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References

1. Wood G. Coronavirus could break Iranian society [cited 2020 Feb 29]. https://www.theatlantic.com/ideas/archive/2020/02/iran-cannot-handle-coronavirus/607150/
2. Viboud C, Simonsen L, Chowell G. A generalized-growth model to characterize the early ascending phase of infectious disease outbreaks. Epidemics. 2016;15:27–37. https://doi.org/10.1016/j.epidem.2016.01.002
3. Banks HT, Hu S, Thompson WC. Modeling and inverse problems in the presence of uncertainty: CRC Press; 2014.
4. Chowell G, Ammon CE, Hengartner NW, Hyman JM. Transmission dynamics of the great influenza pandemic of 1918 in Geneva, Switzerland: assessing the effects of hypothetical interventions. J Theor Biol. 2006;241:193–204. https://doi.org/10.1016/j.jtbi.2005.11.026
5. Chowell G, Shim E, Brauer F, Diaz-Dueñas P, Hyman JM, Castillo-Chavez C. Modelling the transmission dynamics of acute haemorrhagic conjunctivitis: application to the 2003 outbreak in Mexico. Stat Med. 2006;25:1840–57. https://doi.org/10.1002/sim.2352
6. Vynnycky E, White RG. An introduction to infectious disease modelling. Oxford (UK): Oxford University Press; 2010.
7. Nishiura H, Linton NM, Akhmetzhanov AR. Serial interval of novel coronavirus (COVID-19) infections. Int J Infect Dis. 2020;93:284–6. https://doi.org/10.1016/j.ijid.2020.02.060
8. Tuite AR, Bogoch II, Sherbo R, Watts A, Fisman D, Khan K. Estimation of coronavirus disease 2019 (COVID-19) burden and potential for international dissemination of infection from Iran. Ann Intern Med. 2020. https://doi.org/10.7326/M20-0696

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Cluster of Coronavirus Disease Associated with Fitness Dance Classes, South Korea

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During 24 days in Cheonan, South Korea, 112 persons were infected with severe acute respiratory syndrome coronavirus 2 associated with fitness dance classes at 12 sports facilities. Intense physical exercise in densely populated sports facilities could increase risk for infection. Vigorous exercise in confined spaces should be minimized during outbreaks.

By April 30, 2020, South Korea had reported 10,765 cases of coronavirus disease (COVID-19) (*1*); ≈76.2% of cases were from Daegu and North Gyeongsang provinces. On February 25, a COVID-19 case was detected in Cheonan, a city ≈200 km from Daegu. In response, public health and government officials from Cheonan and South Chungcheong Province activated the emergency response system. We began active surveillance and focused on identifying possible COVID-19 cases and contacts. We interviewed consecutive confirmed cases and found all had participated in a fitness dance class. We traced contacts back to a nationwide fitness dance instructor workshop that was held on February 15 in Cheonan.

Fitness dance classes set to Latin rhythms have gained popularity in South Korea because of the high aerobic intensity (*2*). At the February 15 workshop, instructors trained intensely for 4 hours. Among 27 instructors who participated in the workshop, 8 had positive real-time reverse transcription PCR (RT-PCR) results for severe acute respiratory syndrome coronavirus 2, which causes COVID-19; 6 were from Cheonan and 1 was from Daegu, which had the most reported COVID-19 cases in South Korea. All were asymptomatic on the day of the workshop.

By March 9, we identified 112 COVID-19 cases associated with fitness dance classes in 12 different sports facilities in Cheonan (Figure). All cases were confirmed by RT-PCR; 82 (73.2%) were symptomatic and 30 (26.8%) were asymptomatic at the time of laboratory confirmation. Instructors with very mild symptoms, such as coughs, taught classes for ≈1 week after attending the workshop

