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Title Page

Title

Interruption of influenza transmission under public health emergency response for COVID-19 based on real-world data, Beijing, China.

Running Head: Interrupt influenza with COVID19 NPIs

Keyword: COVID-19 control measures; influenza; ARIMAX

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ABSTRACT

To estimate effect of COVID-19 control measures taken to mitigate community transmission in many regions, we analyzed data based on influenza surveillance system in Beijing from week 27th, 2014 to week 26th, 2020. We collected weekly number of influenza-like illness (ILI), weekly positive proportion of ILI and weekly ILI proportion in outpatients and the date of COVID-19 measures. We compared influenza activity indicators of season 2019/2020 with preceding five seasons and built two ARIMAX models to estimate the effective of COVID-19 measures which emergency response declared since 24th January 2020. Based on observed data, compared with preceding five influenza seasons, ILIs, positive proportion of ILI, and duration of influenza epidemic period in season 2019/2020 decreased from 13% to 54%, especially, the number of weeks from the peak to the end of influenza epidemic period, decreased from 12 to one. Based ARIMAX model forecasting, after natural decline considered, weekly ILIs decreased by 48.6% and weekly positive proportion dropped 15% in the second week after emergency response declared, and finally COVID-19 measures reduced 83%. We conclude public health emergency response can interrupt the transmission of influenza markedly.

Text

INTRODUCTION

Since December 2019, a novel coronavirus (SARS-CoV-2) has now swept globe over, resulting in pandemic rapidly (1,2). Worldwide, the need for pneumonia hospitalization caused by SARS-CoV-2 surged. Until 1st July 2021, around 182 million confirmed cases and 4 million coronavirus disease 2019 (COVID-19) deaths were reported and the number is still rapidly growing worldwide from World Health Organization (WHO) (3). Stringent non-pharmaceutical interventions (NPIs) seemed to be the only mitigation or prevention measures when effective vaccine and antiviral drugs were unavailable in early 2020. These measures have controlled COVID-19 outbreak and interrupted community transmission in some countries or territories. Some studies also indicated stringent NPIs, such as social distance, wear mask and suspend public activities might interrupt local transmission of SARS-CoV-2 (4,5).

Seasonal influenza and other respiratory infectious diseases epidemics normally peak in winter (6,7). In June 2020, WHO expressed the grave concern about the overlapping of the second wave of COVID-19 and influenza peak in winter (8). Compared with the first wave of COVID-19 in spring 2020, the second wave of COVID-19 in this winter is more serious, while influenza activity is still at the lowest level all around the world (3,9). Influenza and other respiratory infectious diseases are mainly spread via respiratory droplets during close face-to-face contact which is similar with COVID-19 (7,10,11). From aspect of infectious diseases control, these COVID-19 control measures will also work for other respiratory virus. Three studies have reported reduction of influenza activity during COVID-19 pandemic period in China and Singapore (12-14). In this study, we compared influenza activity indicators of season 2019/2020 with preceding five seasons and built ARIMAX(autoregressive integrated moving-average models with explanatory variables) models to estimate the effect of COVID-19 measures on influenza as a proxy of respiratory virus, based on influenza surveillance systems in Beijing. The natural decline caused by seasonal fluctuation was considered in ARIMAX model and predicted value without COVID-19 control measures was given from the models.

MATERIALS AND METHODS

Data sources and properties

This study was accumulated weekly number of influenza-like illness (ILI), weekly positive proportion of ILI for influenza and weekly ILI proportion in outpatients in Beijing, China from week 27th, 2014 to week 26th, 2020, based on influenza surveillance system and the date of NPIs to control for COVID-19. Influenza surveillance systems in Beijing, which were approved by ethical review of the ethics committee of Beijing CDC (No.16 in 2018), had been developed to monitor and characterize seasonal influenza and enhance capacity for influenza pandemic preparedness and response since 2007, which included 421 hospitals to report number of weekly outpatient visits and weekly ILI outpatients, and a sub-group of 23 sentinel hospitals to conduct influenza virological surveillance, where 10 to 20 outpatients with ILI per week each sentinel hospital were tested for influenza using real-time reverse transcription polymerase chain reaction assay (real-time RT-PCR) in local CDC laboratories (6). These laboratories are managed by the Beijing CDC and use the testing protocol of the WHO Collaborating Center for Reference and Research on Influenza at the Chinese National Influenza Center (15). ILI definition are patients presenting with a measured or self-reported axillary temperature ≥38 °C plus cough or sore throat. The coverage of hospitals and laboratories in surveillance system was relatively stationary from 2014 to 2020.

