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Symptom Combinations in a Syndromic Surveillance Approach to Improve Timeliness of Situational Awareness in Evolving COVID-19 Pandemic

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Background

Syndromic surveillance by monitoring suitable symptoms combinations is an increasingly common approach for community surveillance of different infectious diseases to with enhanced timelines.

The World Health Organization (WHO) has recommended the use of influenza-like illness (ILI) and acute respiratory infection (ARI) for COVID-19 surveillance during the evolving pandemic (1). However, it is unclear if these traditional data streams for influenza surveillance may also be useful for timely COVID-19 surveillance, with the optimal symptom combinations remains unknown. Although flu-like symptoms and respiratory symptoms, such as fever, cough, fatigue and shortness of breath, were also very common in COVID-19 (2, 3), they were reported to be not predictive for early COVID-19 detection (4). Moreover, groupings of less commonly encountered symptoms, including combinations of loss of smell and taste, fatigue, persistent cough and loss of appetite (5); or combinations of ageusia, fever, diarrhoea, and anosmia (6), were reported to be more predictive for potential COVID-19 infections than commonly encountered respiratory symptoms, potentially making useful as syndromic data streams for enhancing surveillance timeliness.

Objectives

This study aims to explore the temporal relationship of various data streams of different symptom combinations, and to assess their potential to enhance COVID-19 surveillance timeliness during an evolving novel epidemic.

Methods

We recruited and follow-up a local representative cohort of >10,000 participants, whom were allocated into 7 sub-groups for regularly reporting the presence or absence of symptoms relevant to COVID-19 infection, including fever, chills, cough, sputum, rhinorrhoea, sore throat, sore eyes, fatigue, headache, dizziness, myalgia, diarrhoea, nausea, vomiting, loss of appetite , shortness of breath, chest pain, ageusia and anosmia, on a scheduled day of the week for daily surveillance. This study examined symptom report data from 1/4/2022 to 28/12/2022.

The relative temporal relationships between the official daily number of confirmed cases reported by the Government and five syndromic combinations were compared. These included ILI, ARI, one syndromic group with combinations of common symptoms, and two syndromic groups with combinations of predictive symptoms for COVID-19. ILI cases were defined as fever + cough and/or sore throat (7). ARI cases were defined as those reported any two of the following symptoms: fever, cough, sore throat, runny nose, headache, myalgia and sputum (7). The combination of common symptoms was defined as those reported fever, cough, fatigue and shortness of breath (2, 3). The two combinations of predictive symptoms were defined respectively as those reported ageusia and anosmia, fatigue, cough and loss of appetite (predictive combination 1) (5); and ageusia, fever, diarrhoea and anosmia (predictive combination 2) (6).

The relative temporal relationships between the official daily number of confirmed cases reported by the Government and five symptom combinations were examined by Cross Correlation (CCF) to assess the positive / negative time-shift giving the maximal data correlation between the time series (8) giving an idea of the temporal relationships between the two series at different lags.

Results

A total of 385,618 records of symptom reports were collected in the cohort database during the study period. The overall temporal patterns of daily confirmed cases were closely replicated by all five symptom combinations (Figure 1).

