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Does a Digital Health Application Could Be the Supplement to the Influenza Surveillance System?

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Abstract. Epidemics of seasonal influenza is a major public health concern in china. Historical percentage of influenza-like illness (ILI%) from CDC and health enquiry data from a health-related application were collected, when combining the real-time ILI-related search queries with one-week ago's ILI%, it was able to predict the trend of ILI correctly and timely. Digital health application is potentializing a supplement to the traditional influenza surveillance systems in China.

Keywords. Digital Health Application, Influenza Surveillance, Search Index

1. Introduction

It is unclear whether digital health applications (DHA) are supportive to the surveillance of seasonal influenza, a major public health concern worldwide, amid the era of big data.

2. Methods

Historical percentage of influenza-like illness (ILI%), issued by the Chinese Center for Disease Control and Prevention (CDC) were collected and the electronic health enquiry data (search queries, such as "symptoms of common cold") from March 18th, 2019 to January 26th, 2020, were retrieved from a DHA. Firstly, ILI-related search queries (ILI-SQ) were extracted through a query selection process, considering both medical and statistical significance. To construct a favorable predictive model, we modeled the weekly aggregated percentage of ILI-SQ (ILI-SQ%) over time and compared them against weekly ILI% through three different models: 1) Search Index Model (SIM): ILI-SQ% were used to model with ILI%; 2) Autoregressive Integrated Moving Average model (ARIMA), i.e., time serials only; 3) Mixed Model (MM): historical ILI% together with nowcasting ILI-SQ% were included to forecast ILI%. Mallows' Cp statistic and

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Akaike information criterion (AIC) were taken into accounts as the evaluation metrics when selecting variables and comparing models. In each model, the number of ILI-SQs were included based on Mallows' *Cp* statistic.

And in this study, models were finally constructed as follows: SIM: $\text{Logit}(ILI_t\%) = \alpha_0 + \sum_{i=1}^{n} \alpha_i Logit(\text{ILI\_SQ}\%_{i,t}) + \varepsilon_t$ (N $\in$ [1,10]); ARIMA: $Logit(ILI_t\%) = \beta_0 + \sum_{i=1}^{p} \beta_i Logit(ILI\%_{t-i}) + \mu_t - \sum_{i=1}^{q} \theta_i \mu_{t-i}$, in which, p and q were parameters for AR and MA model, respectively; MM: $\text{Logit}(ILI_t\%) = \gamma_0 + \sum_{i=1}^{n} \gamma_i Logit(\text{ILI\_SQ}\%_{i,t-k}) + \sum_{j=1}^{p} \varphi_j Logit(ILI\%_{t-j}) + \upsilon_t$, one-week lag of historical $Logit(ILI_{t-1})$ and nowcasting $Logit(\text{ILI\_SQ}\%_{t-1})$, (i.e., k=1, j=1) were used.

3. Results

10 of the 31 ILI-SQs were significantly related to the ILI%, involving ILI-related symptoms (fever, cough, runny nose, wheeze, dizziness, having phlegm and nasal congestion), treatment and others (department of respiration, common cold and influenza). And MM performed way better than the SIM and slightly more satisfactory than the ARIMA, with each R^2 of 0.85, 0.59 and 0.82. Combined with one-week lag of historical ILI%, the nowcasting ILI-SQ% in MM were able to fit the officially reported ILI% very well through the whole year of 2019 (12^{th}-52th week), as shown in Figure 1.

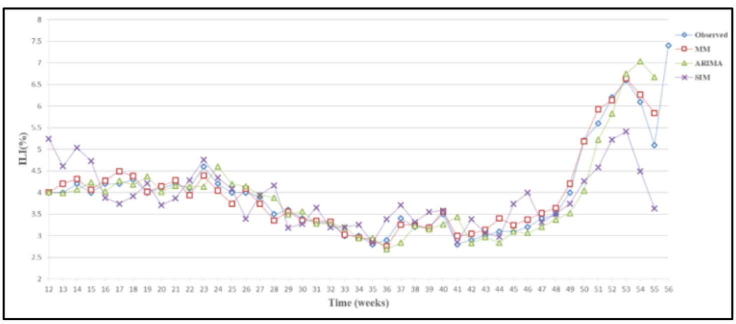

Figure 1. The observed and fitted values computed by three models during March 18th, 2019 to January 26th, 2020 (i.e. 12th to 56th week).

4. Conclusions

Combining ILI% with nowcasting search index from DHA could timely response to the surveillance of ILI, potentializing a supplement to the traditional influenza surveillance systems in China. Yet more longitudinal data are needed to validate its utility furtherly.

References

[1] Rutland BE, Weese JS, Bolin C, Au J, Malani AN. Human-to-dog transmission of methicillin-resistant Staphylococcus aureus. Emerg Infect Dis. 2009 Aug;15(8):1328-30, doi: 10.3201/eid1508.081635.

[2] Hswen Y, Brownstein JS, Liu J, Hawkins JB. Use of a Digital Health Application for Influenza Surveillance in China. Am J Public Health. 2017 Jul;107(7):1130-6, doi: 10.2105/AJPH.2017.303767.