Air and Rail Travels Accelerated Spatial Spread of 2009 Pandemic Influenza A (H1N1) in Mainland China

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Background & Aims

The geographic spread of 2009 pandemic influenza A (H1N1) substantially affected the lives of ten thousands of people in the world. Few studies have investigated the effects of domestic travel on the spatial spread of pandemic influenza within mainland China.

1. Assess the impact of domestic travel on spatial spread of pandemic influenza
2. Explore the explanatory power of travel-related variables for the arrival timing of pandemic influenza

Conclusions

- The pandemic influenza spread across mainland China with an overall direction from southeast to northwest.
- Both air and rail travels accelerated the spatial spread of pandemic influenza between prefectures in mainland China by about 2 weeks.
- The strategy of regulating air and rail travels to mitigate pandemic influenza within mainland China is highlighted.

References

[1] Li-Qun Fang et al. Distribution and risk factors of 2009 pandemic influenza a (h1n1) in mainland china. *Am. J. Epidemiol.*, 175(9):890–897, May 2012.

[2] Parviez Hosseini et al. Predictive power of air travel and socio-economic data for early pandemic spread. *PLoS ONE*, 5(9):e12763–, September 2010.

[3] Wenguo Weng et al. Evaluation of containment and mitigation strategies for an influenza a pandemic in china. *SIMULATION*, 91(5):407–416, May 2015.

Future Research

We are developing a hybrid model combining meta-population and agent-based models to evaluate the containment and mitigation strategies.

Results 1

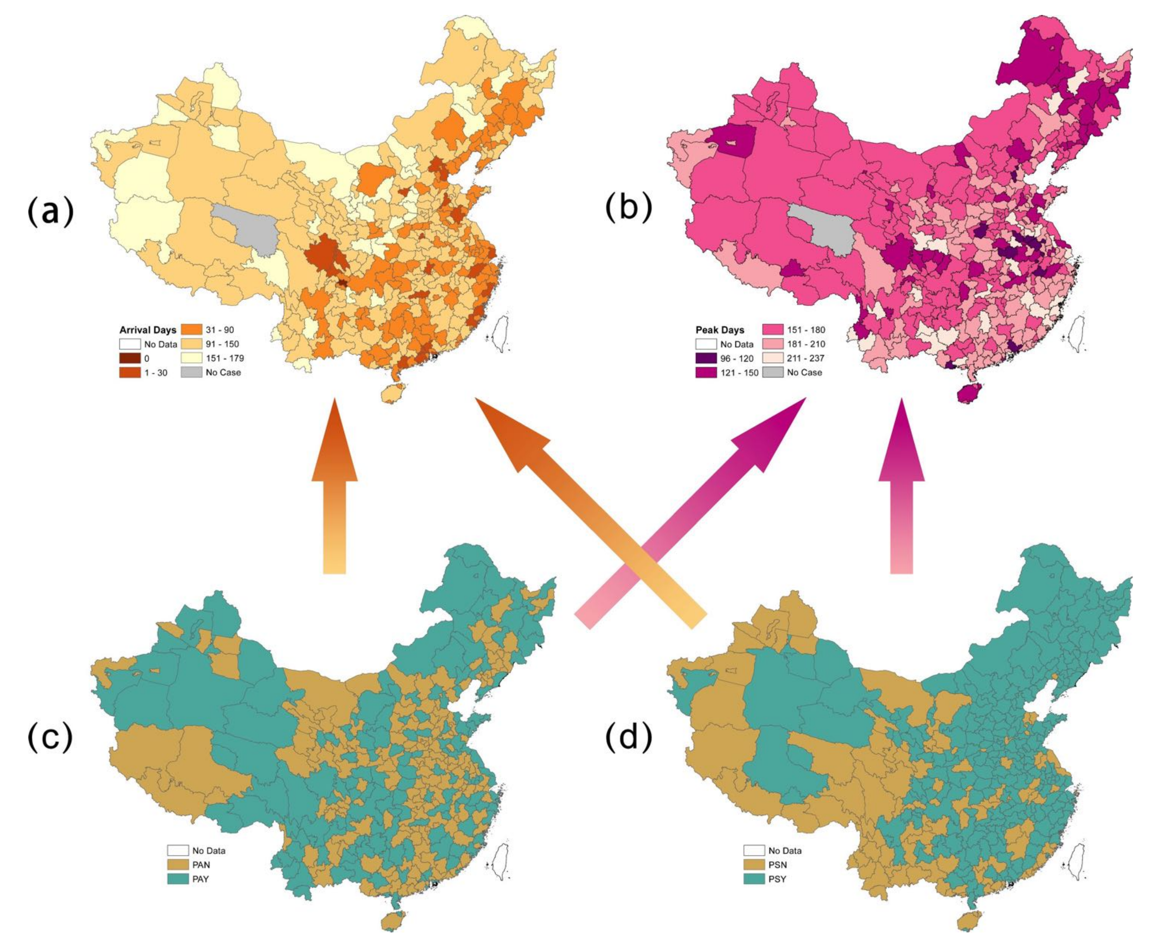

Figure 3: Maps of (a) arrival days, (b) peak days, existence of (c) airports and (d) railway stations