An influenza season in Beijing was defined as the period from the 27th week to the 26th week in the next year. Data in six influenza seasons from influenza season 2014/2015 to season 2019/2020 was collected. The peak of influenza season was defined as the week with maximum weekly positive proportion of ILI (6,16). The influenza epidemic period was defined following the standard: if the positive rate in any week exceeded 40% of maximum weekly positive proportion of ILI in the overall influenza season, this week was then considered the influenza epidemic period.(6,16).

Beijing had launched the highest level (the first level) of response for major public health emergencies since 24th January 2020 due to the surge of Covid-19 cases in China. The response measures included cancel or suspend public activities, movement restrictions, school closures, restrict public transport and encourage people to stay at home, encourage people to wear mask, discourage mass gatherings, open public testing (after 15th April, 2020), isolation and comprehensive contact tracing for all cases, enhance and expand communications to disseminate COVID-19 messages. The COVID-19 Government Response Stringency Index (Stringency Index) in this level exceeded 80 (17). Beijing had lowered the response level to the second level since 30th April 2020, and had continued to lower to the third level since 6th June 2020, because no local COVID-19 case was reported over consecutive 14 days. All domestic restrictions were relaxed, while kept international travel restrictions and controls, isolation and comprehensive contact tracing for all cases. Stringency Index in these levels dropped to about 50 (17). However, the COVID-19 measures had profoundly altered people's behavior pattern, no matter the level of response for major public health emergencies.

Data Management and Statistical Analysis

We exported data into an Excel spreadsheet from influenza surveillance system, and analyzed with SAS University Edition (SAS Institute, Inc., Cary, NC, USA). We calculated means and standard deviations to describe normally distributed continuous variables, medians and inter-quartile ranges to summarize non-normally distributed continuous variables, and percentages for categorical variables. We analyzed normally distributed data with analysis of variance and non-normally distributed data with Wilcoxon's test.

We used time series of weekly number of ILI and weekly positive proportion of ILI for influenza to build two autoregressive integrated moving-average (ARIMA) models, and then introduced COVID-19 control measures as an intervention to develop ARIMAX to analyze the impact of COVID-19 measures. Before emergency response declared (week 4^{th} 2020), the variable value of COVID-19 control measures was zero, and after that, it was one.

The model without interventions was expressed as ARIMA(p,d,q)$(P,D,Q)_S$. The term (p,d,q) gave the order of the nonseasonal part of the ARIMA model ,where "p" was the order of the autoregressive part, "d" was the order of the differencing, "q" was the order of the moving-average process. The term $(P,D,Q)_S$ gave the order of the seasonal part. The model with an intervention was expressed as below:

$$W_t = \frac{\omega(B)}{\delta(B)} B^k X_t + \frac{\theta(B)}{\phi(B)} a_t$$

Where W_t was the original time series or transformed series, which was stationary; X_t was the time series of intervention at time t; $\frac{\omega(B)}{\delta(B)}$ was the polynomial of the transfer function for the intervention series; B^k was the pure time delay for the effect of intervention series; $\frac{\theta(B)}{\phi(B)}a_t$ was ARIMA(p,d,q)(P,D,Q)s. The steps of the whole process are listed as below:

1. Building ARIMA model using series before emergency response declared: First, we transformed the time series to make is stationarily (18). We plotted time series and their autocorrelation function (ACF) to visually examine if it had visible trend or if its variability changes noticeably over time. If the series had a nonstationary variance, we would transform it to a stationary series before ARIMA modeling. The transformation methods we tried included logarithmic transformation, low order difference of the series, seasonal difference of the series, square root anti sine transformation. We checked the stationary for each of transformed time series by Augmented Dickey-Fuller Unit Root Tests (ADF) (19). Second, we estimated initial value of parameters of p, q, P, Q through drawing ACF plot and partial autocorrelation function (PACF), the extended sample autocorrelation function (ESACF), the minimum information criterion (MINIC) and the smallest canonical (SCAN) correlation method. We used many combinations of value of parameters to fit the stationary time series with the ARIMA models using maximum likelihood method. Third, we determined the optimal models which would meet these criteria. (I) Residuals of model were white noise. Both white noise test (Ljung-box test) and graphical check of the residuals (ACF, PACF, and white noise test plots) showed we could not reject the white noise hypothesis. (II) Both Akaike's

information criterion (AIC) and Schwarz's Bayesian criterion (SBC) were used to identify the optimal models.

2. Building ARIMAX model using full time series: intervention factor was incorporated into the previously determined ARIMA model to construct multivariate time series ARIMAX model. The cross-correlation function (CCF) between the pre-whitened inputted series and pre-whitened response series was calculated to identify the significant time lag (20). The optimal ARIMAX model was determined when residuals were white noise and both AIC and SBC were the smallest.

