



# Rapid Review: What is known about the risk of transmission of COVID-19 within post-secondary institutions and the strategies to mitigate on-campus outbreaks?

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The authors declare they have no conflicts of interest to report.

# Executive Summary

## Background

The majority of post-secondary institutions in communities affected by coronavirus-2019 (COVID-19) shuttered their campuses during the 2019-2020 academic year in an effort to stem the spread of the virus. Learning was shifted to online platforms, on-campus activities and living options were restricted or barred altogether, and extracurricular activities and varsity sports were cancelled.

This rapid review summarizes evidence from post-secondary institutions that resumed and subsequently sustained their on-campus operations in 2020-2021, amid the ongoing pandemic, to inform safe and effective campus re-opening plans for 2021-2022. It seeks to identify, appraise, and summarize emerging research evidence to support evidence-informed decision making.

This rapid review includes evidence available up to March 19, 2021 to answer the question: **What is known about the risk of transmission of COVID-19 within post-secondary institutions and the strategies to mitigate on-campus outbreaks?**

## Key Points

- Overall, the certainty of evidence is very low (GRADE); findings are very likely to change as new data become available.
- All studies concluded that return to in-person operations is possible for post-secondary institutions amid the ongoing COVID-19 pandemic. However, all studies reported on-campus positive cases and/or outbreaks with the percentage of students and/or staff testing positive during the Fall term (Aug-Dec 2020) ranging from 0.8% to 16.5%. In addition, a seroprevalence study from post-secondary institutions in the United Kingdom reported 17.5% seropositivity across five institutions with outbreaks (range of 7.6%-29.7%). Six studies reported rates below 3.9%; three studies reported rates above 8.4%, which was higher than reported county/jurisdictional rates at the time.
- Reported mitigation strategies were similar across most studies making it difficult to explain the variation in the percentage of positive cases or identify which combination of strategies resulted in the lowest transmission rates. However, all studies reporting 3.9% positive cases or lower conducted symptomatic testing and contact tracing and had on-campus isolation facilities for positive cases and contacts. Five of these studies also conducted surveillance testing (asymptomatic testing or wastewater monitoring or both). Institutions with the lowest case rates also conducted active screening. All measures were implemented by internal institutional staff.
- Institutions with 3.9% or lower positive cases implemented the following infection prevention and control (IPAC) measures, in addition to the mitigation strategies reported above: masks, physical distancing, and de-densification. Most also implemented hand hygiene and enhanced cleaning. In comparison to institutions with 8.4% cases or higher, those with lower rates generally reported implementing a greater number of IPAC measures.

- The evidence is mixed in terms of the impact of single room versus multiple occupancy on transmission, with some evidence suggesting unsafe gatherings were associated with greater transmission, rather than physical living arrangements.

## Overview of Evidence and Knowledge Gaps

### **Mitigation and IPAC measures**

- A multifaceted mitigation and IPAC approach was implemented in all settings and can be described as a “Swiss Cheese” model in which risk is reduced via multiple layers of protection: a weakness (i.e., “hole”) in one layer is expected to be offset by the strength of another. Important components of this approach, in addition to those listed in the Key Points above, included: coordinated interdisciplinary leadership, student buy-in (e.g., formal agreements to follow IPAC measures), communication, and/or data-driven modelling approaches, as observed in one high and five moderate quality studies.
- Several moderate quality studies concluded that targeted testing, focused on high-risk populations (e.g., athletes, students living on-campus) and high-risk locations (e.g., identified through surveillance or modelling), and isolation, in particular, can effectively contain and/or reduce transmission, especially following rapid increases in case numbers and clusters.
- There is evidence from a small number of studies that wastewater monitoring of on-campus residences and isolation facilities may be a useful strategy to identify positive asymptomatic and pre-symptomatic cases, who can then undergo testing, as well as indicate when an outbreak is resolved.
- Enhanced ventilation was noted as an IPAC measure in two moderate quality studies but not described in detail; its impact on transmission risk is unknown.
- The evidence was mixed on whether risk is higher in shared on-campus accommodations (e.g., with roommates) and common areas (e.g., kitchens, bathrooms). Risk of transmission was higher for students living in multi-occupancy residence rooms in two moderate-high quality studies, while a third moderate quality study found no correlation between risk and occupancy. One high quality study estimated roommate-to-roommate spread occurred 20% of the time; two moderate quality studies noted that the majority of index cases were from off-campus sources. One high quality study concluded that individuals’ behaviours (e.g., unsafe gatherings) were more likely to be associated with outbreak clusters rather than physical housing arrangements.

### **Education Approaches**

- Most studies reported a hybrid learning approach (in-person and online) but few analyzed the relationship between the approach and transmission risk. One moderate quality study showed no impact of instruction mode on cumulative infection rate; three moderate quality studies noted no evidence of classroom transmission.

### **Athletics and Clubs**

- One moderate quality study noted that, even with mandatory daily testing, outbreaks occurred from asymptomatic athletes with false negative antigen tests. There was limited or no evidence related to campus dining facilities, libraries, or university clubs. More research is needed to understand if athletic and club activities can be safely implemented on-campus.

## **Knowledge Gaps and Future Research**

- The evidence in this report pre-dates the introduction of new variants of concern (VOCs); it is not yet known how VOCs will impact the risk of on-campus transmission and effectiveness of mitigation and IPAC strategies.
- The evidence in this report also pre-dates the availability of COVID-19 vaccines; it is not yet known which and to what extent mitigation and IPAC measures will be required to prevent on-campus transmission as students and staff become fully vaccinated.
- Two moderate quality studies used mathematical modelling to target testing and guide selection of IPAC measures. Several purely modelling studies identified in the search for this rapid review will be included in a subsequent update.

