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# Closed environments facilitate secondary transmission of coronavirus disease 2019 (COVID-19) — Source link

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Title:

# Closed environments facilitate secondary transmission of coronavirus disease 2019 (COVID-19)

Running title: Closed environment and COVID-19

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## Abstract

**Objective:** To identify common features of cases with novel coronavirus disease (COVID-19) so as to better understand what factors promote secondary transmission including superspreading events.

**Methods:** A total of 110 cases were examined among eleven clusters and sporadic cases, and investigated who acquired infection from whom. The clusters included four in Tokyo and one each in Aichi, Fukuoka, Hokkaido, Ishikawa, Kanagawa and Wakayama prefectures. The number of secondary cases generated by each primary case was calculated using contact tracing data.

**Results:** Of the 110 cases examined, 27 (24.6%) were primary cases who generated secondary cases. The odds that a primary case transmitted COVID-19 in a closed environment was 18.7 times greater compared to an open-air environment (95% confidence interval [CI]: 6.0, 57.9).

**Conclusions:** It is plausible that closed environments contribute to secondary transmission of COVID-19 and promote superspreading events. Our findings are also consistent with the declining incidence of COVID-19 cases in China, as gathering in closed environments was prohibited in the wake of the rapid spread of the disease.

## Introduction

Although the incidence of coronavirus disease 2019 (COVID-19) in China began to decrease in February 2020,[1] many countries are struggling with containment of the disease. To effectively reduce the spread of COVID-19, it is vital to identify common features of cases so as to better understand what factors promote superspreading events,[2] wherein an extraordinarily large number of secondary transmissions are produced by a single primary case. Commissioned by the Minister of the Ministry of Health, Labour, and Welfare of Japan, we collected secondary transmission data with the aim of identifying high risk transmission settings.

## Methods

As of 28 February 2020,[3] we examined a total of 110 cases among eleven clusters and sporadic cases, and investigated who acquired infection from whom. The clusters included four in Tokyo and one each in Aichi, Fukuoka, Hokkaido, Ishikawa, Kanagawa and Wakayama prefectures. All traced transmission events were examined in relation to close contact in indoor environments, including fitness gyms, a restaurant boat on a river, hospitals, and a snow festival where there were eating spaces in tents with minimal ventilation rate. The number of secondary cases generated by each primary case was calculated using contact tracing data.

## Results

Of the 110 cases examined, 27 (24.6%) were primary cases who generated secondary cases. Figure 1 shows the distribution of these transmissions, of which the mean and variance were 0.6 cases and 2.5 cases$^2$, respectively. The odds that a primary

case transmitted COVID-19 in a closed environment was 18.7 times greater compared to an open-air environment (95% confidence interval [CI]: 6.0, 57.9).

If superspreading events are defined as events where the number of secondary cases generated by a single primary case is greater than the 95th percentile of the distribution (i.e. transmission to three or more persons), then seven of the 110 cases (6.4%) were involved in such events. Six of these events (85.7%) took place in closed environments, and the odds ratio (OR) of superspreading events in closed environments was as high as 32.6 (95% CI: 3.7, 289.5).

## Discussion

It is plausible that closed environments contribute to secondary transmission of COVID-19 and promote superspreading events. Closed environments are consistent with environmental sampling study[4] and also large-scale COVID-19 transmission events such as that of the ski chalet-associated cluster in France and the church- and hospital-associated clusters in South Korea[5]. Our findings are also consistent with the declining incidence of COVID-19 cases in China, as gathering in closed environments was prohibited in the wake of the rapid spread of the disease.

Reduction of unnecessary close contact in closed environments may help prevent large case clusters and superspreading events. We hope that with such a reduction in contact the reproduction number of COVID-19 in Japan will be maintained below 1 and contact tracing will be sufficient to contain disease spread.[6] As the possibility of confounders and interactions was not assessed in this study, additional studies must be conducted to verify the importance of closed environments as facilitators for transmission of COVID-19.

## Conflict of interest:

We declare that we have no conflict of interest.

## Acknowledgement:

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## References:

1. The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. Vital Surveillances: The Epidemiological Characteristics of an Outbreak of 2019 Novel Coronavirus Diseases (COVID-19) — China, 2020. China CDC Weekly 2020;2(8):113-122.

2. Lloyd-Smith JO, Schreiber SJ, Kopp PE, Getz WM. Superspreading and the effect of individual variation on disease emergence. Nature 2005;438:355-359.