3. Predicting using ARIMAX: weekly ILIs and weekly positive proportion of ILIs after emergency response declared were forecasted with ARIMA part of ARIMAX models. The predicted value represented the value when there were no COVID-19 measures. Predicted ILIs minus observed ILIs represented reduced number of ILI visits attributed to COVID-19 measures. ILIs multiplied weekly positive proportion of ILIs to get the number of influenza visits and reduced number due to COVID-19 measures could be calculated.

RESULTS

General Description

In the six influenza seasons from week 27th, 2014 to week 26th, 2020, a total of 4,256,656 ILIs were reported based on influenza surveillance systems in Beijing. During this period, ILIs proportion in outpatients and positive proportion of ILIs for influenza were 1.54% and 16.98% respectively, and 95 weeks were located in influenza epidemic period. As shown in Table 1, during the six influenza seasons, influenza activity was at the highest level in influenza season 2018/2019, in which cumulative ILIs (970,248), cumulative positive proportion of ILI (21.19%), cumulative ILIs proportion in outpatients (1.98%), number of influenza epidemic week (22 weeks), maximum of ILIs (71,555), and maximum of ILIs proportion in outpatients (6.13%) were maximum during these six influenza seasons. The maximum of positive proportion of ILI for influenza was 69.25% in season 2014/2015.

Season 2019/2020 vs. Preceding Five Influenza Seasons

During season 2019/2020, cumulative ILIs, cumulative ILIs proportion in outpatients, cumulative positive proportion of ILI, and number of influenza epidemic week were 632,976, 1.63%, 8.82%, and 8, respectively. The peak of influenza activity was in week 4th, 2020 (the highest level of response for major public health emergencies), in which both positive proportion of ILI (50.12%) and ILIs proption in outpatients (4.95%) were maximum and ILIs was 34,850. As shown in Table 1 and Figure 1, after implementation of comprehensive COVID-19 NPIs, all influenza activity indicators decreased dramatically. Compared with means of preceding five influenza seasons, cumulative ILIs decreased by 12.66% (632,976 *vs* 724,736), cumulative positive proportion of ILI decreased by 52.33% (8.82% *vs* 18.49%), duration of influenza epidemic period decreased by 54.02% (8 weeks *vs* 17.4 weeks), especially, the number of weeks from the peak to the end of influenza epidemic period, decreased from 12 weeks to one week, in season 2019/2020.

In univariate analysis (Wilcoxon's test), three factors were compared between season 2019/2020 and means of preceding five influenza seasons. As shown in Table 2, weekly ILIs and positive proportion of ILI were significantly lower in season 2019/2020 compared with means of preceding five influenza seasons ($p < 0.05$). Weekly ILIs proportion in outpatients in season 2019/2020 was lower than means of preceding five influenza seasons, but without statistically significant difference ($p = 0.07$).

Simulations with ARIMAX Model

We used time series of weekly ILIs and positive proportion of ILI before week 3rd, 2020 to build two ARIMA models, and then introduced COVID-19 control measures as an intervention to develop ARIMAX with the whole series. As shown in Figure 2, both weekly ILIs and positive proportion of ILI fluctuated periodically, and decreased dramatically after COVID-19 emergency response declared.

As shown in Figure 2, original series of weekly ILIs, which had a nonstationary variance, was converted into stationary time series after logarithmic transformation and the first difference and original series of weekly positive proportion of ILI was converted into stationary time series after the first difference. Ljung-Box test ($p < 0.001$) showed the transformed series were not a white noise sequence. After comparison with different combinations of parameters, optimal ARIMA models for weekly ILIs and weekly positive proportion of ILI were determined to fit transformed sequence before emergency response, showing the lowest AIC or SBC. The model for weekly ILIs was ARIMA$(2,1,2)(1,0,1)_{52}$ (AIC=-544.692, SBC= -526.36) and the model for weekly positive proportion of ILI was ARIMA$(3,1,3)(0,0,1)_{52}$ (AIC=-1100.14, SBC= 1074.48), in which all the estimated parameters were statistically significant and did not show autocorrelation (Ljung-Box test $p > 0.05$) in the residual analysis.

We then introduced COVID-19 control measures as an intervention to develop ARIMAX to analyze the impact of COVID-19 measures. In CCF charts (Figure 3), we found both transformed weekly ILIs and positive proportion of ILI were correlated with COVID-19 measures (lags 1 or 2). We then tested several ARIMAX models with COVID-19 measures at significant lags and many combinations of numerator factors to find the most appropriate models with the lowest AIC and SBC. All the estimated parameters of ARIMAX for weekly ILIs (AIC=568.80, SBC= -538.907) and ARIMAX for weekly positive proportion of ILI (AIC=568.80, SBC= -538.907) were statistically significant and did not show autocorrelation (Ljung-Box test $p > 0.05$) in the residual analysis.