# Methods

## Research Question

What is known about the risk of transmission of COVID-19 within post-secondary institutions and the strategies to mitigate on-campus outbreaks?

## Search

On March 19, 2021, the following databases were searched using key terms (colleg\* OR “post secondary” OR “post-secondary” OR “vocational school” OR “technical school” OR campus OR universit\* OR dormitor\* OR residence\* OR sororit\* OR fraternit\*) AND (open\* OR reopen\* OR outbreak\* OR transmit\* OR spread OR risk\* OR seroprevalen\* OR return OR “in person” OR “in-person”):

- [MEDLINE](#) database
- [Trip Medical Database](#)
- World Health Organization’s [Global literature on coronavirus disease](#)
- Joanna Briggs Institute [COVID-19 Special Collection](#)
- [COVID-19 Evidence Alerts](#) from McMaster PLUS™
- [COVID-19 Living Overview of the Evidence \(L·OVE\)](#)
- [McMaster Health Forum](#)
- Cochrane Rapid Reviews [Question Bank](#)
- [Prospero Registry of Systematic Reviews](#)
- NCCMT [COVID-19 Rapid Evidence Reviews](#)
- [MedRxiv preprint server](#)
- NCCDH [Equity-informed Responses to COVID-19](#)
- NCCEH [Environmental Health Resources for the COVID-19 Pandemic](#)
- NCCHPP [Public Health Ethics and COVID-19](#)
- [NCCID](#)
- NCCID [Disease Debrief](#)
- NCCIH [Updates on COVID-19](#)
- [Institute national d’excellence en santé et en services sociaux \(INESSS\)](#)
- [Uncover \(USHER Network for COVID-19 Evidence Reviews\)](#)
- [Morbidity and Mortality Weekly Report \(MMWR\)](#)
- [Institut national de santé publique du Québec \(INSPQ\)](#)
- [BC Centre for Disease Control \(BCCDC\)](#)
- [Public Health England](#)

A copy of the full search strategy is available at this [link](#).

## Study Selection Criteria

The search results were first screened for recent guidelines and syntheses. When available, findings from syntheses and clinical practice guidelines are presented first, as these take into account the available body of evidence and, therefore, can be applied broadly to populations and settings.

Single studies were included if no syntheses were available, or if single studies were published after the search was conducted in the included syntheses. English-language, peer-reviewed sources and sources published ahead-of-print before peer review were included. Surveillance sources were excluded.

	Inclusion Criteria	Exclusion Criteria
Population	Post-secondary institutions (including students, faculty, staff) that were open / had re-opened for on-campus activities	Residency training programs University hospitals Co-op placements Apprenticeships
Intervention	Individual and organizational risk factors Mitigation strategies	-
Comparisons	-	-
Outcomes	Confirmed COVID-19 cases, outbreaks, secondary infection	-
Setting	On-campus activities	Off-campus activities Non-university events that occur on campus (e.g., renting space to community groups, on-campus daycare services, day camps)

## Data Extraction and Synthesis

Data relevant to the research question, such as study design, setting, location, population characteristics, interventions or exposure and outcomes were extracted when reported. We synthesized the results narratively due to the variation in methodology and outcomes for the included studies.

## Appraisal of Evidence Quality

We evaluated the quality of included evidence using critical appraisal tools as indicated by the study design below. Quality assessment was completed by one reviewer and verified by a second reviewer. Conflicts were resolved through discussion. For some of the included evidence a suitable quality appraisal tool was not found, or the review team did not have the expertise to assess methodological quality. Studies for which quality appraisal has not been conducted are noted within the data tables.

<b>Study Design</b>	<b>Critical Appraisal Tool</b>
Case Report	Joanna Briggs Institute (JBI) <a href="#">Checklist for Case Reports</a>
Cohort	Joanna Briggs Institute (JBI) <a href="#">Checklist for Cohort Studies</a>
Cross-sectional	Joanna Briggs Institute (JBI) <a href="#">Checklist for Analytical Cross-Sectional Studies</a>
Prevalence	Joanna Briggs Institute (JBI) <a href="#">Checklist for Prevalence Studies</a>

Completed quality assessments for each included study are available on request.

The Grading of Recommendations, Assessment, Development and Evaluations ([GRADE](#)) (Schünemann *et al.*, 2013) approach was used to assess the certainty in the findings based on eight key domains.

In the GRADE approach to quality of evidence, **observational studies**, as included in this review, provide **low quality** evidence, and this assessment can be further reduced based on other domains:

- High risk of bias
- Inconsistency in effects
- Indirectness of interventions/outcomes
- Imprecision in effect estimate
- Publication bias

and can be upgraded based on:

- Large effect
- Dose-response relationship
- Accounting for confounding

The overall certainty in the evidence for each outcome was determined taking into account the characteristics of the available evidence (observational studies, some not peer-reviewed, unaccounted-for potential confounding factors, different tests and testing protocols, lack of valid comparison groups). A judgement of 'overall certainty is very low' means that the findings are very likely to change as more evidence accumulates.

