International Journal of Infectious Diseases 69 (2018) 85–87

Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Short Communication

Unsynchronized influenza epidemics in two neighboring subtropical cities

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ARTICLE INFO

Article history:
Received 2 December 2017
Received in revised form 21 February 2018
Accepted 22 February 2018
Corresponding Editor: Eskild Petersen, Aarhus, Denmark

Keywords:
Influenza epidemics
Synchrony
Shenzhen
Hong Kong

ABSTRACT

Objective: The aim of this study was to examine the synchrony of influenza epidemics between Hong Kong and Shenzhen, two neighboring subtropical cities in South China.
Methods: Laboratory-confirmed influenza data for the period January 2006 to December 2016 were obtained from the Shenzhen Center for Disease Control and Prevention and the Department of Health in Hong Kong. The population data were retrieved from the 2011 population censuses. The weekly rates of laboratory-confirmed influenza cases were compared between Shenzhen and Hong Kong.
Results: Unsynchronized influenza epidemics between Hong Kong and Shenzhen were frequently observed during the study period. Influenza A/H1N1 caused a more severe pandemic in Hong Kong in 2009, but the subsequent seasonal epidemics showed similar magnitudes in both cities. Two influenza A/H3N2 dominant epidemic waves were seen in Hong Kong in 2015, but these epidemics were very minor in Shenzhen. More influenza B epidemics occurred in Shenzhen than in Hong Kong.
Conclusions: Influenza epidemics appeared to be unsynchronized between Hong Kong and Shenzhen most of the time. Given the close geographical locations of these two cities, this could be due to the strikingly different age structures of their populations.

Introduction

Hong Kong and Shenzhen are two neighboring subtropical cities in South China. Hong Kong is a special administrative region of China and has a population of seven million. Shenzhen is a special economic zone with a population of 10 million. Influenza surveillance specimens are mainly obtained from hospital inpatients in Hong Kong, but from outpatients in Shenzhen. Previous influenza studies focusing on these two cities did not consider their population age structures (Cao et al., 2014; Chiu et al., 2017; Tan et al., 2014).

The aim of this study was to compare influenza epidemic patterns of influenza A/H1N1 (combining the pandemic A/H1N1 and the seasonal A/H1N1, where the former replaced the latter in 2009–10), influenza A/H3N2, and influenza B between Hong Kong and Shenzhen, after scaling (see Methods).

Methods

Influenza laboratory confirmations for the two cities were obtained from the Shenzhen Center for Disease Control and Prevention and the Department of Health in Hong Kong for the period January 2006 to December 2016. Population data for 2010 were obtained from censuses conducted by the National Bureau of Statistics of China (National Bureau of Statistics of China, 2010) and Census and Statistics Department in Hong Kong (Census and Statistics Department, Hong Kong, 2010).

Although Shenzhen and Hong Kong have comparable population sizes, their total numbers of reported influenza cases differ greatly. Shenzhen has about 1/30 positive influenza detections compared to Hong Kong. This may reflect their different surveillance and testing policies and differences in their population sizes.

The data for Shenzhen were, therefore, re-scaled by a factor to make the two influenza epidemiological profiles more comparable. The overall scaling factor was defined as the number of positive influenza detections in Hong Kong divided by the number in Shenzhen during the study period. The overall scaling factor was

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https://doi.org/10.1016/j.ijid.2018.02.019

applied to all three strains. Such a scaling factor could be obtained for each of influenza A/H1N1, influenza A/H3N2, and influenza B. The computational details for the scaling factor are provided in the Supplementary material (Section S1). Note that the study conclusions are not sensitive to the value of the scaling factor (see Supplementary material, Figures S1–S4).

Results

Figure 1 compares the age structures of the populations in Hong Kong and Shenzhen for the year 2010. Shenzhen had a higher percentage of the population in the 10 to 44 years age group and a lower percentage in the 45 years and over age group.

The scaling factors between Shenzhen and Hong Kong were estimated to be as follows: 30.1 for influenza A/H1N1, 35.8 for influenza A/H3N2, and 14.4 for influenza B. The overall scaling factor was calculated to be 26.7. A summary table of the positive influenza detections in each category is provided in the Supplementary material (Table S1).