The equations of models were as follow and the coefficients were shown in Table 3.

$$ln(Y_t) = (\omega_{10} - \omega_{11}B)X_{(t-1)}^T + \frac{(1-\theta_{11}B - \theta_{12}B^2)(1-\theta_{1s}B^{52})}{(1-B)(1-\varphi_{11}B - \varphi_{12}B^2)(1-\varphi_{1s}B^{52})}a_t$$

$$Yp_t = (\omega_{20} - \omega_{21}B)X_{(t-1)}^T + \frac{(1-\theta_{21}B - \theta_{22}B^2 - \theta_{23}B^3)(1-\theta_{2s}B^{52})}{(1-B)(1-\varphi_{21}B - \varphi_{22}B^2 - \varphi_{23}B^3)}a_t$$

$$X_t^T = \begin{cases} 0, & \text{Before emergency response declared } (t < T) \\ 1, & \text{After emergency response declared } (t \geq T) \end{cases}$$

Y_t was weekly ILIs at time t, Yp_t was weekly positive proportion of ILI at time t, X_t^T represented COVID-19 NPIs at time t, a_t was independent disturbance, B was backshift operator, θ_{ij} was a coefficient of polynomial in the moving-average operator, φ_{ij} was a coefficient of polynomial in the autoregressive operator, ω_{ij} was a coefficient of numerator polynomial for the intervention series.

Impact of intervention parameters and estimation of avoid influenza based on ARIMAX model

As shown in Table 3, the coefficients of intervention in the model for weekly ILIs were ω_{10}=-0.66 (t =--7.51, p < 0.001) and ω_{11}= 0.39 (t =-4.03, p < 0.001), which indicated weekly number of ILI decreased by 48.6% in the second week after emergency response declared, and continued to decrease by 80.0% in the third week after emergency response declared. As shown in Table 3, the coefficients of intervention in the model for positive proportion of ILI were ω_{20}= -0.15 (t =--4.73, p < 0.001) and ω_{21}= 0.18 (t =-5.77, p < 0.001), which indicated weekly positive proportion of ILI dropped 15% in the second week after emergency response declared, and continued to decrease 33% in the third week after emergency response declared. Based on the ARIMAX models, from week 3rd to week 26th in 2020, 256,293 ILIs (decreased by 62.86%) and 119,174 influenza cases (decreased by 83.51%) were prevented compared with the predicted value, which was attributed to COVID-19 control measures.

DISCUSSION

The first COVID-19 case in Beijing was reported on 19th January in 2020 and five days later, Beijing had launched the highest level of response for major public health emergencies (6,16). After stringent NPIs implementation, influenza activity decreased dramatically according influenza activity indicators, especially, the number of weeks from the peak to the end of influenza epidemic period, decreased from 12 weeks to one week. Many countries and regions, like United States, Australia, China, Singapore and South Africa, had reported influenza activity decreased after COVID-19 pandemic (12-14, 21,22).

The decrease of influenza activity indicators may be due to natural fluctuation. We used ARIMAX to solve natural decline caused by influenza seasonal fluctuation and estimate the effect of COVID-19 measures. ARIMAX model contained two parts, which were ARIMA part and intervention part. ARIMA part depicted fluctuation of influenza and other factors except COVID-19 measures. Intervention part depicted the decline due to comprehensive

COVID-19 NPIs. After considering natural decline caused by seasonal fluctuation, the decrease was a cliff-like decline in first three weeks and finally COVID-19 measures reduced 83% influenza cases and 63% ILI visits.

In June 2020, WHO expressed the grave concern that the overlapping of the second wave of COVID-19 and influenza peak could overwhelm medical system (8). However, this situation has not occurred so far. Epidemic of COVID-19 is more serious, while influenza activity is still at a low level in latest winter (3,9). The main reason is not the competition between SARS-CoV-2 and influenza virus, but stringent COVID-19 NPIs. The binding receptors of the two viruses are distinct and non-competitive (11,23). Influenza virus targets cells through HA that binds to sialic acid receptor, which primarily locates upper respiratory tract, while SARS-CoV-2 targets cells via the viral structural protein S that binds to ACE2 receptor, and TMPRSS2 promotes viral uptake, which are primarily expressed in alveolar epithelial type II cells. In Beijing, about 1,500 COVID-19 local cases were reported in March, 2022, which indicated extremely low SARS-CoV-2 infection. However, influenza activity declined sharply in January, 2020 and remained the lowest level in December, 2020, which should be the start of influenza epidemic period based on past experience. Obviously, those cannot be explained by competition between SARS-CoV-2 and influenza virus. Actually, people’s behavior pattern has altered profoundly during

COVID-19 pandemic, such as wear mask and keep social distance, even if transmission of COVID-19 was interrupted in Beijing.