## Findings

### Summary of Evidence Quality

This document includes 14 single studies and one in-progress single study for a total of 15 publications included in this review. The quality of the evidence included in this review is as follows:

Research Question	Evidence included		Overall certainty in evidence based on completed evidence
What is known about the risk of transmission of COVID-19 within post-secondary institutions and the strategies to mitigate on-campus outbreaks?	Single studies In-progress single study	14 1	Very low

### Warning

Given the need to make emerging COVID-19 evidence quickly available, many emerging studies have not been peer reviewed. As such, we advise caution when using and interpreting the evidence included in this rapid review. We have provided a summary of overall certainty of the evidence to support the process of decision making. Where possible, make decisions using the highest quality evidence available.



**Table 1: Single Studies**

Reference	Date Released	Study Design	Location, Context	Description of Virus Control	Summary of Findings	Quality Rating
Weil, A. A., Sohlberg, S. L., O’Hanlon, J. A., Casto, A. M., Emanuels, A. W., Lo, N. K., ... Chu, H. Y. (2021). <a href="#">SARS CoV-2 epidemiology on a public university campus in Washington State</a> . <i>Preprint</i> .	Mar 17, 2021	Cohort	<p>Large, urban public university</p> <ul style="list-style-type: none"> <li>• 60,000 students</li> <li>• 30,000 staff</li> </ul> <p>Seattle, Washington, United States</p> <p style="text-align: center;">* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• Hybrid learning</li> </ul> <p>On-campus living (unknown %)</p>	<p>Surveillance/testing plan:</p> <ul style="list-style-type: none"> <li>• Testing (symptomatic, exposure)</li> <li>• Screening (daily self-report symptoms)</li> <li>• Contact tracing</li> </ul> <p>Other IPAC measures:</p> <ul style="list-style-type: none"> <li>• De-densification (on-campus living)</li> <li>• Enhanced cleaning and disinfection</li> <li>• Hand hygiene</li> <li>• Isolation facilities</li> <li>• Masks</li> </ul> <p>Physical distancing</p>	<p>From Sep 24 – Dec 18, 2020, 29,783 tests were performed on 11,644 individuals; 265 tested positive (0.80%).</p> <ul style="list-style-type: none"> <li>• Fraternities/sororities (1.5%; 1,796/12,045)</li> <li>• Students living on-campus (1.2%; 43/3,507)</li> <li>• Staff / faculty (0.4%; 23/5,884)</li> </ul> <p>Among the 265 positive cases, 60.8% were symptomatic, 19.6% pre-symptomatic, 3.4% asymptomatic, and 16.2% possible asymptomatic. 34.7% reported exposures and 21.5% reported high-risk behaviours.</p> <p>Risk factors for testing positive:</p> <ul style="list-style-type: none"> <li>• Fraternity/sorority affiliation (OR=2.71, 95%CI=1.84,4.00)</li> <li>• Latinx/Hispanic ethnicity (OR=2.12, 95%CI=1.28,2.18)</li> <li>• Self-reported symptoms (OR=1.86, 95%CI=1.43,2.41)</li> </ul> <p>88.1% of viral genomes sequenced from fraternity/sorority-affiliated students were genetically identical, vs. 37.9% of genomes from non-fraternity/sorority students. Transmission was thought to have then occurred within outbreaks (i.e., within groups), with no evidence of further spread.</p>	<p>Moderate</p> <p><b><i>PREPRINT</i></b></p>