Figure 2 displays the epidemic curve in Hong Kong and the scaled curve in Shenzhen (with scaling of 26.7 for the three panels). Similar figures generated using different scaling factors (10, 15, 20, and 30) are provided in the Supplementary material. About half of the major epidemics were in synchrony in both places. The A/H1N1 pandemic in 2009 caused a higher peak in Hong Kong than in Shenzhen (Figure 2a), while the seasonal epidemics from 2010 onwards displayed similar amplitudes in both cities. A/H3N2 showed two major waves but only minor epidemics in Shenzhen in 2015 (Figure 2b). Influenza B was more prevalent in Shenzhen than in Hong Kong, especially from 2006 to 2013. It became more prevalent in Hong Kong after 2013 (Figure 2c).

Discussion

This appears to be the first study to compare influenza patterns between Hong Kong and Shenzhen using a scaling factor approach. This study showed that, despite the geographic proximity between the two cities, the influenza epidemic patterns could be unsynchronized. This is surprising, since the two cities likely shared the same influenza strains. A/H3N2 epidemic waves were very severe in Hong Kong in 2015 but only minor in Shenzhen. Shenzhen had relatively more influenza B activity than Hong Kong.

A/H3N2 has a higher attack rate in the older population, whereas the attack rate of influenza B is higher in the younger population (Paules and Subbarao, 2017). Figure 1 indicates that Shenzhen has a substantially younger age structure, which provides a potential explanation for the differences in epidemic severity of the different influenza strains. A/H3N2 evolves rapidly. If a new strain does not have age-specific attack rates, then synchronized patterns between the two cities would be expected; otherwise, unsynchronized patterns would be expected. Thus Hong Kong and Shenzhen provide a unique setting for the study of age-specific influenza strains, in particular due to their geographic proximity. A preliminary model simulation is given in the Supplementary material (Section S2), which shows that the epidemic among the elderly could be much greater in Hong Kong than in Shenzhen.

This study is limited by the lack of age information in the weekly influenza reported case data for the two cities. However, severe cases in 2015 in Hong Kong were mainly seen in the elderly, and the positive influenza detections of A/H3N2 in Canada tended to involve the elderly too, which supports the explanation given here for the minor epidemic in Shenzhen. Also, other factors were not considered, such as differences in influenza surveillance systems, public health interventions, and sanitary conditions, which could explain the differences in influenza epidemic patterns in these two cities. Future work should obtain more detailed influenza data to explore further the relationships between age structures and the patterns of influenza epidemics. The present study findings shed light on the importance of considering the population age structure when comparing influenza epidemics between Shenzhen and Hong Kong.

Ethical approval

Approval was not required.

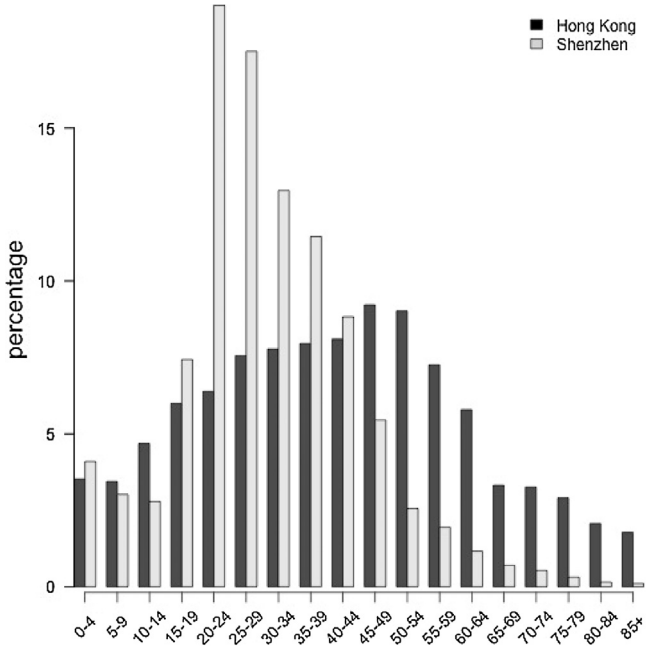

Figure 1. Comparison of population age structures between Hong Kong and Shenzhen for the year 2010.