The highest correlation coefficients with the daily number of confirmed cases occurred at 0-day without any time lag for ILI (0.85 95% CI: 0.81, 0.88), ARI (0.84 95% CI: 0.80, 0.87), and the combination of common symptom (0.81 95% CI: 0.76, 0.84). For the combinations of predictive symptoms, the highest correlation coefficients occurred with a 4-day lead for combination 1 (0.77 95% CI 0.71, 0.81) and with 3-day lead for combination 2 (0.61 95% CI 0.53, 0.68) (Figure 2).
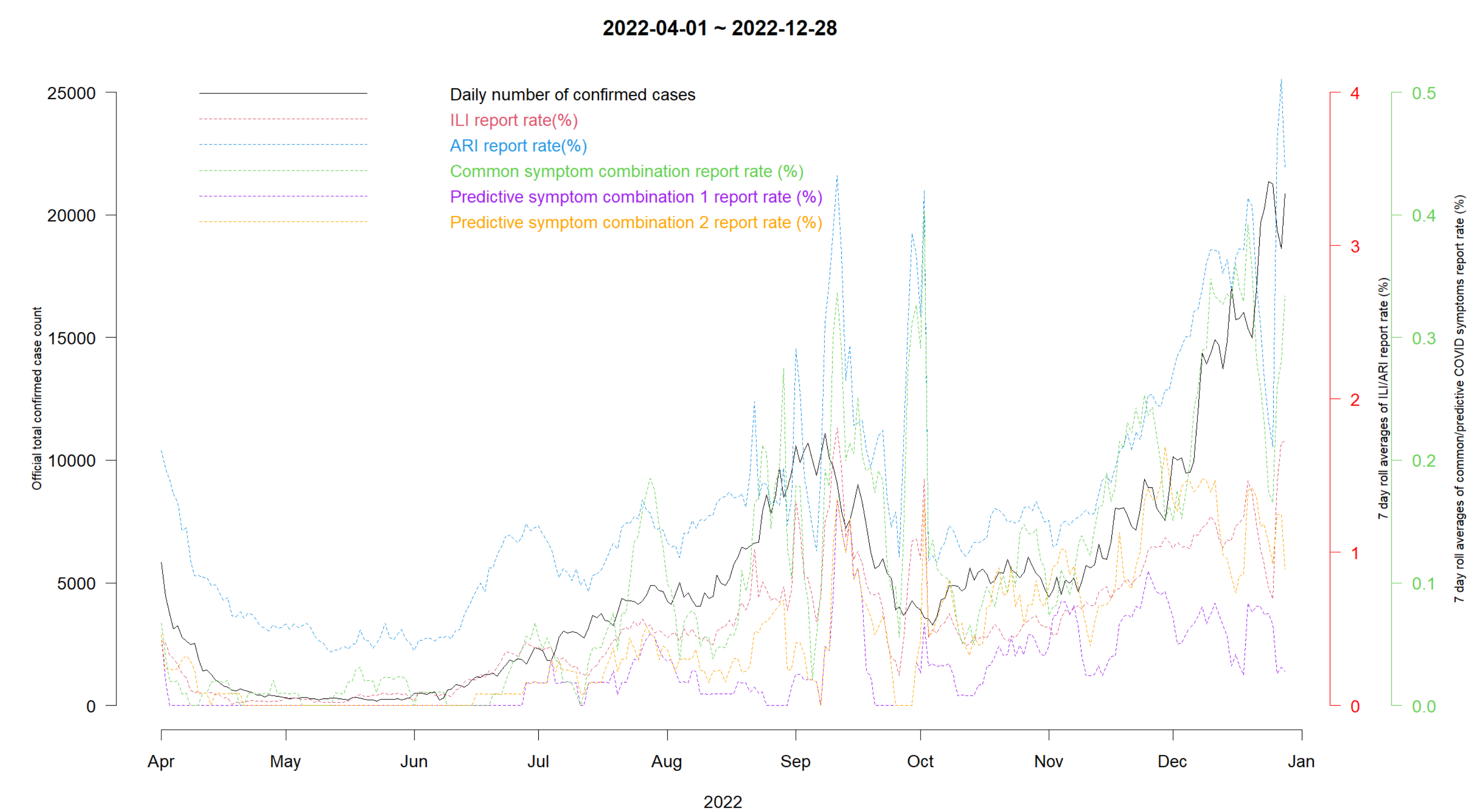

Figure 1 Trends in daily number of confirmed cases VS 7-day averages among 5 tested symptom combinations reported rate in surveillance cohort between April 1, 2022 and December 28, 2022 in Hong Kong

