The 1918 influenza pandemic in Florianopolis: A subtropical city in Brazil

Wladimir J. Alonso a, b, *, Francielle C. Nascimento a, b, c, Rodolfo Acuña-Soto c, Cynthia Schuck-Paim b, Mark A. Miller a

a Fogarty International Center, National Institutes of Health, Bethesda, MD, USA
b Orégem Scientifica, Florianopolis, Brazil
c Department of Microbiology and Parasitology at the Medical School of the Universidad Nacional Autónoma de México, Mexico

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ABSTRACT

Few studies have addressed the impact and dynamics of the 1918–1919 influenza pandemic in tropical and sub-tropical areas. To help cover this gap, we analyzed all death certificates issued from October 1913 to June 1921 in Florianopolis (Brazil), a subtropical state capital with a population of 41,298 inhabitants in 1920. In November and December 1918 (spring) there were a total of 70 and 14 deaths due to influenza and pneumonia, respectively, in contrast to a mean annual mortality attributed to these causes of 8.1 deaths, usually concentrated between January and August (summer to winter). We also determined the mortality burden due to the pandemic through the analysis of excess mortality during the pandemic period against the baseline mortality in the same months from other years. We obtained a total of 127 deaths (0.33% of the total population), nearly twice the number of deaths documented by death certificates from this period. No other influenza pandemic waves were detected in earlier or subsequent months. Our results confirm the observed patterns of age-shift in mortality in pandemic scenarios, with young adults as the most affected age-group. The pandemic in Florianopolis was further characterized by some specific outcomes: (1) there was a discrete peak in mortality due to renal causes in the initial phase of the pandemic; (2) pandemic influenza did not affect the number of reported bronchitis and bronchiolitis deaths (unusually high in the year preceding the pandemic); and (3) the mortality burden was proportionally lower in Florianopolis than in large urban centers such as São Paulo and Rio de Janeiro. We suggest that this latter outcome was the result of an effective and prompt network of voluntary solidarity assistance (as endorsed by contemporaneous documents), which was probably more difficult to implement in larger metropolis.

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1. Introduction

In absolute numbers, the 1918–1919 influenza pandemic was the deadliest in history, with estimates of global mortality ranging from 20 to 100 million people. Paradoxically, an event that, within the span of a few months, killed more people than the contemporaneous First World War (WWI) and brought society to the verge of collapse [1] has left a relatively small impression on the collective memory of modern society and has been mentioned relatively little in its textbooks [2]. From a still unresolved origin, the pandemic first manifested through a mild wave (but see [3] for exceptions) mainly in the Northern Hemisphere (in addition to some other places as Singapore, Australia and New Zealand), between March and July 1918, and then spread globally with full strength in a devastating second wave, which lasted from approximately August 1918 to early 1919. A third wave occurred between February and April 1919 and was intermediate in severity [1,2,4]. Still, important factors about the pandemic, especially its transmission dynamics and the mechanisms for its extreme virulence, remain unknown. For instance, the role of secondary and/or co-infections on mortality and on disease severity have not been thoroughly understood. Similarly, the causes underlying the particular severity of that pandemic in young adults remain unclear [4,5]. The importance of understanding the 1918–1919 event is yet crucial for the development of well balanced and efficient preparedness measures for a future pandemic event of such magnitude [6].

Studies on the age and temporal distribution of infections and deaths in the pandemic period and surrounding years have been pivotal in this process [1,4–9]. Understandably, such studies have concentrated mostly on temperate regions, given the demographic distribution of the population and the geopolitical profile of the world at the time of the pandemic. Yet, the dynamics and impact of the 1918–1919 pandemic in tropical and sub-tropical regions can
be a source of insightful data for the understanding of the interaction of influenza with concurrently circulating malaises, climate, and related sociopolitical factors.

The first direct contact of Brazil with the Spanish Flu occurred outside its borders in early September 1918, when the crew of a military fleet sent to Europe (as a result of the late involvement of Brazil in WWI) suffered heavy losses due to an infection that spread in a stop in the port of Dakar, Senegal [10–12]. Within the territorial borders of Brazil, the pandemic arrived in mid-September (possibly from an infected English ship named Demerara [11], initially affecting northeastern cities and then descending to southern Brazilian ports [12]. Like in many other countries, the pandemic was a very traumatic episode in Brazil (among the victims was the just-elected president, Rodrigues Alves), most likely aggravated by its precarious preparedness measures [11]. The influenza pandemic overwhelmed the health system, even requiring the use of mass graves to dispose the corpses. Absolute mortality resulting from the 1918 to 1919 pandemic in Brazil has been estimated to be about 35,240 deaths, representing approximately 0.1% of the total population, but this figure has been challenged as being greatly underestimated [12]. Indeed, in large urban centers such as São Paulo (an important metropolis even at the time, with a population of half a million people and better sanitary indices than those of cities like Madrid, Lyon, or Berlin) and Rio de Janeiro (then the capital of Brazil, with nearly one million people), mortality due to the pandemic was 1% and 1.6%, respectively [11,12].

