**Abstract**

# Quantitative Analysis of a Coronavirus Disease 2019 (COVID-19) Call Center Outbreak, South Korea

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Worldwide, it is generally accepted that crowded office settings such as call centers pose a high risk for the spread of Coronavirus Disease-19 (COVID-19). Through a quantitative analysis of the results of a COVID-19 outbreak at a call center in Korea, this study aimed to identify the risk factors of transmission. In February 2021, a total of 121 call center related COVID-19 cases were reported, including 93 call center employees and 28 secondary cases.

Online surveys, CCTV analysis for contact tracing measures and indoor air propagation environments were evaluated to identify the general characteristics. Epi-curves of confirmed case were collected through epidemiological surveys and assess the implementation of 'daily life quarantine' was assessed. Daily life quarantine is a term coined by the Korean Ministry of Health and Welfare to describe a social distancing level that allows people to engage in certain economic and social activities under specified conditions such as mask wearing. The incidence rate on the fourth floor of the call center, where the first confirmed case occurred, was 47.9%, the highest among the which was 78.3%. According to a survey on the implementation of daily life quarantine, 41.5% of confirmed case and 58.5% of non-confirmed case wore Korean Filter 94 (KF94) masks (masks regulated by the Korean Ministry of Food and Drug Safety [MFDS]) while 40.4% of confirmed case and 59.5% of non-confirmed case wore non-KF94 masks as 38.9% of the CCTV analysis showed. As a result of this study's air diffusion experiment, a change in concentration the air was observed from the seat of the first confirmed cases to a case that sat at the center of team C. It was therefore, determined that the cross infection was a result of the virus spreading through air diffusion.

This study concluded that it is important for governments to establish specific quarantine measures in the facilities that house call centers (mask-wearing daily life, entry and exit management, symptom management, ventilation check, etc.) and for organizations to create work  environments in which daily life quarantine can be properly implemented.

**Keywords:** Coronavirus Disease-19 (COVID-19), Call-Center, Outbreak, Epidemiology

**Table 1.** General Characteristics (n=121)

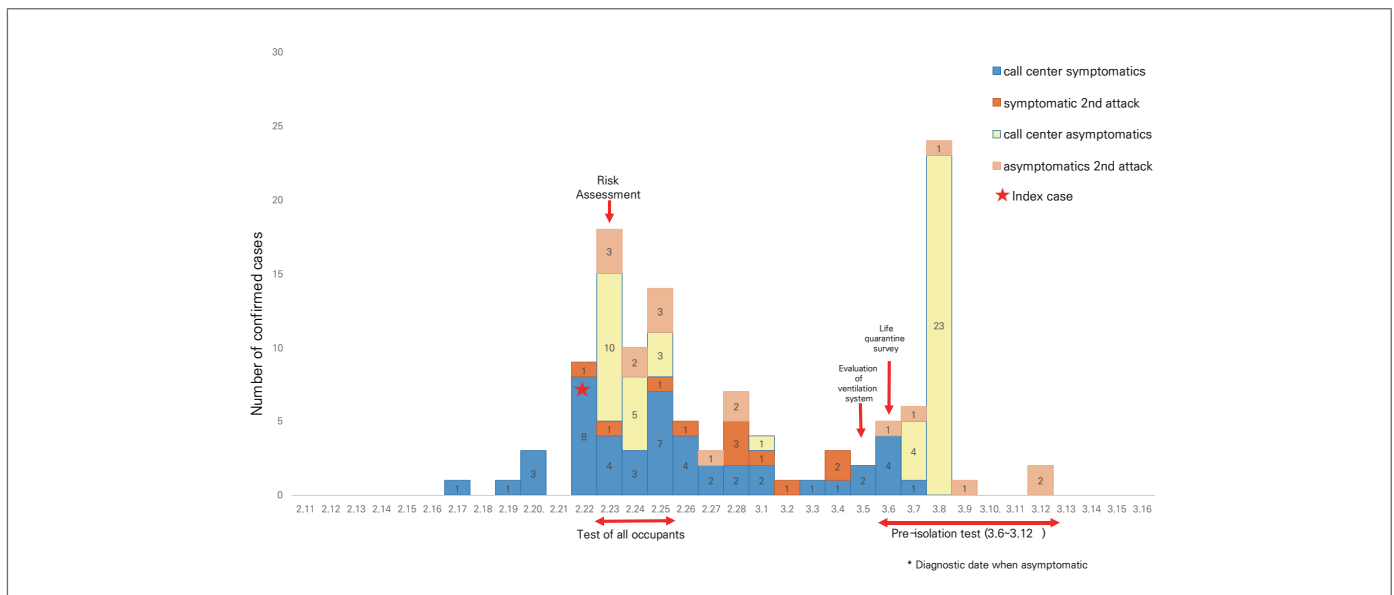| Demographics | | No. (%) |
|---|---|---|
| Gender | Female | 109 (90.1) |
| | Male | 12 (9.9) |
| Age | 〈 20 | 6 (5.0) |
| | 20−29 | 11 (9.1) |
| | 30−39 | 14 (11.6) |
| | 40−49 | 34 (28.1) |
| | 50−59 | 36 (29.8) |
| | ≥60 | 20 (16.5) |
| Presence of Symptoms | Symptomatic | 57 (47.1) |
| | Asymptomatic | 64 (52.9) |