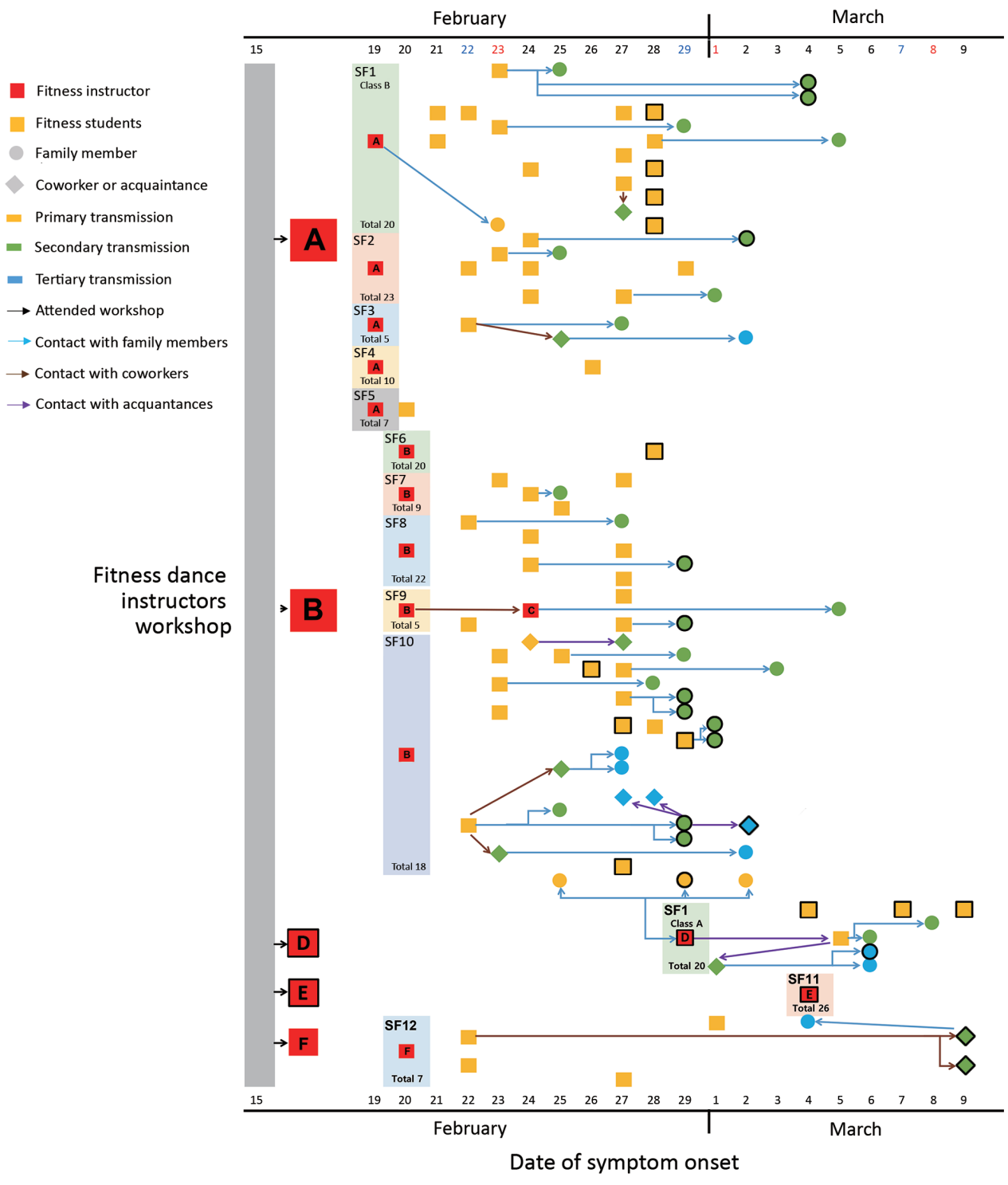

Figure. Case map of confirmed coronavirus disease (COVID-19) cases associated with fitness dance classes in Cheonan, South Korea, by date of symptom onset and relationship. Instructors outside of Cheonan are excluded. In 7 cases, transmission was suspected in the presymptomatic phase and the longest period before symptom onset was 5 days. None of the instructors had COVID-19 symptoms on the day of the workshop, but instructors from Daegu, which recently had a large outbreak, developed symptoms 3 days after the workshop. Sports facilities are represented by bars on the left with the number of students per class included. Bold outlines indicate a positive test for COVID-19 in a person in the presymptomatic phase.

(Appendix Figure 1, https://wwwnc.cdc.gov/EID/article/26/8/20-0633.App1.pdf). The instructors and students met only during classes, which lasted for 50 minutes 2 times per week, and did not have contact outside of class. On average, students developed symptoms 3.5 days after participating in a fitness dance class (*3*). Most (50.9%) cases were the result of transmission from instructors to fitness class participants; 38 cases (33.9%) were in-family transmission from instructors and students; and 17 cases (15.2%) were from transmission during meetings with coworkers or acquaintances.

