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## Serial Intervals and Household Transmission of SARS-CoV-2 Omicron Variant, South Korea, 2021

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To clarify transmissibility of the severe acute respiratory syndrome coronavirus 2 Omicron variant, we determined serial intervals and secondary attack rates among household contacts in South Korea. Mean serial interval for 12 transmission pairs was 2.9 days, and secondary attack rate among 25 households was 50.0%, raising concern about a rapid surge in cases.

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) Omicron (B.1.1.529) variant of concern has been confirmed on all continents and has spread through communities around the world at unprecedented speed (1). Given uncertainties about current estimates of virus transmissibility, we analyzed real-life data on serial intervals for transmission pairs (time from infector symptom onset to infectee symptom onset) and secondary attack rate among household contacts, offering metrics essential for predicting epidemic size, forecasting healthcare demand, and devising effective public health interventions. Details of the epidemiologic situation with regard to importation and transmission of the Omicron variant in South Korea have been described elsewhere (2). We further traced a total of 76 case-patients with Omicron infection that originated from 2 persons with imported cases (75 confirmed cases and 1 suspected case) and their contacts, focusing on infector-infectee relationships and household transmission during November–December 2021.

Because of the possibility of their being exposed to other potential sources of infection at church on

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November 28, 2021, we excluded infectees who had visited church on that date from transmission pairs. As for the time of infection in households, we assumed that the earliest exposure occurred 2 days before symptom onset of an infector and the last exposure before isolation of the infector. To calculate serial intervals, we did not include case-patients without a clear date of symptom onset. We defined a household as a group of persons living in the same residence with a shared space. This study was conducted as a legally mandated public health investigation under

the authority of the Korean Infectious Diseases Control and Prevention Act (no. 12444 and no. 13392). The study was not research that was subject to institutional review board approval; therefore, written informed consent was not required.

We identified 25 households, comprising 55 household members. Only 1 household comprised South Korea nationals; the others, foreign nationals. Of the 55 household members, 36 were confirmed to be Omicron-positive, among which secondary attack rate was 0.65 (95% CI 0.48–0.81). After we

**Table.** Characteristics of SARS-CoV-2 Omicron (B.1.1.529) variant of concern of index case-patients and household members, South Korea, 2021\*

Household	Age, y/sex	Index case-patient			Household members†	
		Transmission route	Signs/symptoms at diagnosis	COVID-19 vaccination status (vaccine)‡	No. members, n = 36	No. confirmed cases, n = 18
1	44/M	Imported case	Cough, sputum, sore throat	Fully (mRNA-1273)	2	1
2	38/M	Contact with a confirmed case at the airport	Fever, cough, myalgia	Unvaccinated	2	1
3	33/M	Contact at church and restaurant	Fever, cough, myalgia, headache	Unvaccinated	1	1
4	39/F	Contact at church	Fever, myalgia	Partially (BNT162b)	1	0
5	31/F	Contact at church	Myalgia	Unvaccinated	0	0
6	27/F	Contact at church	Fever, sore throat	Unvaccinated	1	1
7	33/F	Contact at church	Fever, chill, cough, myalgia, headache	Unvaccinated	2	2
8	34/F	Contact at church	Sore throat	Unvaccinated	2	1
9	50/F	Contact at church	Cough, sore throat, headache	Fully (Ad26.COVS.2)	1	1
10	56/F	Contact with a friend	Cough, fatigue	Fully (Ad26.COVS.2)	0	0
11	46/M	Contact at church	Asymptomatic	Fully (mRNA-1273)	0	0
12	39/F	Contact at a restaurant	Sore throat	Unvaccinated	2	2
13	77/F	Contact at church	Cough, sore throat	Fully (BNT162b)	2	0
14	44/F	Contact at church	Sputum, sore throat	Fully (mRNA-1273)	1	1
15	6/M	Contact at a childcare center	Asymptomatic	Unvaccinated	2	0
16	31/F	Contact at church	Fever, sputum, sore throat	Unvaccinated	1	0
17	23/F	Contact with a friend	Fever, chill, cough, sputum, sore throat, myalgia, headache	Fully (mRNA-1273)	1	0
18	4/M	Contact at street	Asymptomatic	Unvaccinated	3	0
19	64/F	Contact at church	Asymptomatic	Fully (mRNA-1273)	0	0
20	67/F	Contact at church	Asymptomatic	Unvaccinated	1	1
21	34/F	Contact at church	Fever, myalgia	Unvaccinated	1	1
22	33/F	Contact at church	Sore throat, rhinorrhea	Fully (BNT162b)	2	0
23	45/F	Contact with a family member	Asymptomatic	Fully (Ad26.COVS.2)	2	1
24	2/F	Contact at playground	Fever, rhinorrhea	Unvaccinated	4	3
25	3/M	Contact at a childcare center	Asymptomatic	Unvaccinated	2	1
Total		NA	NA	NA	36	18
Attack rate		NA	NA	NA	NA	0.50

\*COVID-19, coronavirus disease; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

†Household members who participated in church service on November 28, 2021, were excluded.