Therefore, in the situation that effective vaccine against SARS-CoV-2 is available, NPIs still deserve our attention. First, in the most optimistic scenarios, which is vaccine against SARS-CoV-2 and 5 VOCs (variants of concern) could provide effective and long-time protection, stringent NPIs can help us through the period before forming adequate immunological barrier. Second, if adequate COVID-19 immunological barrier is built, influenza with high incidence may also impact medical system with the relaxation of stringent NPIs in the next influenza season. Because vast number of people didn't contact influenza virus in influenza seasons of 2019/2020 and 2020/2021, which will result in a low level of immunity to influenza. Third, the protective effect of vaccine against SARS-CoV-2 may reduce with passing of time or even lose efficacy because of mutation of virus.

Our study had some limitations. First, the data used in this study were based on surveillance, which may be incomplete. Confounding factors, such as age and reporting bias, could not be controlled for. However, the effective of COVID-19 measures on influenza was so marked that the confounding factors may hardly reverse the conclusion. Second, there could be fewer ILIs visit hospitals because COVID-19 epidemic may alter health-seeking behavior. The number of ILIs may be underestimated. However, that cannot affect positive proportion of ILI for influenza. Third, the lower limit of predicted value for positive proportion of ILI using ARIMAX model may be less than zero. We solved this problem with square root anti sine transformation, the first order difference. The different of predicted value between two transformations was small. However, effect of COVID-19 measures become hard to explain.

In summary, we showed that stringent COVID-19 control measures could interrupt the transmission of influenza and other respiratory infectious diseases markedly. Considering excellent effect on COVID-19 and influenza, even though we encounter a particularly terrible situation, which included overlapping of COVID-19 and influenza epidemic, lose efficacy of vaccine against SARS-CoV-2, and mismatched influenza vaccine, we could reintroduce COVID-19 measures to contain the spread both of SARS-CoV-2 and influenza.

Author Contributions:

Conceptualization, P.Y., Y.S., Q.W. and Z.W.; methodology, Y.S., X.W. and Z.W.; software, Y.S. and Y.P.; validation, Q.W. and P.Y.; formal analysis, Y.S.; investigation, Y.S., L.Z., S.W., Y.Z., C.M., and W.D.; resources, Y.S., L.Z., S.W., Y.Z., C.M., and W.D., data curation, Y.S., L.Z., S.W., Y.Z., C.M., and W.D.; writing—original draft preparation, Y.S.; writing—review and editing, Y.S. and P.Y.; visualization, Y.S.; supervision, P.Y., Q.W. and Z.W., project administration, P.Y. and Q,Y.; funding acquisition, P.Y. and Q,Y. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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Figure 1 Seasonal influenza activity of influenza season 2019/2020 (red) compared with previous 5 influenza seasons from season 2014/2015 to season 2018/2019 (average values from 2014 to 2019 were blue).

A, Weekly number of ILI. B, Weekly ILI proportion among patients visiting outpatient and emergency clinics of internal medicine and pediatric wards in 421 hospitals. C, Weekly positive proportion of ILI for influenza. Abbreviations: ILI, influenza-like illness.

Figure 2 Effective of COVID-19 control measures on weekly number of ILI and weekly positive proportion of ILI, using ARIMAX model.

A, Weekly number of ILI. B, Weekly positive proportion of ILI for influenza. Abbreviations: ILI, influenza-like illness. The blue circles represented observed values. The blue lines represented the forecast for real-world data; before emergency response, it represented forecast values without COVID-19 interventions and after emergency response, it represented forecast values with COVID-19 interventions. The red dashed lines represented forecast values without COVID-19 interventions after emergency response.

Figure 3 Cross correlation analysis. A, Cross correlation between transformed weekly number of ILI and COVID-19 measures. B, Cross correlation between weekly positive proportion of ILI and COVID-19 measures.

Table 1 Characteristic of seasonal influenza activity based on influenza surveillance system, from season 2014/2015 to season 2019/2010, in Beijing.