Among 54 fitness class students with confirmed COVID-19, the median age was 42, all were women, and 10 (18.5%) had preexisting medical conditions (Appendix Table 1). The most common symptom at the time of admission for isolation was cough in 44.4% (24/54) of cases; 17 (31.5%) case-patients had pneumonia. The median time to discharge or end of isolation was 27.6 (range 13–66) days after symptom onset.

Before sports facilities were closed, a total of 217 students were exposed in 12 facilities, an attack rate of 26.3% (95% CI 20.9%–32.5%) (Appendix Table 2). Including family and coworkers, transmissions from the instructors accounted for 63 cases (Appendix Figure 2). We followed up on 830 close contacts of fitness instructors and students and identified 34 cases of COVID-19, translating to a secondary attack rate of 4.10% (95% CI 2.95%–5.67%). We identified 418 close contacts of 34 tertiary transmissions before the quarantine and confirmed 10 quaternary cases from the tertiary cases, translating to a tertiary attack rate of 2.39% (95% CI 1.30%–4.35%).

The instructor from Daegu who attended the February 15 workshop had symptoms develop on February 18 and might have been presymptomatic during the workshop. Evidence of transmission from presymptomatic persons has been shown in epidemiologic investigations of COVID-19 (*4*,*5*).

Characteristics that might have led to transmission from the instructors in Cheonan include large class sizes, small spaces, and intensity of the workouts. The moist, warm atmosphere in a sports facility coupled with turbulent air flow generated by intense physical exercise can cause more dense transmission of isolated droplets (*6*,*7*). Classes from which secondary COVID-19 cases were identified included 5–22 students in a room ≈60 m^2 during 50 minutes of intense exercise. We did not identify cases among classes with <5 participants in the same space. Of note, instructor C taught Pilates and yoga for classes of 7–8 students in the same facility at the same time as instructor B (Figure; Appendix Table 2), but none of her students tested positive for the virus. We hypothesize that the lower intensity of Pilates and yoga did not cause the same transmission effects as those of the more intense fitness dance classes.

A limitation of our study is the unavailability of a complete roster of visitors to the sports facilities, which might have meant we missed infections among students during surveillance and investigation efforts. Discovery of outbreak cases centered on exercise facilities led to a survey of instructors who participated in a fitness dance workshop and provided clues to identifying additional cases among students. Early identification of asymptomatic persons with RT-PCR–confirmed infections helped block further transmissions. Because of the increased possibility of infection through droplets, vigorous exercise in closely confined spaces should be avoided (*8*) during the current outbreak, as should public gatherings, even in small groups (*9*,*10*).

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References

1. Korea Centers for Disease Control and Prevention. Current status of the coronavirus disease 2019 (COVID-19) outbreak in Republic of Korea [in Korean] [cited 2020 Apr 30]. http://ncov.mohw.go.kr
2. Vendramin B, Bergamin M, Gobbo S, Cugusi L, Duregon F, Bullo V, et al. Health benefits of Zumba fitness training: a systematic review. PM R. 2016;8:1181–200. https://doi.org/10.1016/j.pmrj.2016.06.010
3. Korea Centers for Disease Control and Prevention. Updates on COVID-19 in Korea as of 5 March 2020 [cited 2020 Mar 5]. https://www.cdc.go.kr/board/board.es?mid=a30402000000&bid=0030
4. Tong ZD, Tang A, Li KF, Li P, Wang HL, Yi JP, et al. Potential presymptomatic transmission of SARS–CoV–2, Zhejiang Province, China, 2020. Emerg Infect Dis. 2020;26:1052–4. https://doi.org/10.3201/eid2605.200198

