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Original Article
Infectious Diseases, Microbiology & Parasitology

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Coronavirus Disease 2019 Cases at Universities and Colleges in Seoul Metropolitan Area

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ABSTRACT

Background: To facilitate evidence-based policy-making on safe reopening of higher education facilities, there is an urgent need to assess baseline profile of coronavirus disease 2019 (COVID-19) incidents within the university/college settings. We aimed to describe the epidemiology of COVID-19 in universities/colleges in Seoul Metropolitan Area during COVID-19 pandemic period.

Methods: Among the 38 universities in Seoul, 23 have agreed to participate in the study. Confirmed COVID-19 cases were identified from individual-level case reports submitted to the universities and to the health authorities from February 1, 2020, to June 30, 2021. Through the linkage with the Central Disease Control Headquarters' database, number of secondary infected cases (both within and outside of the campus) were counted.

Results: Between February 2020 and June 2021, a total of 827 COVID-19 cases were confirmed and reported in the universities across Seoul Metropolitan City. Generally, the community-associated cases had peaks preceding the university/college-associated. Of those with the documented clinical parameters, 38.6% of the cases were asymptomatic. Among them, 93% were potentially exposed off-campus, and 87.7% of the cases had not produced the secondary infection cases.

Conclusion: In the setting of rigorous infection prevention measures in combination with on- and off- hybrid classes, COVID-19 incidences and outbreaks were limited in university and college campus area across Seoul Metropolitan Area. The evidence around the infection preventive measures in higher education facilities in Seoul Metropolitan Area, suggest insignificant impact on community transmission.

Keywords: Coronavirus; COVID-19; University; College; Epidemiology

INTRODUCTION

Closing of educational facilities due to coronavirus disease 2019 (COVID-19) pandemic have resulted significant disruptions to higher educations across the globe.[1,2] Young adults, although have shown least amount of concern on severe COVID-19 compared to elderly population, are among the most affected by the societal impact and economic crisis as a result of COVID-19 responding measures.[3] While there is evidence that young adults are

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effective at transmitting the severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2), many outbreaks have occurred at locations without protective measures in place, outside of the educational settings.[4,5]

Since mid-March 2020, many universities and colleges in South Korea have shifted to online learning environment.[6] Unfortunately, initial reports show that the core competencies and academic achievements of students were significantly lower in 2020 than before the COVID-19 pandemic.[7,8] Without clear and consistent public health leadership and guidance on COVID-19 preventive measures in universities/colleges, individual campuses are left with non-standardized, uncoordinated responses which then result in risk of transmission to the community.[9,10]

To facilitate evidence-based policy-making on safe reopening of higher education facilities, there is an urgent need to assess baseline profile of COVID-19 incidents within the university/college settings. In such view, we aimed to describe the epidemiology of COVID-19 in universities/colleges in Seoul Metropolitan Area during COVID-19 pandemic period, therefore to have better understanding on transmission risks and to inform policy-making in regard to on-campus preventive measures.

METHODS

As the COVID-19 outbreak trend and the population size of universities vary for each region, the government allowed autonomy to local governments and universities when deciding the specifics of managing response scheme, operating online and offline classes in parallel, splitting each class into morning and afternoon groups, and implementing flexible class hours. In specific, the methods include: 1) government's on-site support offered to colleges and universities as part of COVID-19 pandemic (February-March 2020); 2) postponement of school openings and providing online classes (February 2020-); 3) plan to provide financial support for disadvantaged college students developed (April 2020); 4) stepwise reopening of the classes (May 2020); 5) disinfection guidelines (May 2020); 6) physical spacing and density managements (May 2020); and 7), tracked international students from the point of their arrival (February 2020-).[11]

Among the 38 universities in Seoul, 23 have agreed to participate in the study (**Supplementary Fig. 1**). The background population include: 234,891 undergraduate students, 83,067 graduate students, 42,712 professors/lecturers and 10,624 staffs. Individual university/college's COVID-19 surveillance set linked to the Central Disease Control Headquarters' database was used to identify the epidemiologic trend of COVID-19 in universities in Seoul. The linked database was derived from epidemiologic investigation files, collected through a legally mandated public health investigation under the authority of the Korean Infectious Diseases Control and Prevention Act (No. 12444 and No. 13392).[12] Confirmed COVID-19 cases were identified from individual-level case reports submitted to the universities and to the health authorities from February 1, 2020, to June 30, 2021. The incidence density on new cases from corresponding age group during each epidemiologic week was calculated. Following the merging of datasets, personal identifiable data were deleted and were not included in the analyses.