To cover the gap in the knowledge of the dynamics and burden of the 1918–1919 pandemic in such regions, we digitalized and analyzed all death certificates issued from October 1913 to June 1921 in Florianopolis, the capital of the Southern Brazilian state of Santa Catarina.

2. Methods

2.1. Locality

Florianopolis is the capital of the state of Santa Catarina, located in the southern region of Brazil (Fig. 1). In the period analyzed here (1913–1921), Florianopolis’s territory comprised only an insular region (“Island of Santa Catarina”), reachable just by boats and ships. In 1920, its resident population comprised 41,298 inhabitants (approximately a tenth of the current population) [13], mainly composed of Portuguese descendants. The primary economic activities were related to port commerce, fishing, weaving, and semi-industrial production of commodities such as sugar, flour, sugarcanes, spirits, and home utensils. Many of these activities were performed through communal work, which was also employed for building houses and public facilities like churches and stilted.

Located in a subtropical coastal region (−27.597, −48.553), Florianopolis enjoys a tropical climate with moderate seasonal variation of temperatures (monthly averages range from 16 to 25 °C) and year-round well-distributed precipitation (76–198 mm/month).

2.2. Arrival of the pandemic

On October 6, 1918, the steamboat on transit “Itaqueru”, carrying among its passengers 38 persons infected with influenza, arrived at the port of Florianopolis, where the only two (non-infected) landing passengers remained under medical surveillance. Two days later, two further steamboats arrived carrying more infected passengers. On October 13, the first autochthonous case in the city was reported. The patient was held in solitary home care, but many new cases were observed on this same day at several points in the city. From October 20 onwards the disease became more intense, with the first casualties being notified in November.

Florianopolis was reported as one of the worst hit municipalities in Santa Catarina, with more than half of its population falling ill [14].

2.3. Dataset

The first compilation of mortality records in Brazil was conducted in 1944 and encompassed the period from 1929 to 1939 [15]. To examine mortality in the 1918–1919 pandemic, we had to transcribe relevant information directly from individual death certificates, which were obtained from the “Public Cemetery” that served the population of the capital of the municipality and are currently preserved in the Municipal Historic Archive of “Profesor Oswaldo Rodrigues Cabral”. We considered all records from October 1913 to June 1921, from five years before the start of the pandemic in Florianopolis, in October 1918, to approximately two and a half years after it was officially considered locally eliminated, in December 1918.

Individual entries containing name, age, date, and cause of death from all records were tabulated, translated into English, and coded using the 10th Revision of the International Statistical Classification of Diseases and Related Health Problems [16]. Disease records were aggregated in the following major groups (ICD-10 coding criterion parenthesized): influenza and pneumonia (influenza meningitis G00.0 and J10 to J18 with the exception of J18.0 [bronchopneumonia]); enteric diseases (A01); bronchitis and bronchiolitis (J20 to J21, as well as J18.0 [bronchopneumonia]); cardiovascular (I00 to I99) and renal (N00 to N99).

The dataset was inspected to determine how missing data (unrecorded or illegible causes of death) and other diseases could
2.4. Baseline and pandemic mortality burden

To obtain a monthly baseline profile of mortality (namely, mortality in the absence of the pandemic) in Florianópolis before and after the pandemic period, we considered the records of the period from October 1913 to June 1921 while excluding those from October 1918 to September 1919 (Fig. 2). Pandemic mortality burden was calculated from the excess of all cause deaths of the pandemic months (October to December 1918 – the period when an abnormal number of influenza and pneumonia deaths were recorded) by subtracting the absolute number of all cause deaths during this period (October–December) from the average of all cause deaths during these same months from the other years in the dataset (1913–1917 and 1919–1921). Similarly, the age-profile of the excess mortality of the three months defining the pandemic period was compared with another baseline, based on the number of deaths during these same months in other years (this is especially important since the age profile of deaths changes among seasons; see results and supplemental figures).

To examine the putative mortality due to secondary complications in the months following the pandemic, we also investigated excess mortality during the pandemic due to diseases that were characterized by an abnormally high level of activity and/or that were described in the literature as being related to influenza (the ICD-10 coded disease groups listed in previous section).