5. Arons MM, Hatfield KM, Reddy SC, Kimball A, James A, Jacobs JR, et al. Presymptomatic SARS-CoV-2 infections and transmission in a skilled nursing facility. N Engl J Med. 2020 Apr 24 [Epub ahead of print]. https://doi.org/10.1056/NEJMoa2008457
6. Bourouiba L. Turbulent gas clouds and respiratory pathogen emission: potential implications for reducing transmission of COVID-19. JAMA. 2020 Mar 26 [Epub ahead of print]. https://doi.org/10.1001/jama.2020.4756
7. van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. N Engl J Med. 2020;382:1564–7. https://doi.org/10.1056/NEJMc2004973
8. Andrade A, Dominski FH, Pereira ML, de Liz CM, Buonanno G. Infection risk in gyms during physical exercise. Environ Sci Pollut Res Int. 2018;25:19675–86. https://doi.org/10.1007/s11356-018-1822-8
9. Musher DM. How contagious are common respiratory tract infections? N Engl J Med. 2003;348:1256–66. https://doi.org/10.1056/NEJMra021771
10. Ebrahim SH, Memish ZA. COVID-19 - the role of mass gatherings. Travel Med Infect Dis. 2020 Mar 9 [Epub ahead of print]. https://doi.org/10.1016/j.tmaid.2020.101617

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Infectious SARS-CoV-2 in Feces of Patient with Severe COVID-19

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Severe acute respiratory syndrome coronavirus 2 was isolated from feces of a patient in China with coronavirus disease who died. Confirmation of infectious virus in feces affirms the potential for fecal–oral or fecal–respiratory transmission and warrants further study.

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) recently emerged in China, causing a major outbreak of severe pneumonia and spreading to >200 other countries (*1*). As of May 5, 2020, a total of 3,517,345 cases of coronavirus disease (COVID-2019) and 243,401 deaths had been reported to the World Health Organization (https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200505covid-19-sitrep-106.pdf?sfvrsn=47090f63_2). The virus is believed to be spread by direct contact, fomites, respiratory droplets, and possibly aerosols (*2*). Viral RNA has been detected in feces and urine of some patients (*3*–*7*). Infectious virus was also isolated from urine of a patient with severe COVID-19 (*8*). However, it is unclear whether the virus in feces is infectious and might be an additional source for transmission.

This study was approved by the Health Commission of Guangdong Province and the Ethics Committees of Guangzhou Medical University to use patient and healthy donor sample specimens. On January 17, 2020, a 78-year-old man who had a history of recent travel to Wuhan, China, was admitted to the Fifth Affiliated Hospital of Sun Yat-Sen University because of a cough for 7 days and intermittent fever (Appendix Figure 1, panel A, https://wwwnc.cdc.gov/EID/article/26/8/20-0681-App1.pdf). Computed tomography of his chest showed multiple, ground-glass opacities (Appendix Figure 2). Nasopharyngeal and oropharyngeal swab specimens were positive for SARS-CoV-2 RNA by quantitative reverse transcription PCR (qRT-PCR).

On January 22, the patient's condition deteriorated and he was intubated. Ventilator-assisted breathing was instituted. The first feces specimen was collected on January 27 and was positive for viral RNA by qRT-PCR. Serial feces samples were collected on January 29, February 1, and February 7. All samples were positive for viral RNA (Appendix Figure 1, panel A). Viral antigen was also detected in gastrointestinal epithelial cells of a biopsy sample, as reported (*9*). The patient died on February 20.

We collected fecal specimens on January 29 to inoculate Vero E6 cells. Cycle threshold values for the fecal sample were 23.34 for the open reading frame 1lab gene and 20.82 for the nucleoprotein gene. A

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Appendix

Appendix Table 1. Clinical characteristics of 54 persons with diagnosed coronavirus disease who participated in fitness dance classes, South Korea*