**Figure 1.** A−call center epi−curve

Table 2. Incidence rate by floor

| Location type and floor | | Exposed | Confirmed | Attack, % (95% CI) |
|---|---|---|---|---|
| | | No. (%) | No. (%) | |
| Total | | 1,457 (100.0) | 93 (100.0) | 6.4 (5.2–7.7) |
| Call center total | | 820 (56.3) | 91 (97.8) | 11.1 (9.1–13.5) |
| 3th | Call center / B office | 74 (9.0) | 4 (4.4) | 5.4 (2.1–13.1) |
| 4th | Call center (east) | 119 (14.5) | 56 (61.5) | 47.1 (37.9–56.4) |
| | Call center (west) | 101 (12.3) | 3 (3.3) | 3.0 (0.8–9.1) |
| 5th | Call center | 220 (26.8) | 17 (18.7) | 7.7 (4.7–12.3) |
| 6th | Call center | 31 (3.8) | 3 (3.3) | 9.7 (3.3–24.9) |
| 10th | Call center (edu center) | 15 (1.8) | – | – |
| 12th | Call center (H) | 260 (31.7) | 8 (8.8) | 3.1 (1.4–6.2) |
| Others Floor | | 637 (43.7) | 2* (2.2) | 0.3 (0.1–1.3) |

*4, 6 floor cleaning staff

Table 3. Household secondary attack rate, by presence of symptoms

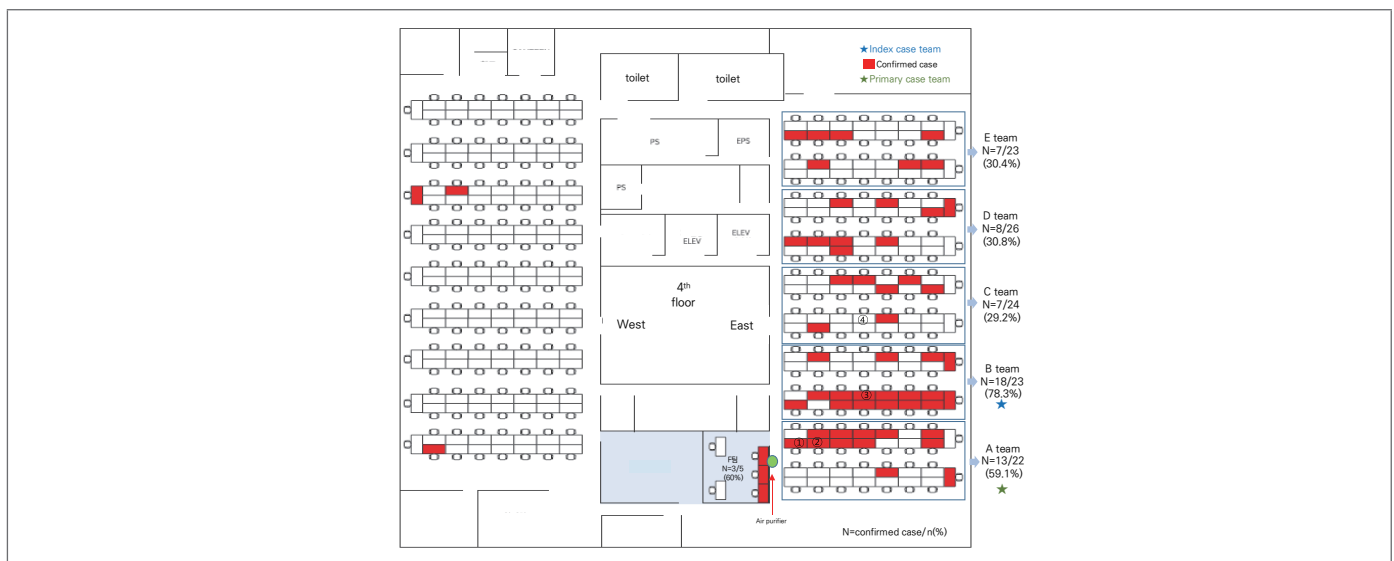| Variables | Exposed | Confirmed case | Attack, % (95% CI) |
|---|---|---|---|
| | No. (%) | No. (%) | |
| Total | 189 (100.0) | 13 (100.0) | 6.9 (3.9–11.7) |
| Symptomatic | 83 (43.9) | 8 (61.5) | 9.6 (4.6–18.6) |
| Asymptomatic | 106 (56.1) | 5 (38.5) | 4.7 (1.8–11.2) |