3. Results

3.1. Data collection

Four death record books (October/1913–August/1915; August/1915–September/1917; August/1917–July/1919; August/1919–June/1921) contained a total of 3052 death certificates, out of which 14.1% did not have cause of death information due to the absence of any notation (1.1%), illegibility (2.7%), or notation simply indicating “without medical care” (10.3%). As shown in Fig. 2, these records are concentrated mainly in the time period prior to the beginning of 1917. The source of this imbalance lies in the records classified as “without medical care” (which accounted for 23.9% of the records until January 1917, but only 1.1% afterwards). Although the historic reasons for this change in information availability are unknown, the detection of this inconsistency was taken into account for interpreting the baseline and excess mortality estimates.

3.2. Baseline mortality burden

Baseline mortality (Fig. 2) was estimated at 31.4 monthly deaths, of which 43.8% corresponded to children from 0 to 4 years of age. If the stillbirths group (14.5% of total mortality) is included in the analysis, the total percentage of the population dying before reaching 5 years of age totals 58.3%.

As shown in Fig. 3, there was a biannual pattern of mortality with a peak in mid-summer (February) and another in early winter (May–June). Enteric-related causes of death were greatly responsible for the concentration of deaths in the summer, primarily in children (Supplementary Fig. 4). Similarly, bronchitis and bronchiolitis related deaths primarily affected children younger than five years old, with almost no noticeable seasonality apart from an apparent drop in the number of deaths in February and March (Supplementary Fig. 3). Conversely, mortality due to influenza and pneumonia (mean annual mortality of 8.1 deaths), was higher during the winter months and more evenly distributed among the age groups (Supplementary Fig. 2). Cardiovascular-related mortality was also higher during winter, with adults and seniors as the most heavily affected group (Supplementary Fig. 5).

3.3. Pandemic mortality burden

Pneumonia and influenza attributed deaths were recorded in only one pandemic wave, which caused 70 deaths in November and 14 in December 1918 (compared to a monthly average of 0.6 deaths in the remaining months examined; Fig. 2). Nevertheless, when deaths from all causes between October and December 1918 (Fig. 4a and b) are compared to the average number of deaths during the same months from 1913 to 1917 and 1919 to 1920 (Fig. 4c and d), mortality during the influenza pandemic wave rises to a total of 127, representing 0.33% of the city’s population. Still, a note of caution is needed here, as even though the mortality records were systematic and complete, the only document found [17] reporting the population in the capital of the municipality at that time (putatively the population served by the “Municipal Cemetery”) is a non-official source.

The figure showing incidence per age group (Fig. 4b) shows that seniors (>60 years-old, and more pronouncedly those >70 years-old) are the group most heavily affected. Still, the same figure also shows that mortality among young adults is proportionally higher in the pandemic period as compared to the baseline mortality of this group during the same months of other years (Fig. 4d), suggesting an age shift in mortality towards young adults typical of influenza pandemics.

Excess mortality in the months following the critical pandemic period was too low to enable substantial quantitative analysis; however, we were able to detect a small yet noticeable peak (May
1919) in the number of stillborn deaths from March to September 1919, which could be related to viral circulation before the onset of the pandemic. There is also an unusually high number of deaths in the >50 year-old age group in the first months of 1919 (Supplementary Fig. 13). To a large extent, these deaths are due to cardiac causes which, in fact, also had an unusually high frequency in the periods during and after the pandemic. The number of renal deaths also increased markedly in October 1918 (Supplementary Figs. 12 and 18).

4. Discussion

The analysis of the 1918–1919 influenza pandemic in Florianópolis, with an estimated death toll of 127 individuals, reveals some interesting epidemiological patterns. The first was the presence of a single wave of influenza, similarly to the pattern found in other Brazilian cities such as Rio de Janeiro [11] and São Paulo [12]. Although it is not possible to rule out the possibility that an earlier and milder pandemic wave was not detected by the surveillance system, it is more likely that the virus had not yet been introduced to the country. The onset of the pandemic in Florianópolis in mid-October occurred one month later than in the busier ports of the Northeast (e.g. Recife, Salvador) and Southeast (e.g. Rio de Janeiro) [12], but similarly to what happened in these other cities, Florianópolis also served as the regional hub enabling the spread of the pandemic inland. The delay of two months in the onset of the pandemic in relation to the onset of the second (and deadliest) wave of the pandemic [1,2,4] in Europe and the US (or that observed in the inland city of São Paulo [12]) also coincides with the timing observed in various places located at long distances from Europe and US, like Singapore [18] and Japan [although in this latter country the more deadly season occurred afterwards, in 1919–1920 [7]].