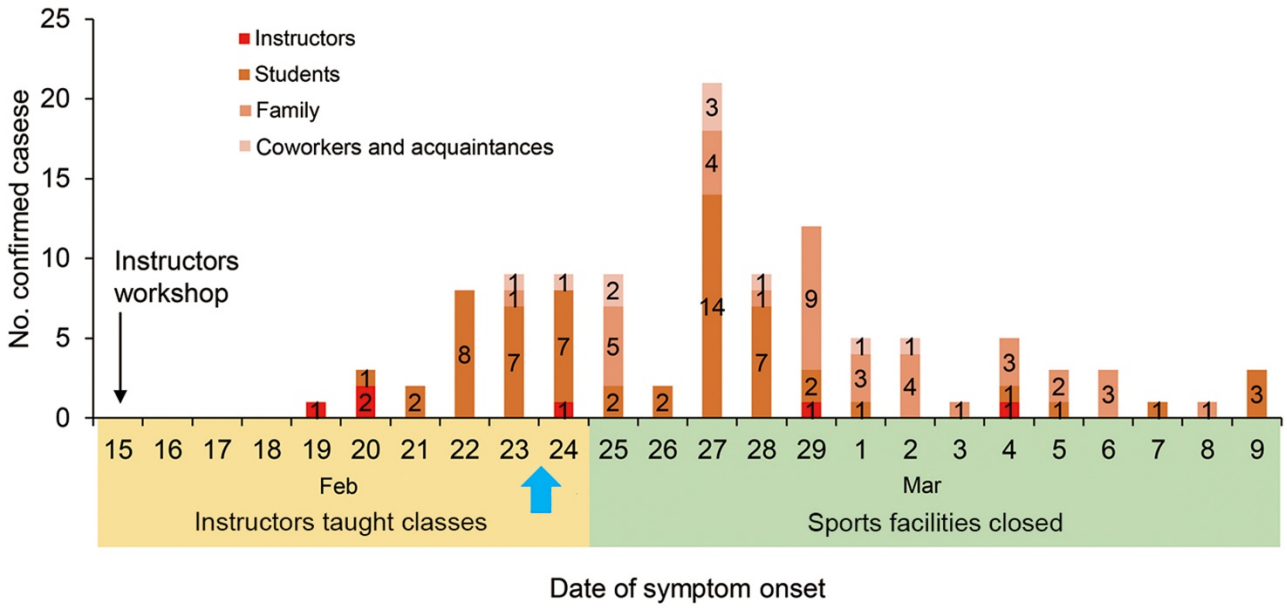
Characteristics	No. (%)
Age, y (mean ± standard deviation)	41.6 ± 10.2
Sex	
M	0
F	54 (100)
Preexisting conditions	10 (18.5)
Hypertension	4 (7.4)
Diabetes	4 (7.4)
Chronic obstructive pulmonary disease	1 (1.9)
Congestive heart failure	0
Chronic kidney disease	1 (1.9)
Chronic liver disease	2 (3.7)
Malignancy	2 (3.7)
Body mass index, kg/m^2†	22.8 ± 3.04
Symptoms at admission	
Fever (>37.5°C)	13 (24.1)
Chills	17 (31.5)
Cough	24 (44.4)
Sputum	22 (40.7)
Dyspnea	4 (7.4)
Rhinorrhea	15 (27.8)
Sore throat	20 (37.0)
Nausea	2 (3.7)
Diarrhea	12 (22.2)
Abdominal pain	2 (3.7)
Myalgia	14 (25.9)
Headache	12 (22.2)
Anosmia or taste abnormality	3 (5.6)
Laboratory findings	
Blood leukocyte count, reference range 4.0–11.0 × 10^9/L	
≤4.0 × 10^9/L	16 (29.6)
>4.0 × 10^9/L	38 (70.4)
Lymphocyte count; reference range 1.0–3.4 × 10^9/L†	1.554 ± 0.556 × 10^9/L
Lymphopenia, <1.0 × 10^9/L	8 (14.8)
Platelet count, reference range 182–369 × 10^9/L	
≤150 × 10^9/L	2 (3.7)
>150 × 10^9/L	52 (96.3)
Hemoglobin; reference range 11.2–15.7 g/dL†	13.4 ± 1.48 g/dL
C-reactive protein level ≥10 mg/L	5 (9.26)
Procalcitonin level ≥0.5 ng/mL	0
Lactate dehydrogenase ≥250 IU/L	40 (74.1)
Creatinine ≥133 µmol/L	0
Alanine aminotransferase >40 IU/L	5 (9.26)
Infiltration in chest x-ray	15 (27.8)
Infiltration in computed tomography	17 (31.5)
Bilateral infiltration	10 (58.8)
Unilateral infiltration	7 (41.2)
Predominantly ground glass opacity	15 (88.2)
Predominantly consolidation	2 (11.8)
Supplementary oxygen	1 (1.9)

*Characteristics and clinical findings at time of isolation or hospital admission.
†Mean ± standard deviation