Demographics including age, gender, nationality, and status (undergrad student, grad student, professor/lecturer, staffs) were assessed. For those available, clinical parameters were collected during the encounter of the cases during COVID-19 laboratory testing. The routes of testing

(symptom-based, contact-based, random screening, inbound travelers screening) were assessed. School seasons during the encounter of the cases were classified as: online class, offline class, and summer/winter break. Potential routes of transmission were classified as: off-campus vs. on-campus (large lecture hall, midsize/small lecture room, lab spaces, restaurant/cafeteria) based on the epidemiological investigation. Self-reported mean daily time of stay at the university/college was assessed, and was stratified into: < 3 hours, 3–6 hours, and > 6 hours. Through the linkage with the Central Disease Control Headquarters' database, number of secondary infected cases (both within and outside of the campus) were counted.

Ethics statement

This study was approved by the Korea University Institutional Review Board (IRB No. 2021AN0421).

RESULTS

Between February 2020 and June 2021, a total of 827 COVID-19 cases were confirmed and reported in the universities across Seoul Metropolitan City. The age group of 20–29 years comprised 65.1% of the cases, with 21% foreign nationals and 53.8% of undergrad students (**Table 1**). **Fig. 1** depicts the epidemic curve for community-associated versus university/college-associated COVID-19 cases in Seoul Metropolitan Area, during the surveillance weeks. Generally, the community-associated cases had peaks preceding the university/college-associated cases; however, with exception during the 46-52nd surveillance week of the year 2020. Between 4th epidemiologic week of 2020 and 24th epidemiologic week of 2021, the average incidence density for community-associated student cases was 41 per 1 million; university-associated student cases was 25 per 1 million; and national 20–29 years cases was 47 per 1 million.
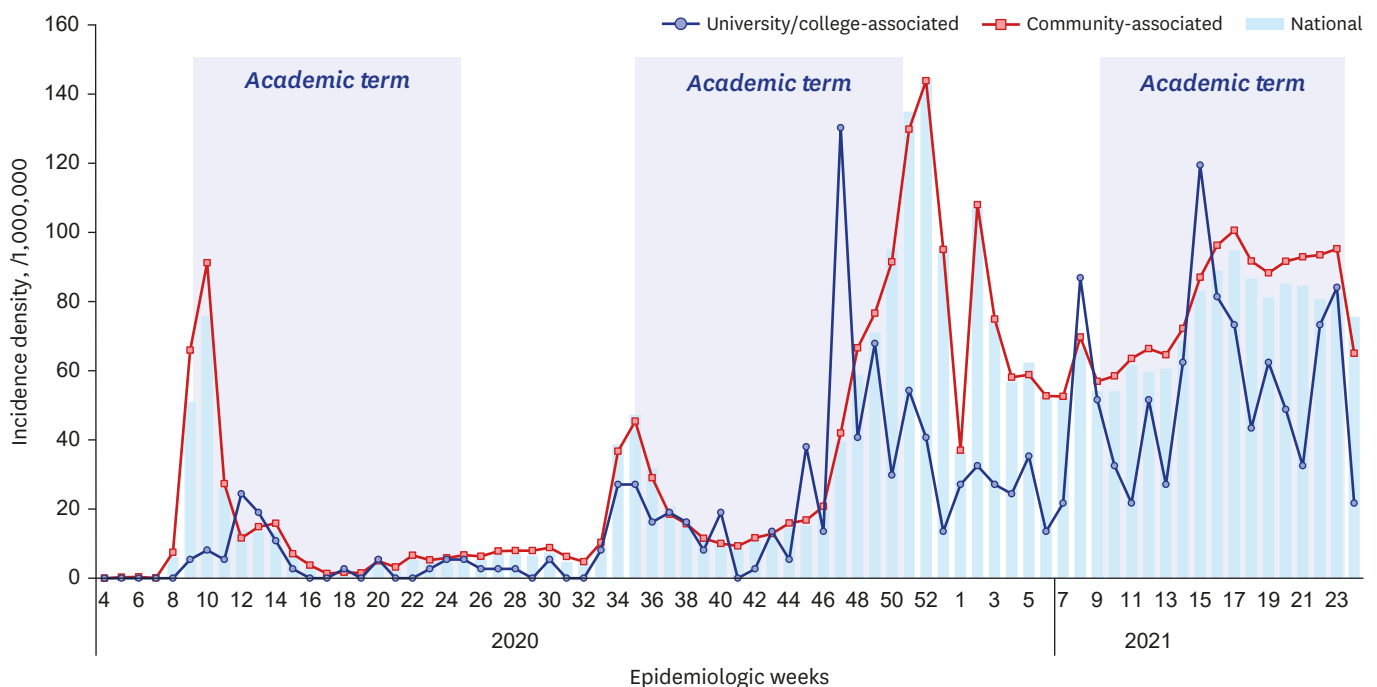