Figure 2. Incidence rate on the fourth floor (n=59)

Table 4. General characteristics and rate of daily life quarantine

| Characteristics | No.(%) of attendees | | | OR* (95% CI§) | aOR† (95% CI§) |
| --- | --- | --- | --- | --- | --- |
| | Total (n=106) | With COVID−19 (n=46) | Without COVID−19 (n=60) | | |
| Gender | | | | | |
| Male | 5 (4.7) | 1 (2.2) | 4 (6.7) | Ref. | Ref. |
| Female | 101 (95.3) | 45 (97.8) | 56 (93.3) | 3.2 (0.34−29.77) | 4.2 (0.40−44.86) |
| Age | | | | | |
| 〈 40 | 15 (14.2) | 9 (19.6) | 6 (10.0) | Ref. | Ref. |
| 40−49 | 33 (31.1) | 14 (30.4) | 19 (31.7) | 0.5 (0.14−1.70) | 0.5 (0.12−1.85) |
| 50−59 | 47 (44.3) | 19 (41.3) | 28 (46.7) | 0.5 (0.13−1.48) | 0.4 (0.10−1.38) |
| ≥60 | 11 (10.4) | 4 (8.7) | 7 (11.7) | 0.4 (0.07−1.89) | 0.4 (0.06−2.39) |
| Type of Mask | | | | | |
| KF94 | 53 (50.0) | 22 (47.8) | 31 (51.7) | Ref. | Ref. |
| Surgical mask | 46 (43.4) | 22 (47.8) | 24 (40.0) | 1.3 (0.58−2.86) | 1.2 (0.50−2.85) |
| Other (Cloth, Acryl mask) | 7 (6.6) | 2 (4.3) | 5 (8.3) | 0.6 (0.10−3.17) | 0.4 (0.06−2.62) |
| Wearing a mask when making a call (n=104) | | | | | |
| sometimes 〈50% | 47 (45.2) | 23 (50.0) | 24 (41.4) | 1.4 (0.65−3.08) | 1.2 (0.52−2.84) |
| Mostly ≥50% | 57 (54.8) | 23 (50.0) | 34 (58.6) | Ref. | Ref. |
| Hand hygiene | | | | | |
| Sometimes 〈50% | 11 (10.4) | 7 (15.2) | 4 (6.7) | 2.5 (0.68−9.17) | 3.6 (0.82−15.62) |
| Mostly ≥50% | 95 (89.6) | 39 (84.8) | 56 (93.3) | Ref. | Ref. |