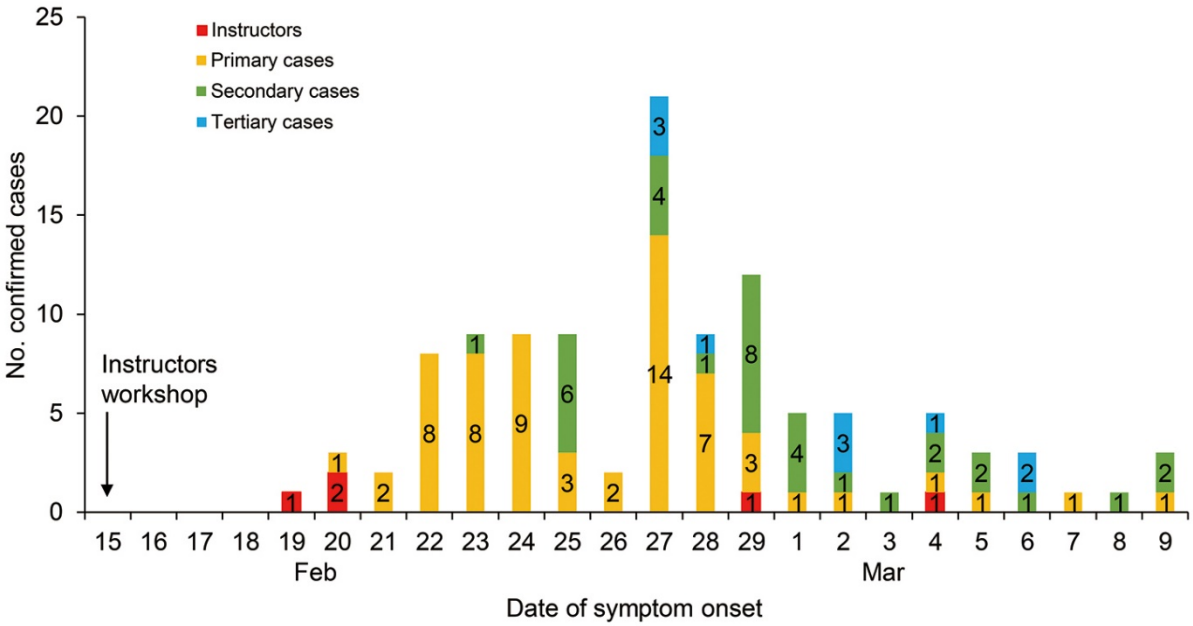
Appendix Table 2. Attack rate by instructor and sports facility during an outbreak of coronavirus disease associated with fitness dance classes, South Korea, 2020

Instructor, sports facility	Potentially exposed, no.	Confirmed, no.	Attack rate, % (95% CI)
Instructor A			
Sports facility 1	20	14	70 (48.1–85.5)
Sports facility 2	23	7	30.4 (15.6–50.9)
Sports facility 3	5	1	20.0 (3.6–62.5)
Sports facility 4	10	1	10.0 (1.8–40.4)
Sports facility 5	7	1	14.3 (2.6–51.3)
Instructor B			
Sports facility 6	20	1	5 (0.9–23.6)
Sports facility 7	9	4	44.4 (18.9–73.3)
Sports facility 8	22	5	22.7 (10.1–43.4)
Sports facility 9*	5	3	60.0 (23.1–88.2)
Sports facility 10	18	12	66.7 (43.8–83.7)
Instructor C, sports facility 9	25	0	0
Instructor D	20	4	20.0 (8.1–41.6)
Instructor E	26	0	0
Instructor F	7	4	57.1 (25.1–84.2)
Total	217	57	26.3 (20.9–32.5)

*Instructor C taught Pilates and yoga in the same facility as Instructor B. Instructor C tested positive for coronavirus disease, but her students did not test positive for coronavirus, possibly because her fitness classes were lower intensity than those of instructors teaching fitness dance classes.



Appendix Figure 1. Epidemic curve of laboratory-confirmed coronavirus disease (COVID-19) cases in Cheonan, South Korea, by date of symptom onset and relationship. Blue arrow indicates date that South Korea raised the alert level for COVID-19 to the highest level and requested cooperation for reduction or closure of multi-dense facilities as a part of social and physical distancing policy.



Appendix Figure 2. Epidemic curve of laboratory-confirmed coronavirus disease (COVID-19) cases in Cheonan, South Korea, by date of symptom onset and relationship. February 15, 2020 marks the date of a workshop for fitness dance instructors in Cheonan.