Indicators	Season 2014/2015	Season 2015/2016	Season 2016/2017	Season 2017/2018	Season 2018/2019	Season 2019/2020	Season 2014/2015 to season 2018/2019	Total
ILI	621613	625148	588142	818529	970248	632976	724736	4256656
Max of weekly ILI	31031	24940	21594	49628	71555	48846	71555	71555
ILI proportion in outpatients[1]	1.38%	1.30%	1.23%	1.75%	1.98%	1.63%	1.53%	1.54%
Max of weekly ILI proportion in outpatients	2.67%	4.18%	2.47%	4.95%	6.13%	4.95%	6.13%	6.13%
ILI positive proportion for influenza	20.35%	16.83%	13.35%	20.87%	21.19%	8.82%	18.49%	16.98%
Max of weekly positive proportion of ILI for influenza	69.25%	53.67%	41.89%	58.51%	57.08%	50.12%	69.25%	69.25%
Weeks of influenza epidemic period[2]	19	14	17	15	22	8	17.4	95
Weeks from the onset to the peak of influenza epidemic	4	5	6	6	6	7	5.4	34
Weeks from the peak to the end of influenza epidemic	15	9	11	9	16	1	12	61

1, outpatients included patients visiting outpatient and emergency clinics of internal medicine and pediatric wards in 421 hospitals. 2, influenza epidemic period was defined as period of exceeded 40% of the maximum weekly positive rate for influenza in the overall influenza season. Abbreviations: ILI, influenza-like illness.

Table 2 Comparison of influenza activity between season 2019/2020 and the previous 5 influenza seasons.

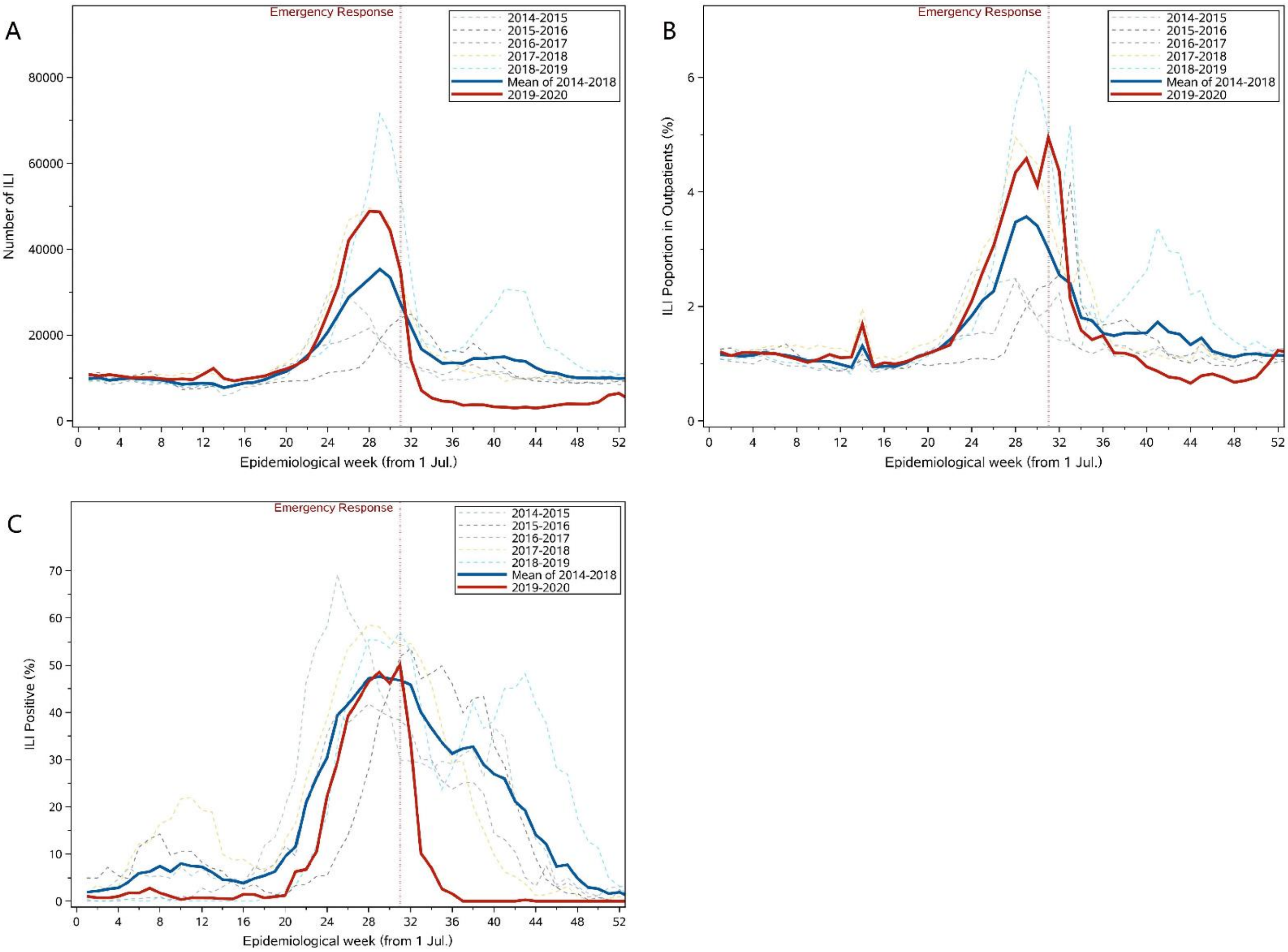
Indicators	Season 2014/2015 to season 2018/2019 (Median, inter-quartile range)	Season 2019/2020 (Median, inter-quartile range)	Total (Median, inter-quartile range)	Z	*p* Value
Weekly ILI	10917.7(9704.5~14845.5)	9801(4171.5~11765.5)	10255(9092-13863)	2.74	0.006
ILI proportion in outpatients (%)[1]	1.21(1.14~1.58)	1.17(0.99~1.46)	1.18(1.06~1.52)	1.80	0.071
Weekly positive proportion of ILI for influenza (%)	7.82(4.74~30.89)	0.85(0.00~4.52)	6.95(1.24-28.77)	5.53	<.0001