<p>Betancourt, W. Q., Schmitz, B. W., Innes, G. K., Prasek, S. M., Pogreba Brown, K. M., Stark, E. R., ... Pepper, I. L. (2021). <a href="#">COVID-19 containment on a college campus via wastewater-based epidemiology. targeted clinical testing and an intervention.</a> <i>Science of the Total Environment</i>, 779, 146408.</p>	<p>Mar 13, 2021</p>	<p>Case report</p>	<p>University of Arizona  Arizona, United States  * * *  Open/available: • In-person learning (limited) • On-campus living (unknown %)</p>	<p>Surveillance/testing plan: • Wastewater monitoring (residences) • Testing (upon arrival, symptomatic, or if identified through wastewater) • Contact tracing  Other IPAC measures: • Isolation data platforms and communication • Isolation facilities • Shelter-in-place policy</p>	<p>Between Aug – Nov 2020: • 91 / 111 (82.0% positive predictive value) positive wastewater samples lead to targeted identification of at least one positive case • 185 / 208 (88.9% negative predictive value) negative wastewater samples concurred with no positive tests • 43 / 319 total wastewater samples were discordant with clinical testing (suggesting samples not provided during testing or non-residents using washrooms)  From Sep 15-29, 2020, students remained on campus, but a shelter-in place policy was implemented, due to increasing cases, resulting in a decrease of new cases and virus detections in wastewater. Cases remained low (often zero) thereafter.</p>	<p>Moderate</p>
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<p>Bjorkman, K. K., Saldi, T. K., Lasda, E., Bauer, L. C., Kovarik, J., Gonzalez, P. K., ... Parker, R. (2021). <a href="#">Higher viral load drives infrequent SARS-CoV-2 transmission between asymptomatic residence hall roommates.</a> <i>Preprint.</i></p>	<p>Mar 12, 2021</p>	<p>Cohort</p>	<p>University of Colorado Boulder  Boulder, Colorado, United States  * * *  Open/available: • On-campus living (6,408 students)  *Students provided proof of negative test result at move-in.</p>	<p>Surveillance/testing plan: • Surveillance (asymptomatic; mandatory, weekly for students living on-campus (exempt after a COVID-19 diagnosis)) • Testing (symptomatic, exposed) • Contact tracing  IPAC measures: Isolation facilities</p>	<p>From Aug 17 – Nov 25, 2020, 1058 (16.5%) students living on-campus tested positive for COVID-19: • 198 / 1916 (10.3%) of students in single residence rooms • 860 / 4492 (19.1%) of students in multiple occupancy residence rooms • Cases usually asymptomatic at time of diagnosis  While students in multiple occupancy residence rooms had a greater infection rate than those in single rooms, only 116 / 574 multiple occupancy rooms had likely in-room transmission (i.e., roommate-to-roommate; secondary attack rate (SAR): 20.2%), suggesting transmission occurred elsewhere the majority of the time.</p>	<p>High  <b><i>PREPRINT</i></b></p>
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<p>Ryan, B. J., Muehlenbein, M. P., Allen, J., Been, J., Boyd, K., Brickhouse, M., ... Brickhouse, N. (2021). <a href="#">Sustaining university operations during the COVID-19 pandemic.</a> <i>Disaster Medicine and Public Health Preparedness</i>. Epub ahead of print.</p>	<p>Mar 8, 2021</p>	<p>Case report</p>	<p>Baylor University</p> <ul style="list-style-type: none"> <li>• 19,297 students (14,399 undergrad, 4,898 grad)</li> <li>• ~3,400 staff</li> </ul> <p>Waco, Texas, United States</p> <ul style="list-style-type: none"> <li>• Population: 256,600</li> </ul> <p style="text-align: center;">* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• Hybrid learning (25% of classes)</li> <li>• In-person learning (39% of classes)</li> <li>• Online learning (36% of classes)</li> <li>• On-campus living (4,736 students)</li> </ul>	<p>Surveillance/testing plan:</p> <ul style="list-style-type: none"> <li>• Surveillance (asymptomatic; random, surge (i.e., increased temporary testing capacity with government-provided tests), targeted)</li> <li>• Wastewater monitoring (on-campus living, isolation facilities)</li> <li>• Testing (symptomatic, exposed)</li> <li>• Contact tracing</li> <li>• Screening</li> </ul> <p>Other IPAC measures:</p> <ul style="list-style-type: none"> <li>• Compliance monitoring</li> <li>• De-densification (athletics crowd capacities)</li> <li>• Enhanced cleaning and disinfecting</li> <li>• Isolation facilities</li> <li>• Limited non-university events</li> <li>• Masks</li> <li>• Physical distancing</li> </ul> <p>Other components of approach:</p> <ul style="list-style-type: none"> <li>• Communication</li> <li>• In-house dashboard</li> <li>• Multisectoral systems approach</li> <li>• Population-based management</li> <li>• “Swiss Cheese” risk mitigation model</li> </ul>	<p>From Aug 1-Dec 8, 2020, 1,435 / 62,970 individuals tested positive (2.28% positivity rate) and 235 self-reported (total 1670 cases):</p> <ul style="list-style-type: none"> <li>• 1,416 students</li> <li>• 140 staff/faculty</li> <li>• 90 athletes</li> <li>• 22 contractors</li> <li>• 2 others</li> </ul> <p>Testing completed:</p> <ul style="list-style-type: none"> <li>• Pre-arrival (135/13,621; 0.99%)</li> <li>• Clinic (i.e., symptomatic/exposed) (798/11,188; 7.13%)</li> <li>• Surveillance (360/21,435; 1.68%)</li> <li>• Surge (29/4,362; 0.66%)</li> <li>• Athletics (91/8,901; 1.02%)</li> <li>• Contractor (22/3,463; 0.64%)</li> </ul> <p>246 positive students used isolation facilities (peaked at 30% of capacity).</p> <p>All staff cases and 76% of student cases were from off-campus sources.</p>	<p>Moderate</p>
