

Research Letter

Assessment of SARS-CoV-2 transmission among attendees of live concert events in Japan using contact-tracing data

Naoru Koizumi, PhD^{1,†,*}, Abu Bakkar Siddique^{ID}, MPP¹, and Ali Andalibi, PhD^{2,†}

¹Schar School of Policy and Government, George Mason University, Arlington, VA, USA and ²College of Science, George Mason University, Fairfax, VA, USA

*To whom correspondence should be addressed. Email: nkoizumi@gmu.edu

†These authors contributed equally to the study.

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Coronavirus disease 2019 (COVID-19) is caused by a novel coronavirus named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The virus is relatively infectious, with the basic reproduction number ranging from 2.24 to 3.58.¹ To date, public health officials have relied on the identification and quarantining of symptomatic patients and their contacts to contain the virus. Yet, there is strong evidence that a significant proportion of infected individuals may show no symptoms.^{2,3} As we have learned more about the virus, it has become clear that we need to identify infected individuals and their contacts regardless of their symptoms.

Japan has not been spared of the COVID-19 pandemic, and as of early June 2020, there have been >16 900 cases of the infection reported across the country. Yet, this number is relatively small,

given the density of population in Japanese cities and the central role that Japan plays as a nexus of today's interconnected world economy. As such, it appears that the active contact-tracing measures—called 'cluster countermeasure'—implemented by the Government of Japan have helped the nation to reduce the potential impact of the virus. One of the most important aspects of Japan's national strategy has been the establishment of a detailed registry of COVID-19 patients and their contacts at the level of each prefecture. The scheme identifies all individuals who were in contact with each confirmed cluster or case in the 2 weeks before the diagnosis.

Between 15th and 25th February 2020, a series of 'Live House' (LH) concert events were held in the Osaka prefecture. These concerts are small (~50) to medium size (~100) live

Table 1. Patient information

Age group	Male (n = 32)		Female (n = 67)	
	Symptomatic	Asymptomatic	Symptomatic	Asymptomatic
1–9	0 (0%)	0 (0%)	0 (0%)	1 (7%)
20–29	1 (4%)	0 (0%)	8 (15%)	1 (7%)
30–39	5 (19%)	3 (50%)	10 (19%)	2 (13%)
40–49	8 (31%)	1 (17%)	17 (33%)	10 (67%)
50–59	7 (27%)	1 (17%)	10 (19%)	1 (7%)
60–69	3 (12%)	1 (17%)	5 (10%)	0 (0%)
>70	2 (8%)	0 (0%)	2 (4%)	0 (0%)
Total	26 (100%)	6 (100%)	52 (100%)	15 (100%)
P-value*	0.781		0.299	

*Fisher's exact test.