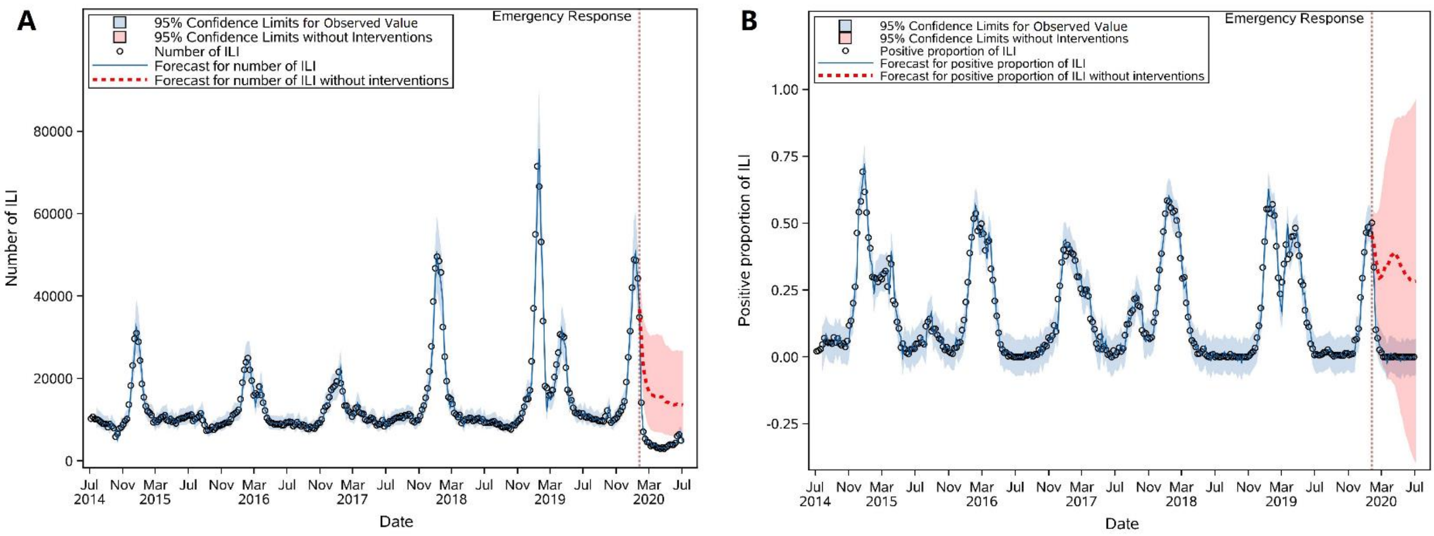
1, outpatients included patients visiting outpatient and emergency clinics of internal medicine and pediatric wards in 421 hospitals. Abbreviations: ILI, influenza-like illness.