Fig. 1. Epidemic curve for community-associated vs. university/college-associated severe acute respiratory syndrome-coronavirus-2 laboratory-confirmed cases, Seoul Metropolitan Area, Feb. 2020–Jun. 2021.

Table 1. Demographic characteristics of university/college-associated coronavirus disease 2019 laboratory-confirmed cases, Seoul Metropolitan Area, Feb. 2020–Jun. 2021

Variables	No. (%)
Age group, yr	
10–19	55 (6.7)
20–29	538 (65.1)
30–39	78 (9.4)
40–49	45 (5.4)
50–59	27 (3.3)
≥ 60	22 (2.7)
Unknown	62 (7.5)
Gender	
Female	428 (51.8)
Male	395 (47.8)
Unknown	4 (0.5)
Nationality	
Korean national	633 (76.5)
Foreign national	174 (21.0)
Unknown	20 (2.4)
Status[a]	
Undergrad student	445 (53.8)
Grad student	160 (19.3)
Professor/lecturer	55 (6.7)
Staffs	54 (6.5)
Unknown	112 (13.5)

[a]Background population as follows: 234,891 undergrad students, 83,067 graduate students, 42,712 professor/lecturers, and 10,624 staff members.

Of those with the documented clinical parameters, respiratory symptom (25.4%) was the most common symptom, followed by fever/chill (19.7%), and myalgia/muscle ache (10.7%) (**Table 2**). Of note, 38.6% of the cases were confirmed with COVID-19 while they had no symptoms ascribed to the infections.

A total of 62.1% of the cases were identified through contact-based screening, followed by 23.2% with symptom-based testing and 9.9% of random screened cases (**Table 3**). Of them, 50.9% were infected during the online class season, followed by 31.2% during offline class season. A total of 93% of the cases were potentially exposed off-campus, while lab spaces (arts, sciences) comprised largest portion of the on-campus transmissions (4.3% of all). 52.1% of infected cases had spent less than 3 hours per day on average at the campus. 87.7% of the cases had not produced the secondary infection cases, while 10.4% had resulted 1–3 cases of secondary cases. Among 144 cases identified to have linkage with off-campus clusters, 58 cases were associated with community-based clusters, seven cases were with imported cluster, and four cases were associated with healthcare-associated transmission.

Table 2. Clinical parameters of university/college-associated severe acute respiratory syndrome-coronavirus-2 laboratory-confirmed cases, Seoul Metropolitan Area, Feb. 2020–Jun. 2021

Symptoms	Undergrad student	Grad student	Professor/lecturer	Staff	Total
Fever/chill	73 (18.3)	27 (18.5)	11 (22.9)	16 (30.2)	127 (19.7)
Myalgia/muscle ache	43 (10.8)	17 (11.6)	2 (4.2)	7 (13.2)	69 (10.7)
Respiratory symptoms	108 (27.1)	29 (19.9)	13 (27.1)	14 (26.4)	164 (25.4)
Gastrointestinal symptoms	2 (0.5)	3 (2.1)	1 (2.1)	0 (0.0)	6 (0.9)
Anosmia/ageusia	19 (4.8)	10 (6.8)	1 (2.1)	0 (0.0)	30 (4.7)
Asymptomatic[a]	153 (38.4)	60 (41.1)	20 (41.7)	16 (30.2)	249 (38.6)
Total	398	146	48	53	645

Values are presented as number (%).
[a]P = 0.568 for asymptomatic rates among undergrad vs. grad students; P = 0.231 for asymptomatic rates among professor/lecturer vs. staff.