- No evident significant difference in peak days is indirectly verified that the local transmission of pandemic influenza was modulated by environmental factors such as climatic variables.

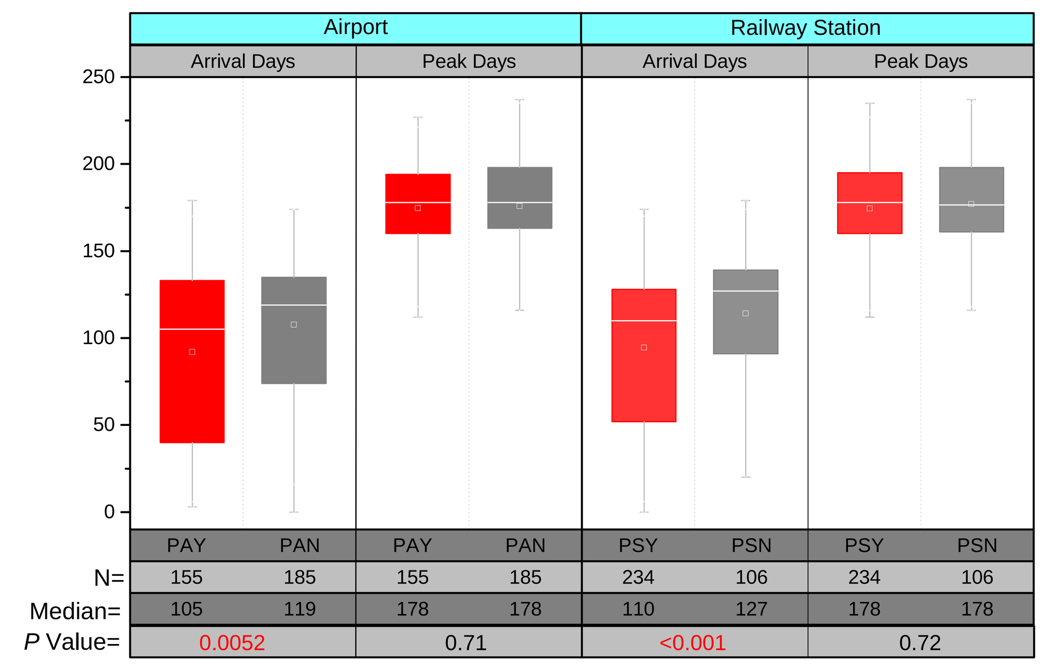

Figure 4: Boxplots and Mann-Whitney U test of arrival days and peak days in different groups

- The difference of median arrival days either between PAY and PAN or between PSY and PSN was about 2 weeks.
- Approximate 1 week time lag was observed when comparing the median arrival days between PAY and PSY or between PAN and PSN.

Results 2

Table 1: Summary of multivariate regression model

Variable	B	CI	p
(Intercept)	439.05	291.78 - 586.32	**<.001**
Lng	-1.16	-2.07 - -0.25	**.013**
Lat	2.29	1.15 - 3.42	**<.001**
log*PopDen*	-5.07	-17.59 - 7.45	.424
log*PAir*	-14.53	-21.88 - -7.19	**<.001**
log*PRail*	-6.71	-13.41 - -0.02	**.049**
log*PTotal*	-6.77	-15.30 - 1.77	.119
RoadDen	-194.10	-836.00 - 447.79	.550
log*PAir*:*RoadDen*	50.64	12.60 - 88.68	**.010**
log*PopDen*:*RoadDen*	-57.14	-127.42 - 13.14	.110
Observations		111	
R^2 / adj. R^2		.619 / .585	

- The neagtive coefficient of *Lng* and positive coefficient of *Lat* show that the pandemic influenza spread across mainland China with an overall direction from southeast to northwest, which is line with results from [1].
- The coefficients of log*PAir* and log*PRail* indicate that air and raili passenger volumes were significantly negatively associated with the invasion of pandemic influenza.
- Different from [1], our results indicates that rail travel also played an important role in the spread of pandemic influenza in mainland China. Because our study is conducted at prefecture-level while theirs is carried out at county-level.