*ILI Influenza-like illness; ARI Acute respiratory infection;
Common symptom combination: fever, cough, fatigue and shortness of breath
Predictive symptom combination 1: ageusia and anosmia, fatigue, cough and loss of appetite
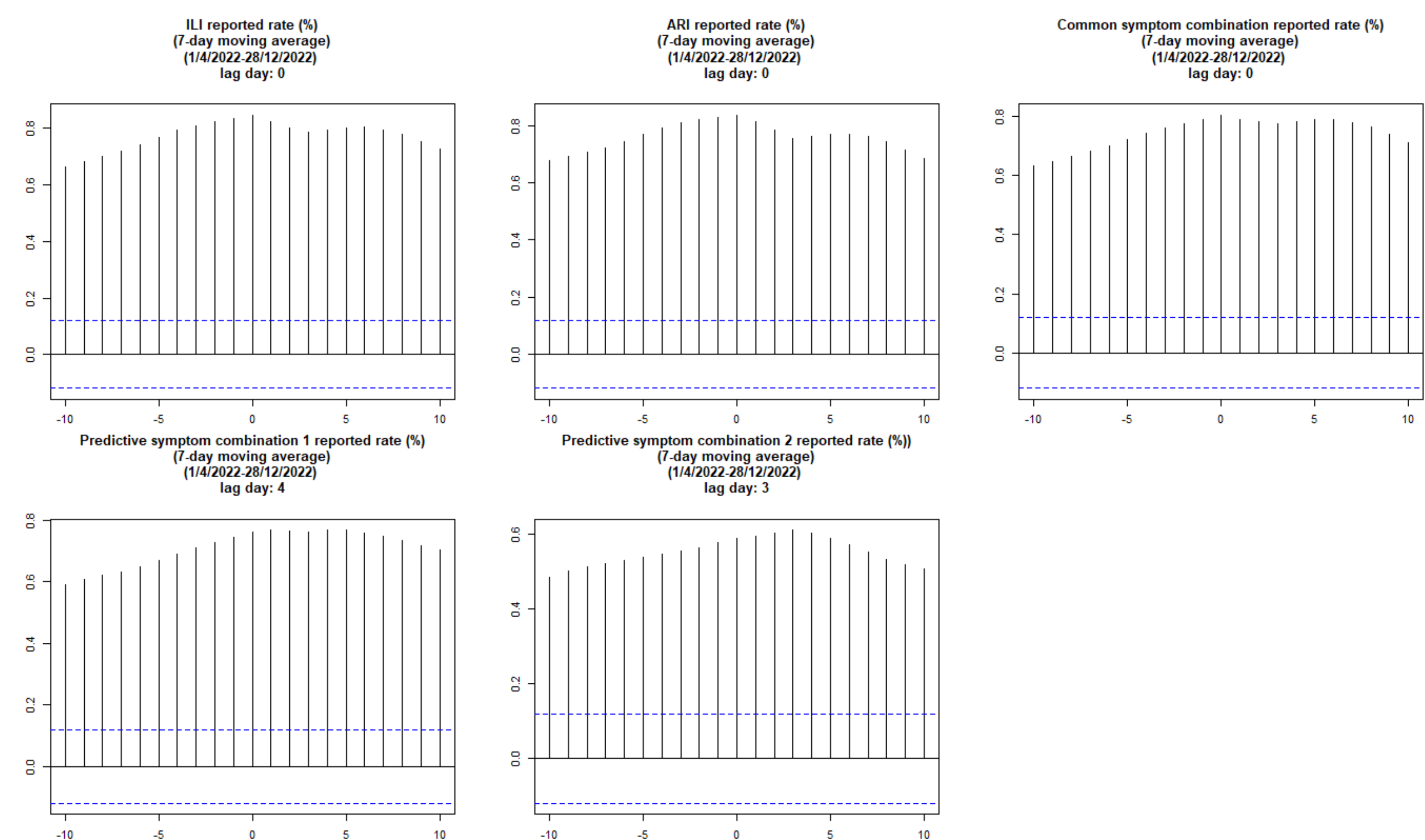Predictive symptom combination 2: ageusia, fever, diarrhoea and anosmia

Figure 2. Correlation plots for daily number of confirmed cases VS 7-day averages among 5 tested symptom combinations reported rate in surveillance cohort between April 1, 2022 and December 28, 2022 in Hong Kong

*ILI Influenza-like illness; ARI Acute respiratory infection;
Common symptom combination: fever, cough, fatigue and shortness of breath
Predictive symptom combination 1: ageusia and anosmia, fatigue, cough and loss of appetite
Predictive symptom combination 2: ageusia, fever, diarrhoea and anosmia

Conclusion

This study demonstrated the potential of significant timeliness improvement of syndromic surveillance in the of COVID-19 surveillance. These results suggested that while all the symptom combinations of ILI, ARI and common symptom combination were able to reflect the overall trajectory of the daily confirmed cases, they offered no gain in surveillance timeliness. Syndromic combinations of predictive symptom, including ageusia and anosmia, fatigue, cough, loss of appetite, and ageusia, fever, diarrhoea anomia, may potential help to improve surveillance timeliness of up to 3-4 days for reflecting the rapidly changing disease activity in an evolving epidemic.

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