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<p>Moreno, G. K., Braun, K. M., Pray, I. W., Segaloff, H. E., Lim, A., Poulson, K., ... O'Connor, D. H. (2021). <a href="#">SARS-CoV-2 transmission in intercollegiate athletics not fully mitigated with daily antigen testing.</a> <i>Preprint.</i></p>	<p>Mar 6, 2021</p>	<p>Case report</p>	<p>University athletics program (de-identified data)</p> <p>United States</p> <p style="text-align: center;">* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• Athletic programs: <ul style="list-style-type: none"> <li>○ Indoor meetings</li> <li>○ Practices</li> <li>○ Scrimmages</li> <li>○ Intercollegiate competitions</li> </ul> </li> </ul> <p>*Some sports were considered “high-risk” due to frequent contact / collision.</p>	<p>Surveillance/testing plan:</p> <ul style="list-style-type: none"> <li>• Antigen testing (daily)</li> <li>• Diagnostic testing (if positive antigen test)</li> <li>• Contact tracing (household and social close contacts only)</li> </ul> <p>Other IPAC measures:</p> <ul style="list-style-type: none"> <li>• Masks</li> <li>• Physical distancing</li> <li>• Program suspension</li> <li>• Quarantine / isolation</li> </ul>	<p>Outbreaks occurred affecting high-risk sport programs:</p> <p>Outbreak 1:</p> <ul style="list-style-type: none"> <li>• 32 cases (22 students, 10 staff)</li> <li>• Index case (antigen test negative) attended meeting infectious; IPAC measures were followed</li> <li>• 4 contacts developed symptomatic infection</li> <li>• Contact tracing identified: <ul style="list-style-type: none"> <li>○ 13 (40%) attended team meeting with a case</li> <li>○ 6 (13%) were roommates</li> <li>○ 8 (25%) no identified exposure</li> </ul> </li> <li>• 24 of 26 (92%) sequences were closely related, suggesting a single viral introduction</li> </ul> <p>Outbreak 2:</p> <ul style="list-style-type: none"> <li>• 12 cases occurred among athletes during a two-team competition: <ul style="list-style-type: none"> <li>○ Sequences were closely related and unique from strains circulating in the community</li> </ul> </li> </ul> <p>Antigen testing, as a sole surveillance measure, may not be sufficient to prevent outbreaks.</p>	<p>Moderate</p> <p><b><i>PREPRINT</i></b></p>
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<p>Travis, S. A., Best, A. A., Bochniak, K. S., Dunteman, N. D., Fellingner, J., Folkert, P. D., ... Schuitema, A. J. (2021). <a href="#">Providing a safe, in-person, residential college experience during the COVID-19 pandemic.</a> <i>Preprint.</i></p>	<p>Mar 5, 2021</p>	<p>Case report</p>	<p>Hope College Holland, Michigan, United States</p> <p style="text-align: center;">* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• In-person learning</li> <li>• On-campus living (unknown %)</li> </ul>	<p>Surveillance/testing plan:</p> <ul style="list-style-type: none"> <li>• Wastewater monitoring (residences)</li> <li>• Surveillance (asymptomatic; random and identified by wastewater monitoring)</li> <li>• Testing (symptomatic and on arrival, i.e., baseline)</li> <li>• Contact tracing (household and social close contacts only)</li> <li>• Screening</li> </ul> <p>Other IPAC measures:</p> <ul style="list-style-type: none"> <li>• Adapted instructional spaces</li> <li>• Isolation facilities</li> </ul> <p>Other components of approach:</p> <ul style="list-style-type: none"> <li>• Communication</li> <li>• Earlier class start, reduced break days for earlier class completion</li> <li>• Mathematical modelling</li> </ul>	<p>Between Jul 29 – Nov 24, 2020, 10,700 tests were conducted among students and staff (2.2% positive test percentage):</p> <ul style="list-style-type: none"> <li>• 38 / 3,878 baseline tests (0.98% positivity rate*)</li> <li>• 57 / 5,696 random and targeted asymptomatic tests (from wastewater identification) (1% positivity rate)</li> <li>• 124 / 960 symptomatic tests (12.9% positivity rate)</li> <li>• Additional subset testing (e.g., athletes) not reported here</li> </ul> <p>(*Compared to national (6.1%) and state (2.5%) positivity rates, at the time).</p> <p>Contact tracing identified 670 contacts (average 4-5 per positive case); 21 tested positive (SAR: 3.1%).</p>	<p>Moderate</p> <p><b><i>PREPRINT</i></b></p>
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<p>Hamer, D. H., White, L. F., Jenkins, H. E., Gill, C. J., Landsberg, H. N., Klapperich, C., ... Brown, R. A. (2021). <a href="#">Control of COVID-19 transmission on an urban university campus during a second wave of the pandemic.</a> <i>Preprint.