Table 3. Transmission of university/college-associated severe acute respiratory syndrome-coronavirus-2 laboratory-confirmed cases, Seoul Metropolitan Area, Feb. 2020–Jun. 2021

Identification of cases	Undergrad student	Grad student	Professor/lecturer	Staff	Total
Testing route					
Symptom-based testing	95 (24.8)	32 (21.6)	10 (20.8)	9 (18.4)	146 (23.2)
Contact-based screening	236 (61.6)	81 (54.7)	37 (77.1)	36 (73.5)	390 (62.1)
Random screening	38 (9.9)	20 (13.5)	0 (0.0)	4 (8.2)	62 (9.9)
Inbound travelers screening	14 (3.7)	15 (10.1)	1 (2.1)	0 (0.0)	30 (4.8)
Subtotal	383	148	48	49	628
School season					
Online class	118 (52.2)	38 (51.4)	11 (39.3)	1 (50.0)	168 (50.9)
Offline class	77 (34.1)	13 (17.6)	12 (42.9)	1 (50.0)	103 (31.2)
Summer/winter break	31 (13.7)	23 (31.1)	5 (17.9)	0 (0.0)	59 (17.9)
Subtotal	226	74	28	2	330
Potential route of transmission					
Off-campus	239 (95.2)	93 (93.9)	30 (83.3)	25 (83.3)	387 (93.0)
On-campus	12 (4.8)	6 (6.1)	6 (16.7)	5 (16.7)	29 (7.0)
Large lecture hall	1 (0.4)	1 (1.0)	0 (0.0)	0 (0.0)	2 (0.5)
Mid-size/small lecture room	2 (0.8)	0 (0.0)	2 (5.6)	0 (0.0)	4 (1.0)
Lab space (arts, science)	9 (3.6)	5 (5.1)	4 (11.1)	0 (0.0)	18 (4.3)
Restaurant/cafeteria	0 (0.0)	0 (0.0)	0 (0.0)	5 (16.7)	5 (1.2)
Subtotal	251	99	36	30	416
Mean daily time of stay, hr					
< 3	93 (55.7)	34 (61.8)	9 (40.9)	0 (0.0)	136 (52.1)
3–6	47 (28.1)	7 (12.7)	8 (36.4)	0 (0.0)	62 (23.8)
> 6	27 (16.2)	14 (25.5)	5 (22.7)	17 (100.0)	63 (24.1)
Subtotal	167	55	22	17	261
Secondary infection case					
None	369 (87.6)	139 (86.3)	47 (90.4)	43 (89.6)	598 (87.7)
1–3 cases	39 (9.3)	22 (13.7)	5 (9.6)	5 (10.4)	71 (10.4)
> 3 cases	13 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)	13 (1.9)
Subtotal	421	161	52	48	682

Values are presented as number (%).

DISCUSSION

In the setting of rigorous infection prevention measures in combination with on- and off-hybrid classes, COVID-19 incidences and outbreaks were limited in university and college campus area across Seoul Metropolitan Area. Most on-campus outbreaks had few cases per outbreak, with less than 2% affecting more than three cases on campus. More than 90% of the identified transmissions have occurred outside of the campus, and more so, 50% of the infections indeed, had happened during online class seasons. This finding is in line with studies from other countries. In Cambridge, UK, a study has found that the transmission from the university to local community was limited, and that only a small number of lineages of the virus accounted for the outbreaks, reflecting the efficacy of the university's screening policy.[13] Indeed, the findings may not be replicable in the settings without stringent on-campus infection prevention policies. A modelling study from the US suggested that the college/university outbreaks have affected neighboring communities, however, the outbreak dynamics remained manageable in the campuses with test-trace-isolate strategies.[14] An analysis using the US university/college mobile phone data have shown that re-opening a college have increased the incidence of COVID-19 in the community, however the policies limiting daily mobility interactions would prevent such spillovers.[14] Our finding showing the epidemic curve for community-transmission generally preceded the campus-transmission, albeit setting of heterogeneity in campus policy on infection preventions, may not be applicable in the setting of distant-travelling college students. A modelling estimates

from the US shows that university students travelling from states to states have provided a significant contribution on inter-state transmission.[15] Continued research and data are needed to document the varying infection prevention policy relative to effects on university/ college opening on community-transmissions.