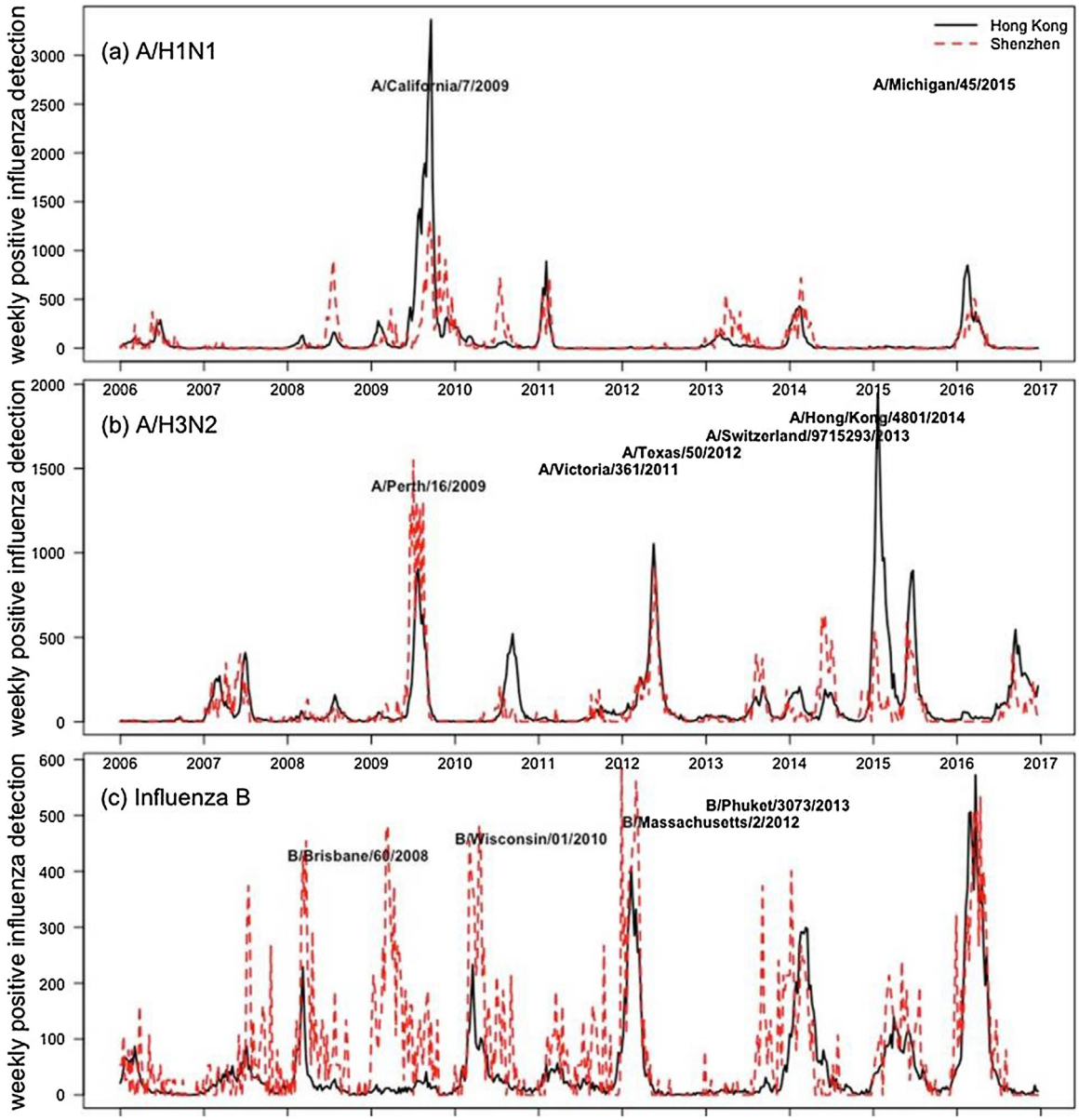

Figure 2. Weekly positive influenza detections for Hong Kong and Shenzhen from January 2006 to December 2016. The data for Shenzhen were multiplied by the estimated scaling factor of 26.7 to account for the differences in influenza surveillance in the two cities. (a) Influenza A/H1N1, (b) influenza A/H3N2, and (c) influenza B. Strains are shown in the years when they were reported.

Conflict of interest

No conflict of interest to declare.

Acknowledgements

The authors thank Lin Yang for helpful comments. This study was supported by a Shenzhen Science and Technology Innovation Project Grant (JCYJ20150402102135501) and the Early Career Scheme from Hong Kong Research Grants Council (PolyU 251001/14M).

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.ijid.2018.02.019.

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