Obstet 2018; 141:141–50.
10. Bloom-Feshbach K, Simonsen L, Viboud C, Molbak K, Miller MA, Gottfredsson M, Andreasen V. Natality decline and miscarriages associated with the 1918 influenza pandemic: the Scandinavian and United States experiences. J Infect Dis 2011; 204:1157–64.
11. Chandra S, Christensen J, Mamelund SE, Paneth N. Short-term birth sequelae of the 1918–1920 influenza pandemic in the United States: State-level analysis. Am J Epidemiol 2018; 187:2585–95.
12. Chandra S, Yu YL. Fertility decline and the 1918 influenza pandemic in Taiwan. Biodemography Soc Biol 2015; 61:266–72.
13. Chandra S, Sarathchandra D. The influenza pandemic of 1918–1919 in Sri Lanka: its demographic cost, timing, and propagation. Influenza Other Respir Viruses 2014; 8:267–73.
14. Wilson N, Telfar Barnard L, Summers J, Shanks G, Baker M. Differential mortality by ethnicity in 3 influenza pandemics over a century, New Zealand. Emerg Infect Dis 2012; 18:71–77.