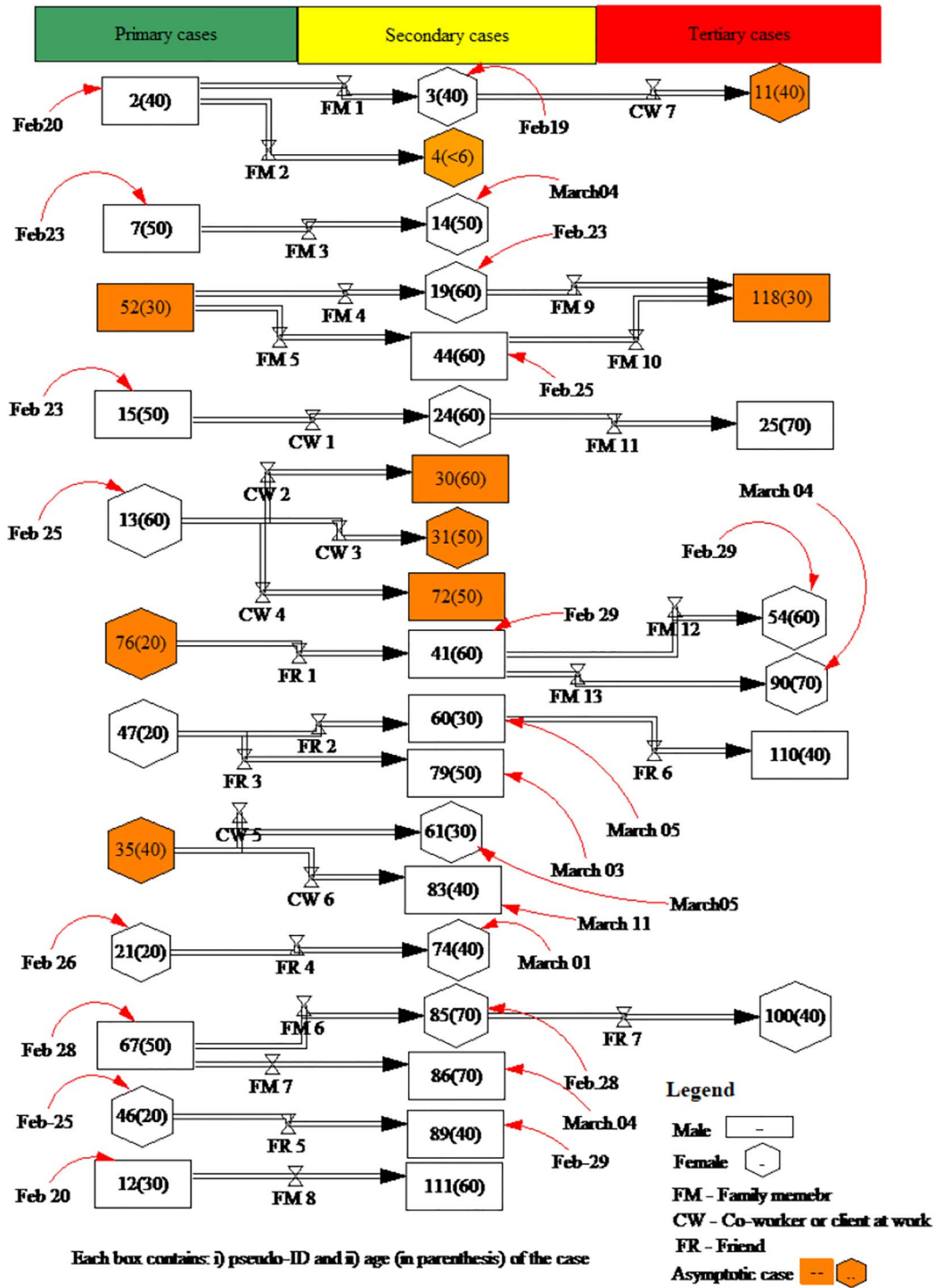


Figure 1. Virus transmission from primary to secondary and to tertiary cases

music venues, often filled to capacity with standing room only. Subsequent to the concerts, many individuals who attended the venues, and others who were exposed to the attendees, developed symptoms of COVID-19. The COVID-19 pandemic was still in its early stages in mid-February, and thus neither social distancing nor ban on mass gatherings was being enforced at these events. Moreover, it was not until recently that the testing and tracing of the attendees and their contacts was started by the Japanese

public health officials, and documented as part of their contact-tracing programme. We used the Japanese registry data to study this LH outbreak cluster of COVID-19.

We queried the central and local government registries for 2 months between 15 February 2020 (the date of the first LH event) and 15 April 2020, and identified 74 individuals who participated in one or more of the eight LH events and who were subsequently confirmed as SARS-CoV-2-positive by

polymerase chain reaction (primary cases). The LH events by and large attracted women in their thirties and forties, which is reflected in the large percentage of female infected cases in this group (Table 1).

We were able to relate all infections in this cluster to a 30-year-old woman whose symptoms at the 15 February concert were cough, fever, rhinitis and sore throat. Her condition subsequently worsened and she was given a positive diagnosis of COVID-19 on 28 February 2019. This suggests that the spread of the virus from one event to another was facilitated by infected participants who attended multiple events.