‡An unvaccinated person had received no COVID-19 vaccine. A partially vaccinated person had received a COVID-19 vaccine but had not completed the primary series  $\geq 14$  d before illness onset. A fully vaccinated person had completed the primary series of COVID-19 vaccine  $\geq 14$  d before illness onset; vaccinated index case-patients received BNT162b, n = 3; mRNA-1273, n = 5; or Ad26.COVS.2, n = 3.

excluded the 19 household members who had visited church on November 28, 2021, the remaining 36 were confirmed to be Omicron case-patients; secondary attack rate among the 18 was 0.50 (95% CI 0.35–0.72) (Table).

We used 12 transmission pairs for the calculation, including 12 infectors and 19 infectees. Mean ( $\pm$  SD) ages were 34.2 ( $\pm$  18.2) years for infectors and 32.5 ( $\pm$  21.7) years for infectees. The mean incubation period of the transmission pairs was 2.5–4.3 days, and the median incubation period was 3–4 days. The mean ( $\pm$  SD) serial interval for the pairs was 2.9 ( $\pm$  1.6) days; the median serial interval was 3.0 days (Appendix, <https://wwwnc.cdc.gov/EID/article/28/3/21-2607-App1.xlsx>).

The estimated mean serial interval of 2.9 days for Omicron was shorter than that determined for wild-type virus and the Delta variant found in other studies conducted in South Korea (3,4). Enhanced nonpharmaceutical interventions such as rapid isolation of case-patients, as revealed by the mean time of 0.75 (range 0–4) days from symptom onset to isolation among infectors, and meticulous contact tracing during the study period may have shortened the serial interval and reduced superspreading potential, as evidenced in other research (5). Thus, further studies in other places or at other periods, are needed, using larger sample sizes to more accurately estimate transmission dynamics and effects of public health measures.

The household secondary attack rate that we found, factoring in vaccination status and prior infections, was substantially higher than rates for wild type virus and the Delta variant of concern previously reported in South Korea and other countries (6). This finding is in line with earlier reports that suggested increased household risk for transmission of Omicron variant (7,8), although enhanced isolation in conjunction with a comprehensive testing strategy for contacts of case-patients may partially inflate secondary attack rate in our study. Of note, in our study, the secondary attack rate among fully vaccinated persons is high (62.5%, 10/16), thus heightening concerns over immune escape and the possibility that Omicron may be associated with considerably reduced vaccine effectiveness. However, further studies are needed to accurately assess the relative roles of increased intrinsic transmissibility and immune escape.

Our findings with regard to Omicron transmissibility by symptomatic index case-patients supports that of a meta-analysis reporting that that secondary attack rates were higher in households with symptomatic rather

than asymptomatic index case-patients (6). However, caution is warranted when interpreting our results because other social and demographic factors could not be properly adjusted and sample size was too small to ensure adequate statistical power. Our findings of a short serial interval among transmission pairs and a high secondary attack rate among household members adds timely real-life evidence of increased transmissibility of the Omicron variant of concern along with the potential for immune escape, thus necessitating a package of effective public health measures to mitigate the spread of Omicron in each country.

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## Restaurant-Based Measures to Control Community Transmission of COVID-19, Hong Kong

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Controlling transmission in restaurants is an important component of public health and social measures for coronavirus disease. We examined the effects of restaurant measures in Hong Kong. Our findings indicate that shortening operating hours did not have an effect on time-varying effective reproduction number when capacity was already reduced.

As of April 14, 2021, a total of 11,608 cases and 207 deaths from coronavirus disease (COVID-19) had been reported in Hong Kong (1). A series of community epidemics have occurred, the largest of which have been the third wave in June–October 2020, which had 3,978 cases, and the fourth wave in November 2020–March 2021, which had 6,048 cases. To suppress local transmission of COVID-19, the government implemented a combination of public health and social measures (PHSMs): bar closures, restaurant capacity restrictions and opening hour restrictions, bans on live music performances and dancing, and work-from-home advisories (2). Ongoing assessment of the effect of these measures on transmission can guide evidence-based policy. One type of location in which COVID-19 transmission is known to occur is restaurants (3). Earlier studies have evaluated the impact of PHSMs, including restrictions on large group gatherings (4–6), but the specific effect of restaurant measures was not studied. Here we focus on the effect of restaurant measures on transmission in Hong Kong.

We collected details and time of implementation of each intervention of all the PHSMs applied during the third and fourth waves from the official reports of the Hong Kong government (7) (Appendix Table 1, <https://wwwnc.cdc.gov/EID/article/28/3/21-1015-App1.pdf>). In wave 3, a ban on dine-in service after 6:00 PM was in force during July 15–August 27, 2020 (Figure, panel A). Other PHSMs were implemented on the same day and kept in place for longer. Wave 4 was initiated by multiple superspreading events in a network of dancing venues. A ban on dine-in service after 6:00 PM was implemented on December 10, 2020, which was a week to a month later than the implementation of other PHSMs (Figure, panel B). Hence, we could disentangle the effect of shortened dine-in hours from other measures. No other PHSMs were implemented before the study period.

To determine the effect of the ban on dine-in services after 6:00 PM, we applied a previous approach to estimate time-varying reproduction number ( $R_t$ ) (8,9). Then, we fitted LASSO regression models to