Following the putative introduction of the virus in October 1918, most of the pandemic deaths in Florianópolis occurred in November and seemed to cease in January 1919 (although still active in other municipalities of the state of Santa Catarina until March [19]). There was no sign or indication of another, third wave of influenza in the months that followed. We did detect a few cardiovascular-related deaths and stillborn deaths in those subsequent months, but they might simply represent a by-product of the influenza pandemic that occurred some months earlier.

It is interesting to note that the mortality rate of 0.33% described here is within the lower range of that described for developed countries (like the US and UK), from approximately 0.3% to approximately 0.6%, and well below the mortality rates estimated for Asian and African countries (up to 4.0–5.8% in Kenya, or even 8% in one province of India) [8]. On a national level, it is also well below the 1–1.6% rate observed in São Paulo and Rio de Janeiro. Official figures from Salvador, in the northeast of Brazil, are of 0.1% [20], therefore similar to the official figure of 0.09% (inferred from [13,21]) for Santa Catarina, although it is not possible to estimate the extent of underreporting associated to these official sources [12,21]. Mortality rates were therefore relatively low in Florianópolis, even though more than half of its population–physicians included–fell ill [14,19]. In this sense, it would be interesting to further investigate the effectiveness of the intense mobilization effort led by the State authorities in the distribution of food, clothes, medicine and cash, and the implementation of several improvised hospitals and emergency centers, where volunteers were also trained to perform home visits to care for those most in need [14,19,21]. Campinas, a São Paulo State municipality with 73,295 inhabitants at the time, equally experienced a relatively low mortality rate, of approximately 0.28%, an outcome attributed to the high level of preparedness following the catastrophic epidemic of yellow fever in that city two decades before (which was responsible for the death or emigration of about 90% of its inhabitants) [22]. Apparently, such mobilization was more difficult to achieve in larger cities, such as São Paulo and Rio de Janeiro, where even the availability of basic items was seriously limited, leading to several cases of looting and death due to malnourishment [12]. If providing basic home care support (food, water, relief medicines, and clothes) to patients through non-specialized community-based health volunteers (without the need for already constrained medical services) is enough to treat most influenza patients in a severe pandemic [23], the value of efficiently organizing these voluntary networks could be an important lesson for severe pandemic preparedness.

A second pattern that emerged in Florianópolis was the confirmation of the age shift in mortality towards young adults, as was demonstrated by global assessments of the 1918 pandemic [5,6,8]. When excess mortality is weighted against the population of each age group, the age profile of mortality shows seniors (60+ years old), and to a lesser extent young children (<4 years old), as the most severely affected groups, but also a proportionally higher mortality among young adults (between 15 and 49 years old) than that observed in other periods, hence the typical “W” shape described elsewhere [9].

Finally, a third pattern that emerged was the concentration of renal deaths during the pandemic months. We identified a clear peak of renal deaths in October 1918, affecting mainly adults. No other similar peak is observed in this time series other than in
May 1917, which coincidentally overlaps with the mortality peak of another respiratory disease – bronchitis. Influenza and pneumonia deaths in Florianópolis were, however, reported mainly in November and December 1918, coinciding with the docking of an infected steamboat in October 6, 1918. Seven of the nine renal deaths occurred in October (October 2, 8, 9, 19, 22, 28 and 29), whereas only two occurred in November and thus could possibly be related to the pandemic. Accordingly, it becomes difficult to relate these renal deaths with the putative historical date of the pandemic’s arrival to Florianópolis. On the other hand, a similar pattern was observed in an ongoing study on the impact of the 1918 pandemic in Toluca, Mexico (A cuña-Soto et al., unpublished data). The study reports an increase in the number of renal deaths during the 1918 pandemic, which makes us doubt that this is mere coincidence. Further research is therefore needed to determine the generality of the presumed association between the 1918 and 1919 pandemic and an increase in mortality from renal causes.

The frequency of bronchitis- and bronchiolitis-related death remained unchanged during the 1918 pandemic year, although they were unusually high during the year preceding it. This observation coincides with a previous suggestion that a higher mortality from bronchitis and bronchiolitis could be related to the earlier circulation of a precursor to the pandemic virus [2], which in turn could underlie severe pus-discharging bronchitis.

In summary, this investigation of the influenza pandemic in the southern subtropical Brazilian city of Florianópolis, a region where very few studies have previously been conducted, revealed epidemiological patterns that we believe are of interest for the understanding of the 1918 pandemic beyond this geographic region. We hope that the present study can also motivate further investigations from other adjacent regions to determine whether the particularities found in this city represent a local anomaly or a broader regional trend.

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Conflict of Interest Statement: None declared.

Appendix A. Supplementary data


References