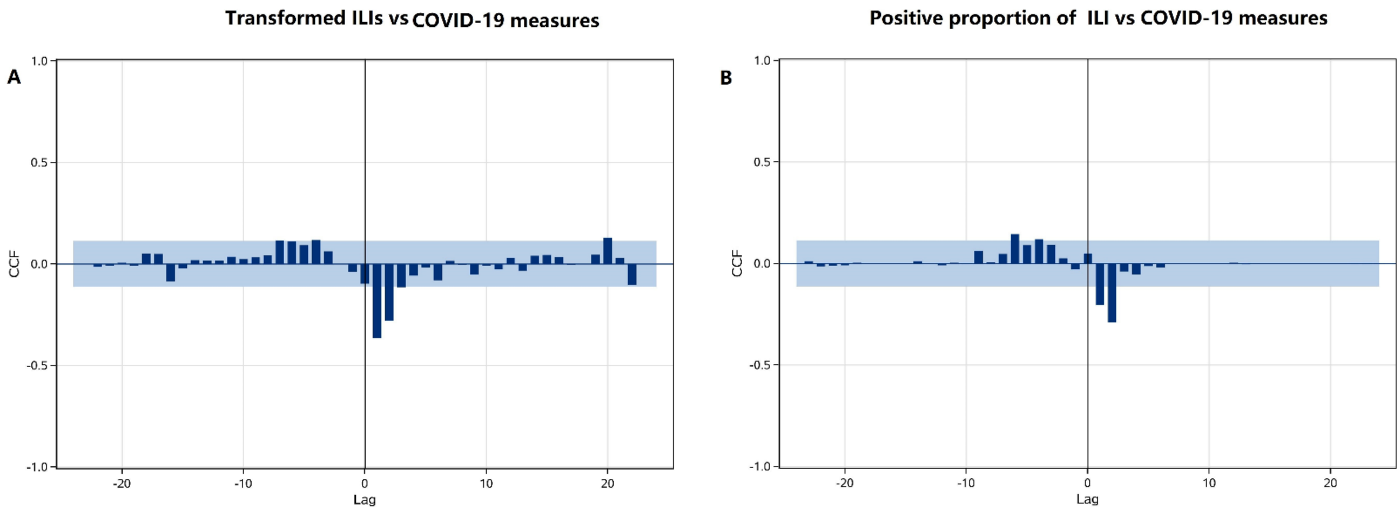
Table 3 Parameter estimates of ARIMAX models with COVID-19 measures intervention for weekly ILI number and weekly positive proportion of ILI from season 2014/2015 to season 2019/2020.

Parameter	Estimate	Standard Error	t Value	p Value
θ_{11}	1.20	0.10	12.37	<.0001
θ_{12}	-0.20	0.10	-2.10	0.035
θ_{1s}	0.56	0.25	2.22	0.026
φ_{11}	1.64	0.07	23.66	<.0001
φ_{12}	-0.71	0.07	-10.55	<.0001
φ_{1s}	0.75	0.21	3.61	0.0003
ω_{10}	-0.66	0.09	-7.51	<.0001
ω_{11}	0.39	0.09	4.28	<.0001
θ_{21}	0.28	0.11	2.61	0.009
θ_{22}	0.52	0.09	5.9	<.0001
θ_{23}	-0.63	0.07	-8.95	<.0001
θ_{2s}	-0.21	0.06	-3.46	0.0005
φ_{21}	0.65	0.12	5.59	<.0001
φ_{22}	0.56	0.10	5.66	<.0001
φ_{23}	-0.61	0.09	-6.52	<.0001
ω_{20}	-0.15	0.03	-4.73	<.0001
ω_{21}	0.18	0.03	5.77	<.0001

Abbreviations: ARIMAX, ARIMA models with input series.


A
B
C
Emergency Response
2014-2015
2015-2016
2016-2017
2017-2018
2018-2019
Mean of 2014-2018
2019-2020
Number of ILI
ILI Poportion in Outpatients (%)
ILI Positive (%)
Epidemiological week (from 1 Jul.)


A
95% Confidence Limits for Observed Value
95% Confidence Limits without Interventions
Number of ILI
Forecast for number of ILI
Forecast for number of ILI without interventions
Emergency Response
Number of ILI
80000
60000
40000
20000
0
Jul 2014
Nov
Mar 2015
Jul
Nov
Mar 2016
Jul
Nov
Mar 2017
Jul
Nov
Mar 2018
Jul
Nov
Mar 2019
Jul
Nov
Mar 2020
Jul
Date
B
95% Confidence Limits for Observed Value
95% Confidence Limits without Interventions
Positive proportion of ILI
Forecast for positive proportion of ILI
Forecast for positive proportion of ILI without interventions
Emergency Response
Positive proportion of ILI
1.00
0.75
0.50
0.25
0.00
-0.25
Date


Transformed ILIs vs COVID-19 measures
A
1.0
0.5
0.0
-0.5
-1.0
CCF
-20
-10
0
10
20
Lag
Positive proportion of ILI vs COVID-19 measures
B
1.0
0.5
0.0
-0.5
-1.0
CCF
-20
-10
0
10
20
Lag