</i></p>	<p>Mar 2, 2021</p>	<p>Case report</p>	<p>Boston University (BU)</p> <ul style="list-style-type: none"> <li>• Large, urban campus</li> <li>• 40,000 students</li> </ul> <p>Boston, United States</p> <p style="text-align: center;">* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• Hybrid learning</li> </ul> <p>On-campus living (7,131 students at 67% capacity)</p>	<p>Surveillance/testing plan:</p> <ul style="list-style-type: none"> <li>• Surveillance (asymptomatic)</li> <li>• Testing (symptomatic)</li> <li>• Contact tracing</li> <li>• Screening (daily self-report symptoms)</li> </ul> <p>Other IPAC measures:</p> <ul style="list-style-type: none"> <li>• De-densification (classrooms, common areas, residences)</li> <li>• Enhanced ventilation</li> <li>• Hand hygiene</li> <li>• Isolation facilities</li> <li>• Masks</li> <li>• Physical distancing</li> </ul> <p>Other components of approach:</p> <ul style="list-style-type: none"> <li>• Coordinated leadership and management structures</li> <li>• Communication</li> <li>• Mathematical modeling</li> </ul> <p>Multiple data systems / data-driven strategy refinements</p>	<p>From Aug – Dec 2020, 719 / &gt;500,000 COVID-19 tests at BU were positive</p> <ul style="list-style-type: none"> <li>• 496 students (69%)</li> <li>• 11 faculty (1.5%)</li> <li>• 212 staff (29.5%)</li> </ul> <p>Approximately 1.8% of the 40,000 BU community tested positive; 37.7% of total cases were asymptomatic. Test positivity rate for those with self-reported symptoms was higher (4.9%) than those who were asymptomatic (0.10%).</p> <p>Incidence rate was less than but followed trends in county.</p> <p>Contact tracing identified:</p> <ul style="list-style-type: none"> <li>• 86/837 positive contacts (10.3%)</li> <li>• 51.5% of total 719 cases had a known source (non-BU source, 55.7% of known exposures)</li> <li>• No classroom transmission</li> </ul> <p>Isolation facility occupancy peaked at 12.9%.</p> <p>Multi-pronged response (surveillance / testing, contact tracing, isolation) controlled campus spread.</p>	<p>Moderate</p> <p><b><i>PREPRINT</i></b></p>
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<p>Vusirikala, A., Whitaker, H., Jones, S., Tessier, E., Borrow, R., Linley, E., ... Amirthalingam, G. (2021). <a href="#">Seroprevalence of SARS-CoV-2 antibodies in university students: Cross-sectional study, December 2020, England.</a> <i>Preprint.</i></p>	<p>Feb 19, 2021</p>	<p>Cross-sectional</p>	<p>5 universities with COVID-19 outbreaks following Sep 2020 re-opening</p> <p>United Kingdom</p> <p>* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• On-campus living (30% of participants)</li> </ul>	<p>Rapid serological evaluation (i.e., serosurveillance) to assess prior infection (captures asymptomatic, symptomatic, and mild transient infections) and provide estimate of spread of infection.</p> <p>IPAC measures not reported.</p>	<p>In Dec 2020, seroprevalence in 2,905 students (aged <math>\leq 25</math>) from universities that had experienced outbreaks was 17.8% (95% CI=16.5,19.3) (range across universities: 7.6 – 29.7%).</p> <p>This was higher than age-matched healthy community blood donors (13.7%, 95% CI=11.1,16.9) and across England (12.1%, 95% CI=11.6,12.7).</p> <p>49% of students who lived in residences that had reported infection rates <math>&gt;8\%</math> were seropositive, suggesting widespread transmission in this setting.</p> <p>Seropositivity was associated with:</p> <ul style="list-style-type: none"> <li>• 1<sup>st</sup> year students (adjusted OR=3.16, 95% CI=2.02,4.93)</li> <li>• On-campus living (adjusted OR=2.14, 95% CI=1.7,2.68)</li> <li>• Shared kitchen with: <ul style="list-style-type: none"> <li>○ 4-7 people (adjusted OR=1.43, 95% CI=1.12,1.82)</li> <li>○ 8+ people (adjusted OR=1.53, 95% CI=1.04,2.24)</li> </ul> </li> <li>• Being symptomatic (adjusted OR=4.3, 95% CI=3.43,5.38)</li> <li>• Confirmed case within shared accommodation (adjusted OR=3.57, 95% CI=2.86,4.44)</li> </ul> <p>Sharing a bedroom (adjusted OR=0.73, 95%CI=0.45,1.19) or bathroom (adjusted OR=0.73, 95%CI=0.57,0.95) had lower odds.</p>	<p>Moderate</p> <p><b><i>PREPRINT</i></b></p>
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<p>Gibson, G., Weitz, J. S., Shannon, M. P., Holton, B., Bryksin, A., Liu, B., ... García, A. J. (2021). <a href="#">Surveillance-to-diagnostic testing program for asymptomatic SARS-CoV-2 infections on a large, urban campus - Georgia Institute of Technology, Fall 2020.</a> <i>Preprint.</i></p>	<p>Jan 31, 2021</p>	<p>Case report</p>	<p>Georgia Institute of Technology</p> <p>Georgia, United States</p> <p>* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• On-campus living (7,370 students)</li> <li>• On-campus visiting (5,000/day; staff, non-resident students)</li> <li>• Online learning</li> </ul>	<p>Surveillance/testing plan:</p> <ul style="list-style-type: none"> <li>• Surveillance</li> <li>• Testing (focused case cluster)</li> <li>• Contact tracing</li> </ul> <p>Other IPAC measures:</p> <ul style="list-style-type: none"> <li>• Isolation facilities</li> <li>• Masks</li> <li>• Physical distancing</li> </ul>	<p>In Fall 2020, 1,508 / 18,029 individuals providing 112,500 saliva samples tested positive (8.4% cumulative positive):</p> <ul style="list-style-type: none"> <li>• Students: 1,351 (90%); 9.7% cumulative positive</li> <li>• Staff: 157 (10%); 3.8% cumulative positive</li> </ul> <p>Targeted testing after two outbreaks (Aug return to campus, Oct high community levels) steadily reduced peak asymptomatic positivity rates from 2-4% to &lt;0.5%.</p> <p>Students in shared double rooms had higher positivity risk (30% of double roommates tested positive; half of cases in Aug-Sep were in doubles).</p>	<p>Moderate</p> <p><b><i>PREPRINT</i></b></p>