*OR, Odds ratio; †aOR, Adjust Odds ratio, CI§ : Confidence interval
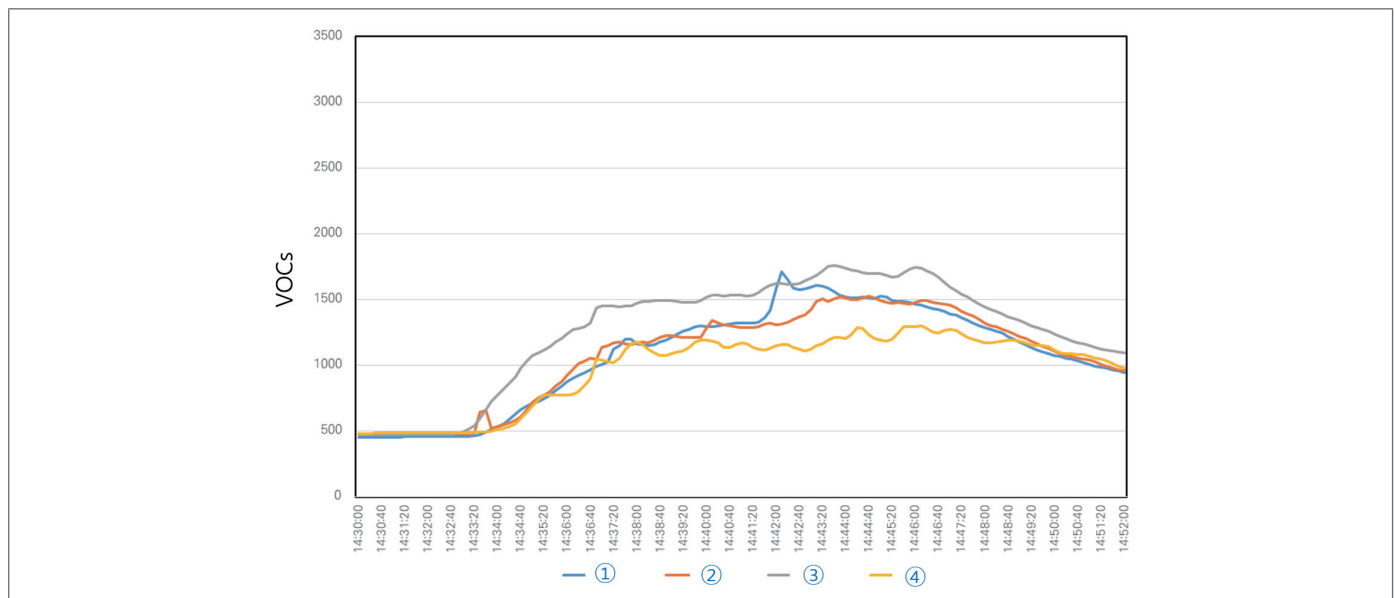


Figure 3. Distribution of particle concentration by location when the air conditioner is turned on and EHP is operated (Particle Generation Location: Point 1)
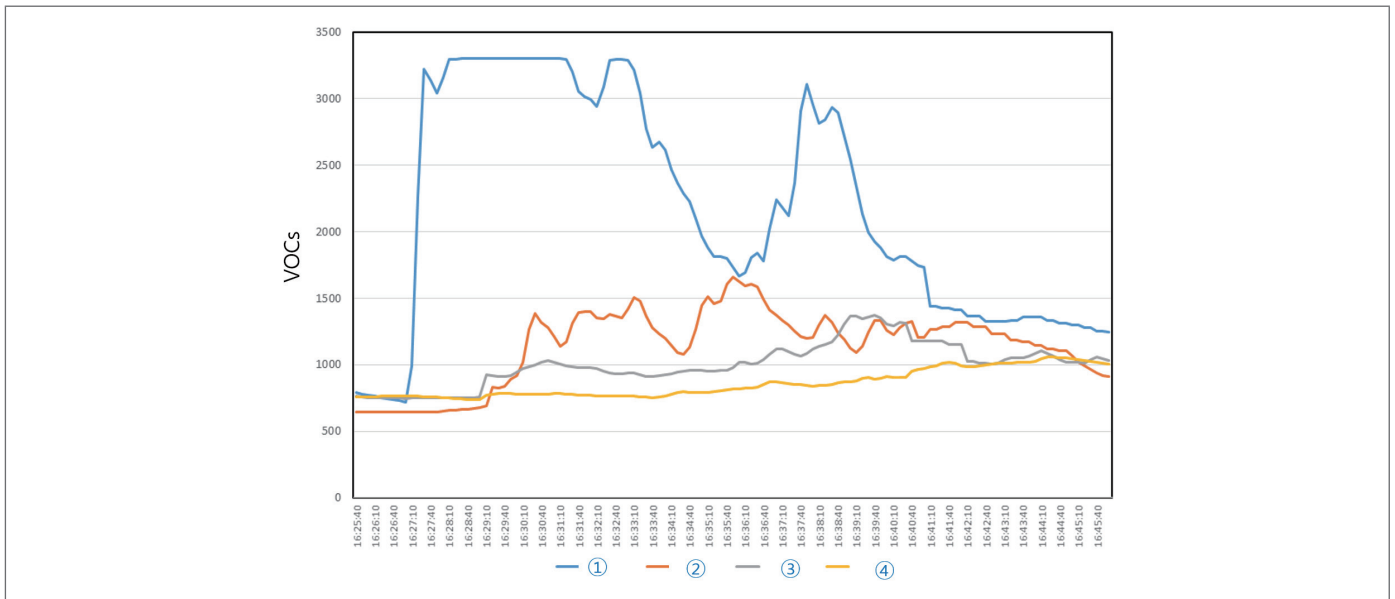
**Figure 4.** Distribution of particle concentration by location when the air conditioner is turned off and EHP is operated (Particle Generation Location: Point 1)