Our findings suggest that nearly 40% of the identified cases did not exhibit any symptoms during the course of investigation. The hall-mark of infection prevention strategies in South Korea has been the rigorous case management through Testing-Tracing-Treatment Strategy in response to local outbreaks.[16] Although more than 60% of the cases were identified through contact-based screening, only 20% have exhibited fevers and/or chills during the time of encounter, suggesting limited value of fever-based screening, on campus. As a complimentary surveillance measure, the wastewater-based epidemiology (WBE) has been suggested a potential as an early-warning tool for determining the presence on the campus.[17] In the US, there had been case studies utilizing WBE that resulted an efficient resource for COVID-19 prevention in the universities.[18] Such WBE have shown to detect small clusters within the university campuses (dorms, buildings), suggesting a possible applicable measure to mitigate the pandemic in universities and colleges.[19]

There are number limitations to this study. First, given the retrospective nature of surveillance data, this study is prone to selection bias on both directions; possible under-detection due to insensitive surveillance scheme; or potentially overestimated cases from campus visitors. Second, there was substantial variability between universities and colleges on their infection preventive measure policies, prohibiting quantitative analyses through data synthesis. Third, given the limited data on college-specific policy (on/offline, hybrid classes) and demographic profile, our data does not provide the exact rate based on the baseline population and the college-specific context. Lastly, our investigation did not distinguish the linked cases to assess the exact exposure history especially among the asymptomatic cases. It should, therefore, be interpreted with caution. Despite these limitations, our study highlights several interesting public health findings, reporting the incidence of university/collage-based cases in comparison to the incidence of community-based cases.

Collectively, the evidence around the infection preventive measures in higher education facilities in Seoul Metropolitan Area, suggest insignificant impact on community transmission. Our investigation suggests that transmission within the universities and colleges was uncommon and was not the primary cause of COVID-19 outbreak in the community. Our finding suggests that it may be possible for colleges to operate offline classes safely while controlling the transmission of COVID-19 to the community. Successful offline classes may be dependent on limiting the introduction of the SARS-CoV-2 virus to the campus, rigorous testing and tracing, and reactive closure, when needed. Further epidemiological evidence is needed to document the impact of university/college opening during the age of delta variant and vaccines, to better understand the current gap of knowledge to mitigate from COVID-19 pandemic.

ACKNOWLEDGMENTS

Seoul Regional Universities COVID-19 Response Working Group and Korea Disease Control and Prevention Agency.

Sang-Hoon Bae, PhD (Sungkyunkwan University), Seung-Ho Cho, PhD (Soongsil University), Hong-Bum Cho (Seokyeong University), Cheon Geun Choi (Hansung University), Jee Yong Chung, PhD (Duksung Women's University), Sung Hoon Jeh, PhD (Hankuk University of Foreign Studies), Sang Wook Kang, PhD (Sangmyung University), Yu-Won Kang, PhD (Sejong University), Jayong Koo, PhD (University of Seoul), Min Gyo Koo, PhD (Seoul National University), Jae Joong Oh, PhD (Konkuk University), Kwanghyoun Park, PhD (Dongguk University), Kwi-Cheon Park, PhD (Ewha Womans University), Yeol Park, PhD (Kwangwoon University), Doh-hyung Riu, PhD (Seoul National University of Science and Technology), Soo-Hyun Ryu, PhD (Sahmyook University), In-Bo Shim, PhD (Kookmin University), Hyun Han Shin, PhD (Yonsei University), Hyeonjin Soh, PhD (Sungshin Women's University), Yun Seon Song, PhD (Sookmyung Women's University), Kang-Oh Yi, PhD (Sogang University), Soohyun Cho (Korea Disease Control and Prevention Agency), Young-Joon Park, MD, MPH (Korea Disease Control and Prevention Agency), Seonju Yi, PhD (Korea Disease Control and Prevention Agency).

SUPPLEMENTARY MATERIAL

Supplementary Fig. 1

Locations of university/college campus participated in the investigation, Seoul Metropolitan Area, 2020–2021.

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