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<p>Fox, M. D., Bailey, D. C., Seamon, M. D., &amp; Miranda, M. L. (2021). <a href="#">Response to a COVID-19 outbreak on a university campus - Indiana, August 2020</a>. <i>Morbidity and Mortality Weekly Report</i>, 70(4), 118-122.</p>	<p>Jan 29, 2021</p>	<p>Case report</p>	<p>Indiana University</p> <ul style="list-style-type: none"> <li>• 12,000 students (8,000 undergrad)</li> <li>• Medium-sized</li> </ul> <p>Indiana, United States</p> <p style="text-align: center;">* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• In-person learning</li> <li>• On-campus living (85% of undergrad)</li> </ul>	<p>Surveillance/testing plan:</p> <ul style="list-style-type: none"> <li>• Testing (symptomatic, athletes)</li> <li>• Contact tracing</li> </ul> <p>Other IPAC measures:</p> <ul style="list-style-type: none"> <li>• De-densification (classrooms, common areas)</li> <li>• Education</li> <li>• Enhanced cleaning and disinfection</li> <li>• Isolation facilities</li> <li>• Masks</li> <li>• Physical distancing (6 feet)</li> </ul> <p>Other components of approach:</p> <ul style="list-style-type: none"> <li>• Communication</li> <li>• Enhanced data systems</li> <li>• Outbreak control measures: <ul style="list-style-type: none"> <li>○ Switch to online learning</li> <li>○ Restricting on-campus access</li> <li>○ Additional testing, tracing, IPAC</li> </ul> </li> </ul>	<p>Baseline student testing prior to semester start:</p> <ul style="list-style-type: none"> <li>• 11,836 tested; 33 (0.28%) positive</li> </ul> <p>From Aug 3-15, 2020</p> <ul style="list-style-type: none"> <li>• 56 tested positive (4.3 cases per day, 11.7% of all tests performed)</li> <li>• 90% of cases were symptomatic</li> </ul> <p>From Aug 16-22 an outbreak occurred:</p> <ul style="list-style-type: none"> <li>• 371 confirmed cases (26.5 per day, 15.3% of all tests performed) <ul style="list-style-type: none"> <li>○ 355 (96%) undergrad</li> <li>○ 13 (3%) grad students</li> <li>○ 1 faculty and 2 staff</li> </ul> </li> <li>• 62% of undergrad cases lived off-campus</li> </ul>	<p>Moderate</p>
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<p>O'Donnell, C., Brownlee, K., Martin, E., Suyama, J., Albert, S., Anderson, S., ... Williams, J. (2021). <a href="#">SARS-CoV-2 control on a large urban college campus without mass testing</a>. <i>Preprint</i>.</p>	<p>Jan 25, 2021</p>	<p>Prevalence</p>	<p>University of Pittsburgh</p> <ul style="list-style-type: none"> <li>• Large, urban campus</li> <li>• 28,234 students</li> <li>• 13,264 staff</li> </ul> <p>Pittsburgh, United States</p> <ul style="list-style-type: none"> <li>• 1.2 million in neighbourhood</li> </ul> <p>* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• Hybrid learning</li> <li>• In-person final exams</li> <li>• On-campus living (6,300 students)</li> <li>• Organized student activities</li> </ul>	<p>Targeted plan:</p> <ul style="list-style-type: none"> <li>• Mitigation (with emphasis on student commitment)</li> <li>• Communication</li> <li>• Containment <ul style="list-style-type: none"> <li>○ Testing (symptomatic; focused cluster)</li> <li>○ Surveillance (asymptomatic, random)</li> <li>○ Contact tracing</li> <li>○ Isolation</li> </ul> </li> </ul> <p>Other IPAC measures:</p> <ul style="list-style-type: none"> <li>• De-densification (residences)</li> <li>• Enhanced cleaning</li> <li>• Enhanced ventilation</li> <li>• Hand hygiene</li> <li>• Isolation facilities</li> <li>• Masks</li> <li>• Physical distancing</li> <li>• PPE</li> <li>• Staggered re-entry with shelter-in-place requirements</li> </ul>	<p>In Fall 2020, 445 / 11,505 students tested positive (3.9%, 95%CI=3.5,4.2):</p> <ul style="list-style-type: none"> <li>• 383/3,102 symptomatic students (12.3%, 95% CI=11.2,13.6)</li> <li>• 31/7,389 asymptomatic students (0.42%, 95% CI=0.29,0.59); slight increase during arrival, remained low throughout semester</li> <li>• 15/228 close contacts (0.31%, 95%CI=0.11,0.68)</li> <li>• 16/786 focused testing (e.g., cluster) (0.46%, 95%CI=0.30,0.68)</li> </ul> <p>During 2 case surges in the community, campus count also increased but 5-day rolling average did not exceed 20 cases/day.</p> <p>Use of isolation facilities peaked at 33.6% occupancy (97/289 beds).</p> <p>Bathroom type (communal vs. private) had no impact on infection incidence; no classroom transmission.</p> <p>Clusters occurred in association with unsafe gatherings or within shared residences not observing IPAC measures (e.g., behaviours greater risk than physical arrangements).</p>	<p>Moderate</p> <p><b><i>PREPRINT</i></b></p>
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<p>Gibas, C., Lambirth, K., Mittal, N., Juel, M. A. I., Barua, V. B., Brazell, L. R., ... Munir, M. (2021).  <a href="#">Implementing building-level SARS-CoV-2 wastewater surveillance on a university campus.</a>  <i>Preprint.</i></p>	<p>Jan 4, 2021</p>	<p>Prevalence</p>	<p>University of North Carolina at Charlotte</p> <ul style="list-style-type: none"> <li>• Large, urban campus</li> </ul> <p style="text-align: center;">* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• On-campus living (unknown %)</li> </ul>	<p>Surveillance/testing plan:</p> <ul style="list-style-type: none"> <li>• Surveillance (wastewater monitoring, 3x/week per residence)</li> <li>• Testing (symptomatic; athletes)</li> <li>• Contact tracing</li> <li>• Screening (daily symptom self-reporting)</li> </ul> <p>*Wastewater monitoring is the focus of this study</p> <p>A typical monitoring timeline:</p> <ul style="list-style-type: none"> <li>• Collection</li> <li>• Detection</li> <li>• Testing, sheltering-in-place</li> <li>• Results, resolution</li> </ul> <p>Other IPAC measures:</p> <ul style="list-style-type: none"> <li>• De-densification (residences)</li> <li>• Isolation facilities</li> </ul>	<p>From Sep 28 – Nov 23, 2020, 332 wastewater samples from 19 building sites were processed; 59 were positive (17.7%).