Materials & Methods

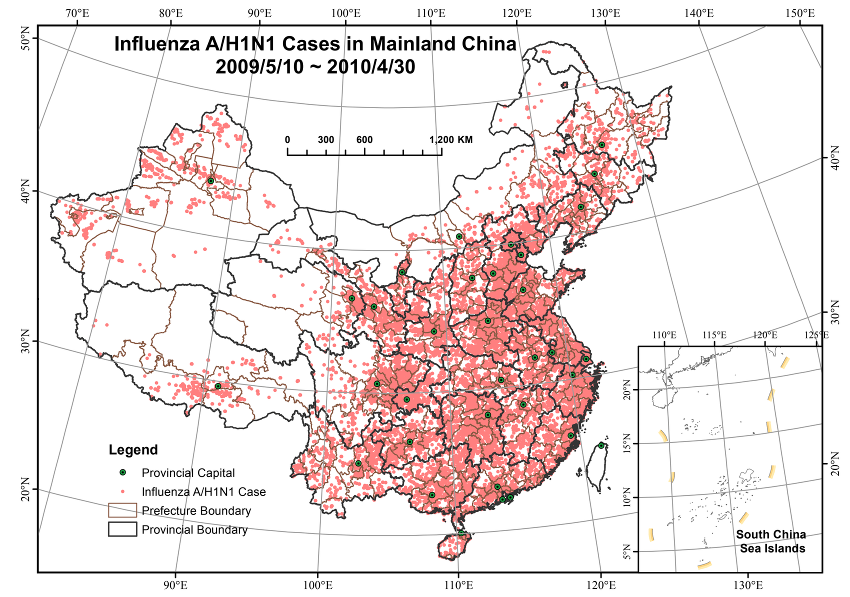

Figure 1: Distribution of 174,675 influenza A (H1N1) cases reported to CISDCP

Mann-Whitney U test at 95% confidence level is used to determine whether significant differences in arrival days (or peak days) exist between prefectures grouped by presence of airports (or railway stations).

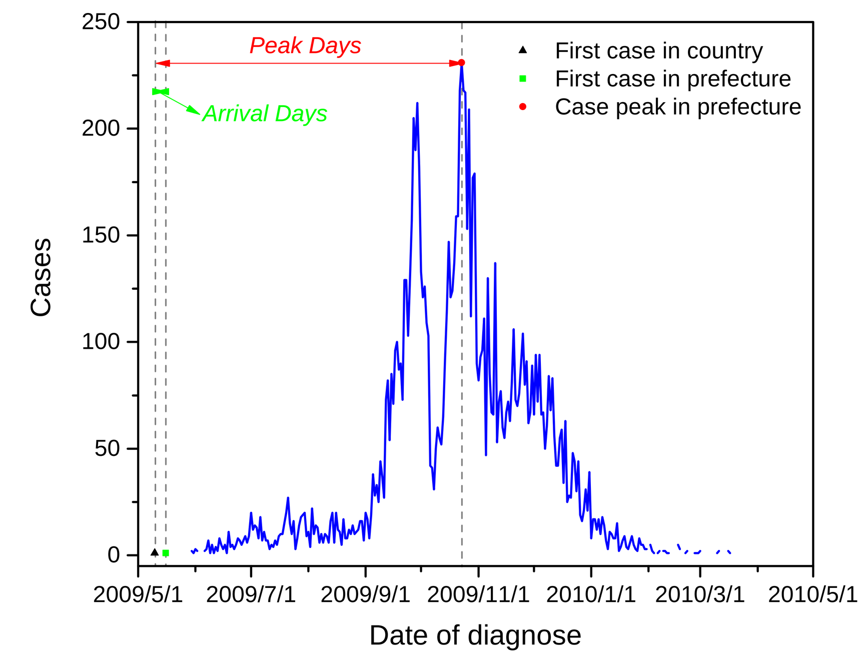

Figure 2: Illustration of arrival days and peak days

Potential variables for predicting arrival days : *Lng*, *Lat*, *Pop*, *PopDen*, *Rail*, *RailDen*, *Road*, *RoadDen*, *PTotal*, *PAir*, *PRail*, *PRoad*, and *PBoat* are compiled for 340 prefectures. A novel method for multivariate regression is developed:

1. Perform univariate regression for each variable and its log transformation
2. Use log-transformed variable if it could improve R^2 by at least 0.01
3. Select variable with $p < 0.05$ and $R^2 > 0.1$
4. Fit selected variables and their interactions to arrival days in a stepwise regression