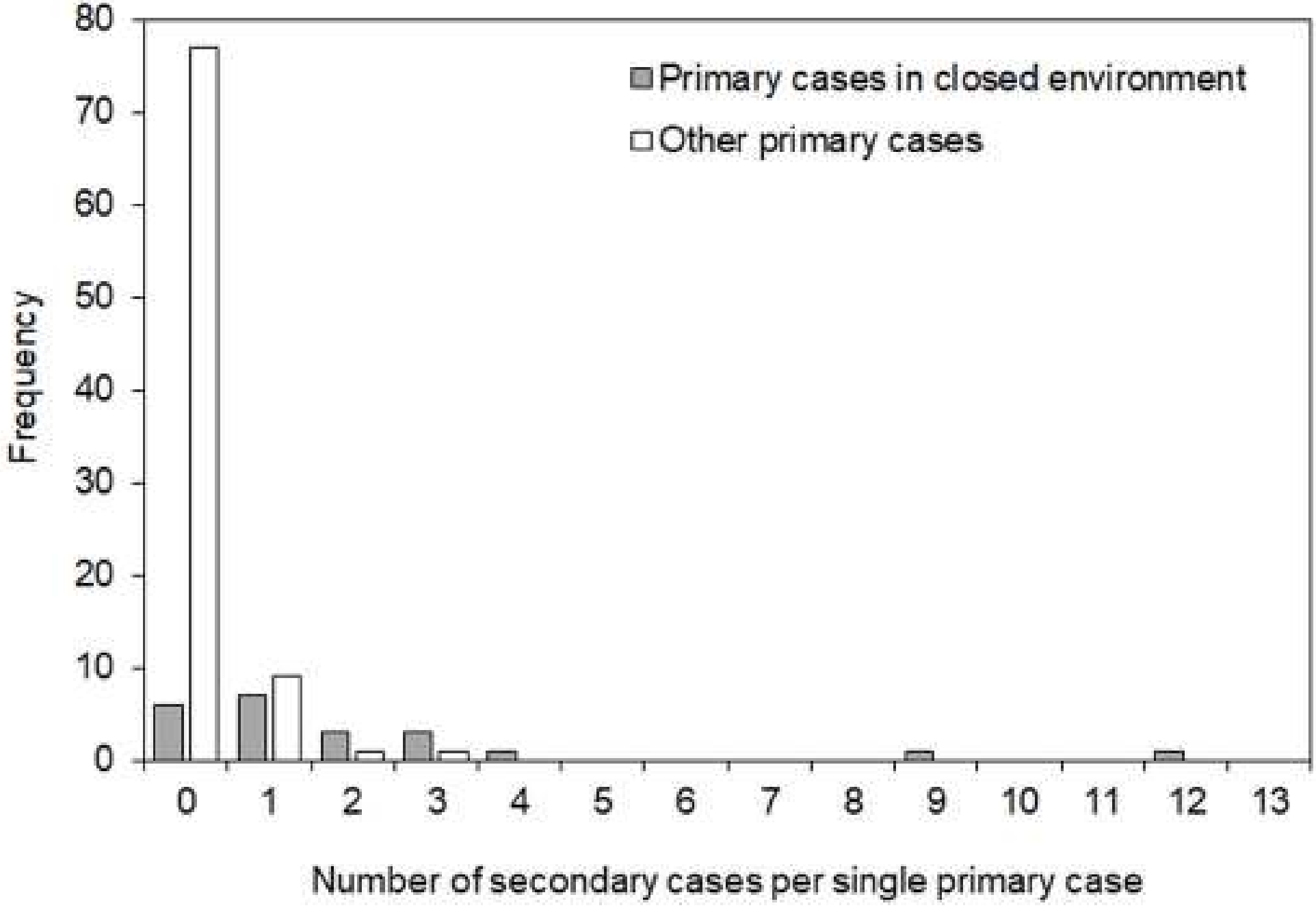
3. Ministry of Health, Labour and Welfare, Japan. On the novel coronavirus infection. Tokyo: Ministry of Health, Labour and Welfare, 2020. Available online from: https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000164708_00001.html (accessed on 26 February 2020).

4. Ong SWX, Tan YK, Chia PY, Lee TH, Ng OT, Wong MSY, Marimuthu K. Air,

109 Surface Environmental, and Personal Protective Equipment Contamination by Severe
110 Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic
111 Patient. JAMA. 2020; in press. doi: 10.1001/jama.2020.3227.
112 5. Promed mail. Subject: PRO/AH/EDR> COVID-19 update (19): China, global, Italy
113 & Iran. imported cases, WHO. Archive Number: 20200226.7029842
114 6. Grantz K, Metcalf JE, Lessler J. Dispersion vs. control. 2020. Available online from:
115 https://hopkinsidd.github.io/nCoV-Sandbox/DispersionExploration.html (accessed on
116 26 February 2020).
117

118 ## Figure legend

119 Figure 1. The distribution of the number of secondary cases generated by a single
120 primary case with novel coronavirus (COVID-19). The mean and variance were 0.6
121 cases and 2.5 cases$^2$, respectively.


Primary cases in closed environment
Other primary cases
Frequency
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13
Number of secondary cases per single primary case