</p> <p>Over the study period, the number of positive samples gradually increased (as did the positivity rates in the surrounding county, Pearson correlation coefficient=0.769).</p> <p>Wastewater monitoring identified smaller clusters than were reported in other types of cluster events (<math>p &lt; 0.001</math>); able to detect asymptomatic individuals in residences of 150-200 students.</p> <p>Wastewater monitoring detected pre-symptomatic cases, corroborated contact tracing cases, and indicated when an outbreak had been contained.</p>	<p>Moderate</p> <p><b><i>PREPRINT</i></b></p>
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<p>Stubbs, C. W., Springer, M., &amp; Thomas, T. S. (2020). <a href="#">The impacts of testing cadence, mode of instruction, and student density on Fall 2020 COVID-19 rates on campus.</a> <i>Preprint.</i></p>	<p>Dec 9, 2020</p>	<p>Cohort</p>	<p>9 colleges / universities (Boston-area), 4 comparison schools</p> <ul style="list-style-type: none"> <li>• Small, large; rural, urban</li> </ul> <p>United States</p> <p style="text-align: center;">* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• Hybrid learning</li> <li>• Online learning</li> <li>• On-campus living (unknown %)</li> </ul>	<p>Surveillance/testing plan:</p> <ul style="list-style-type: none"> <li>• Weekly high-cadence PCR testing of all students living on-campus (asymptomatic and/or symptomatic)</li> <li>• Isolation</li> <li>• Contact tracing</li> </ul> <p>Other specific IPAC measures not described.</p>	<p>From Aug 15 – Nov 22, 2020, estimated COVID-19 prevalence in Boston-area schools, based on publicly available data, was <math>16 \pm 3</math> new cases / 100,000 person-days; the mean case rate for the surrounding county was 10.8/100,000.</p> <p>There was no correlation between positive cases and total number of students living on-campus or dormitory occupancy density.</p> <p>There was no significant impact of mode of instruction (online, hybrid) on cumulative infection rate.</p> <p>Testing more frequently (e.g., 2-3x/week vs. 1x/week) was correlated with lower infection rates (<math>p=0.017</math>).</p>	<p>Low</p> <p><b><i>PREPRINT</i></b></p>
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<p>Denny, T. N., Andrews, L., Bonsignori, M., Cavanaugh, K., Datto, M. B., Beckard, A., ... Wolfe, C. R. (2020). <a href="#">Implementation of a pooled surveillance testing program for asymptomatic SARS-CoV-2 infections on a college campus- Duke University, Durham, North Carolina, August 2-October 11, 2020</a>. <i>Morbidity and Mortality Weekly Report</i>, 69(46), 1743-1747.</p>	<p>Nov 20, 2020</p>	<p>Cohort</p>	<p>Duke University Durham, North Carolina, United States</p> <p style="text-align: center;">* * *</p> <p>Open/available:</p> <ul style="list-style-type: none"> <li>• Hybrid learning</li> <li>• On-campus living (unknown %) <ul style="list-style-type: none"> <li>○ Quarantine before arrival</li> <li>○ Staggered arrivals</li> </ul> </li> </ul>	<p>Surveillance/testing plan:</p> <ul style="list-style-type: none"> <li>• Testing (symptomatic, entry)</li> <li>• Surveillance (asymptomatic; pooled testing; 1-2x/week, focus on cohorts where data suggested an increased risk for transmission)</li> <li>• Contact tracing</li> <li>• Screening (daily symptom self-monitoring (smartphone app; results linked to testing))</li> </ul> <p>Other IPAC measures:</p> <ul style="list-style-type: none"> <li>• De-densification (residences, all single; classrooms, common areas)</li> <li>• Hand hygiene</li> <li>• Masks</li> <li>• Physical distancing</li> <li>• Quarantine policy</li> </ul> <p>*Students signed formal agreement to follow IPAC measures; testing was mandatory (could lose access to campus facilities / services).</p>	<p>From Aug 2 – Oct 11, 2020, 68,913 tests from 10,265 students identified 84 positive cases:</p> <ul style="list-style-type: none"> <li>• 17 (20.2%) upon entry (8,873 tests)</li> <li>• 29 (34.5%) pooled (59,476 tests)</li> <li>• 15 (17.9%) symptomatic (185 tests)</li> <li>• 23 (27.4%) close contacts (379 tests)</li> </ul> <p>51% of positive cases were asymptomatic.</p> <p>Weekly per-capita infection incidence averaged 0.08% (vs. 0.1% in the county, at the time).</p> <p>Asymptomatic and testing of close contacts accounted for 73% of identified positive COVID-19 cases.</p> <p>Student compliance for testing was 95%.</p> <p>No classroom transmission; no substantial outbreaks.</p>	<p>Moderate</p>
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## Table 2: In-progress Single Studies

Title	Anticipated Release Date	Setting	Description of Document
Fretheim, A., Flatø, M., Helleve, A., Helseth, S., Jamtvedt, G., Løyland, B., ... Walte, S. S. V. (2020). <a href="#">Relationship between in-person instruction and COVID-19 incidence among university students: A prospective cohort study.</a> <i>Preprint.</i>	Aug 2021	Universities and university-colleges in Norway	This study will explore whether on campus learning, with infection control measures in place, is associated with higher COVID-19 incidence than online instruction.

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