Including secondary and tertiary cases, the eight LH events resulted in a total of 103 COVID-19 cases across 15 prefectures. Infected individuals ranged from being asymptomatic (21 total) to displaying one or more symptoms (78 total). The youngest patient (<6 years) was asymptomatic (Table 1). The data demonstrate that densely populated venues such as live concerts can 'seed' infections that can spread to other, distant areas. This observation is consistent with prior reports that document transmission of various communicable diseases, including influenza A (H1N1), through mass gatherings and 'music tourism'.^{4,5}

For those who were confirmed in Osaka, we traced their contacts to identify secondary and tertiary cases. Osaka's records have a uniform format that reduces the potential of systematic errors in the data collection process. Osaka is also the second largest prefecture with a significantly higher population density than the other affected prefectures (except Tokyo). Of the 74 primary cases identified, 48 (65%) were found in Osaka. The contact-tracing data for these cases identified that 12 of the 48 primary cases (25%) transmitted the virus to 20 cases (secondary cases). Of those 20 secondary cases, 6 cases transmitted the virus to 7 tertiary cases (Figure 1).

Of the 48 primary cases, the numbers of symptomatic and asymptomatic cases were 36 (75%) and 12 (25%) cases, respectively. Asymptomatic patients transmitted virus at a similar rate to symptomatic patients: Among the 36 symptomatic cases, 9 cases (25%) infected 1 to 3 individuals. Among the 12 asymptomatic cases, 3 cases (25%) infected 1 or 2 individuals subsequently. Among the secondary cases, 4 out of 18 (22%) cases were asymptomatic. None of these four secondary cases transmitted virus, while the 14 symptomatic patients transmitted the virus to 1 or 2 tertiary cases.

The classification of the relationships between infectors and infectees are also shown in the figure—family member (FM), friend (FR), or co-worker or client at work (CW). Transmission occurred predominantly among family members (12 cases, 45%). The transmission rate among friends was the same as that among co-workers/clients at work (7 cases, 27% for both). This suggests that transmission in families, where close contact is inevitable, also results in the spread of the infection, but, as expected, is more localized.

The contact-tracing measures implemented by the Japanese government resulted in the containment of the cluster within a month. The 2-month registry data that we examined indicate that all except one case was identified before 10 March and that no primary or subsequent cases were found in the registry

after 25 March. The evidence seems to confirm the effectiveness of the contact-tracing measure. The quick containment of the virus may also be attributable to cultural behaviour or customs that are common in Japan. The notes available as part of the individual-level records suggested that many patients did not socialize after symptoms appeared. Many individuals also wore a facial mask while travelling after symptoms appeared. Such behaviour may have limited the number of individuals with whom they interacted when symptomatic. At the same time, the evidence also suggests that communities may see a resurgence of infections when public health advice or self-imposed constraints are ignored.

The main limitation of the current study stems from the skewed age distribution of the cases. The fact that the majority of the audience of the LH events were middle-aged women prevented us from investigating the spread of COVID-19 among male and younger (<20) patients, as well as in septuagenarians and octogenarians, who are known to be affected by the disease more severely.

Author Contributions

N.K. accessed and organized the prefecture data, co-designed the study and performed data analysis.

A.A. designed the study, contextualized the results and analysed the medical aspects of the data.

A.B.S. cleaned and co-organized the data, and also designed and created the transmission flow chart.

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Data sharing

Data will be made available upon request.

Ethics committee approval

Not required.

References

1. Lai C-C, Shih T-P, Ko W-C *et al*. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and corona virus disease-2019 (COVID-19): the epidemic and the challenges. *Int J Antimicrob Agents* 2020; 55:105924.
2. Bai Y, Yao L, Wei T *et al*. Presumed asymptomatic carrier transmission of COVID-19. *JAMA* 2020; 323:1406–7.
3. Rothe C, Schunk M, Sothmann P *et al*. Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. *N Engl J Med* 2020; 382:970–1.
4. Botelho-Nevers E, Gautret P. Outbreaks associated to large open air festivals, including music festivals, 1980 to 2012. *Eurosurveillance* 2013; 18:20426.
5. Lu TS, Flaherty GT. Tuning into the travel health risks of music tourism. *J Travel Med* 2018; 25.