Supplementary Online Content

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**eReferences.**

This supplementary material has been provided by the authors to give readers additional information about their work.

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**eMethods.**

**Statistical methodology**

To evaluate the association between the average residential case rate in institution $i$ in semester $s$ with the average test rate in that institution, adjusting for the average case rate in the surrounding town, we fit a linear model

$$(\text{average case rate})_{is} = \alpha + \beta(\text{average test rate})_{is} + \gamma(\text{average town case rate})_{is} + \epsilon_{is}$$

where $\epsilon_{is}$ is an independent error term for institution $i$ in semester $s$. The estimated coefficients and 95% confidence intervals are shown in eTable 2.

To evaluate the change in close interpersonal contact when residential students were brought back to campus, we fit the following linear regression model for institution $i$ in week $w$:

$$(\log \text{average contact})_{iw} = \alpha + \beta(\text{students in residence})_{iw} + \gamma(\text{semester})_{iw} + \delta(\text{students in residence})(\text{semester})_{iw} + \epsilon_{iw}$$

where the coefficient $\delta$ corresponds to the interaction of the indicator that students are in residence and semester, and $\epsilon_{iw}$ is an independent error term for institution $i$ in week $w$. The estimated coefficients and 95% confidence intervals are given in the main text.

To visualize the weekly change in average contact following arrival of residential students on campus, we fit the following model

$$(\log \text{average contact})_{iw} = \beta_w(\text{students in residence})(\text{semester})_{iw} + \epsilon_{iw}$$

where $w$ is measured in weeks relative to arrival of students on campus. eFigure 4 shows estimated weekly coefficients and 95% confidence intervals for both semesters.

To evaluate the association between the residential case rate in institution $i$ in week $w$ with the weekly test rate in that institution, while adjusting for the case rate in the surrounding town, we fit a linear model

$$(\text{case rate})_{iw} = \sum b \beta_b(\text{test rate in bin } b)_{iw} + \gamma(\text{town case rate})_{iw} + \epsilon_{iw}$$

where the sum is over discretized weekly residential testing rate with bins (tests per residential student per week):

$$(0, 0.25], (0.25, 0.5], (0.5, 0.75], (0.75, 1.0], (1.0, 1.25], (1.25, 1.5], (1.5, 1.75], (1.75, 2.0], (2.0, \infty)$$

The error term $\epsilon_{iw}$ is independent for institution $i$ in week $w$. This binned model has no intercept so that we can interpret the coefficients $\beta_b$ as the estimated change in case rate under testing rate in bin $b$, holding town case rate constant. The estimated coefficients $\beta_b$ and 95% confidence intervals are shown in Figure 5 in the main text and numerical results are shown in eTable 4.

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To evaluate the association between case rates in towns where institutions are located and case rates in those institutions, we fit a linear model

\[(town \ case \ rate)_{is} = \alpha + \beta_s(campus \ case \ rate)_{is} + \epsilon_{is}\]

where the coefficient \(\beta_s\) corresponds to semester \(s\) and \(\epsilon_{is}\) is an independent error term for institution \(i\) in semester \(s\). Estimated coefficients are shown in eTable 3.

eAppendix. Additional Results

Details of university plans and policies

eTable 1 shows summary information on COVID-19 residential student testing policies for 18 Connecticut colleges and universities according to public documents and plans submitted to the Connecticut Department of Public Health (CT DPH). We examined four institutions that grant baccalaureate degrees and eleven that also offer masters or doctoral degrees. The number of residential students in the fall ranged from 235 (Albertus Magnus College) to 4,603 (University of Connecticut). Most institutions had fewer residential students in the spring semester. In the fall, CT DPH recommended that students test negative within 14 days of returning to campus. Ten institutions adopted this policy, while seven required a negative test within 7 days of move-in. The University of Connecticut did not require pre-arrival testing but tested students on move-in day; three other universities also tested students upon move-in. Eleven institutions outlined plans to comply with an initial 14-day quarantine for students coming from “hot spot” areas as mandated by Executive Order 7III1,2. Five required all students to quarantine regardless of origin, and two did not have available data on arrival quarantine policies. Thirteen institutions planned for to test 5-10% of residential students each week, the level recommended by CT DPH, while Quinnipiac University stated it would test 15% of students per week. Connecticut College, Trinity College, Wesleyan University, and Yale University stated they would test residential students at least once per week. Twelve institutions implemented a daily health check throughout the semester, while three had a health check for the first 7 days as recommended by CT DPH. Two institutions didn’t have include information on a daily health check in their reopening plans.

CT DPH issued updated guidance for spring 2021 in early January, following several college outbreaks during the fall and increasing statewide incidence 3. Recommendations for residential students included entry testing within 7 days before move-in and on move-in day, a 7-14 day quarantine period, and continued weekly testing through the end of February. Twelve institutions required a test within 7 or fewer days prior to move-in with 5 giving larger windows (i.e., 10 or 14 days) for pre-arrival tests. No data on testing, quarantine policy, or daily health checks was available from the University of Saint Joseph for the spring semester. Eleven school explicitly stated that students were tested on move-in day, while three other schools specified students would be tested within 2-5 days following move-in (Fairfield University), within 6-10 days following move-in (University of Bridgeport) and within 9 days following
move-in (University of New Haven), respectively. Though no other schools explicitly specified testing students upon arrival, most had plans stating they were conducting weekly testing of residential students at the beginning of the semester; therefore, it is feasible this weekly testing began the day of move-in. Fourteen institutions reported implementing a quarantine of 7 days or longer for residential students, in line with CT DPH recommendations. Four had no available data on initial quarantine. Sixteen institutions planned to test students at least weekly through the end of February, as recommended by CT DPH; as in the fall semester, Connecticut College, Trinity College, Wesleyan University, and Yale University stated plans to test students more than once per week. During the spring semester, CT DPH extended its weekly testing recommendations through the end of the semester\(^4,5\); this guidance is not reflected in institutions’ reopening plans which were submitted prior to the start of the semester. Twelve institutions adopted a daily health check throughout the semester, while three implemented this measure only for the first 7 days following move-in and three did not include information on this in their reopening plans.

*Cases as a function of contact*

In both the fall and spring semesters, institutions with higher contact rates had higher case rates (eFigure 6). In the fall semester, most colleges were conducting low levels of testing (less than half of residential students per week). The four institutions with the highest testing rates (Connecticut College, Trinity College, Wesleyan University, and Yale University) had low contact rates and low case rates. Case rates were higher in the spring semester, despite higher testing rates and similar or lower testing rates. As in the fall semester, the four institutions testing students twice per week had the lowest contact rates and case rates.

*Percent of residential student cases detected through institution screening program*

eFigure 7 presents data on the frequency of residential student testing and the proportion of cases detected through each institution’s screening program (compared with the proportion self-reported by students). In the fall, Yale University and the four state universities didn’t report data on self-reported cases. Of the institutions that reported, four institutions detected nearly all cases through their residential testing program (Connecticut College, Mitchell College, Trinity College, and Wesleyan College); of those institutions, three tested their students more than once per week. The remaining institutions detected at least 50% of residential student cases through the testing program, with the exception of Albertus Magnus College. In the spring, increased testing frequency did not lead to improved proportion of cases detected within the testing program. Three of the four institutions detecting almost every case through the testing program (Connecticut College, Wesleyan University, Western Connecticut State University, and Yale University) tested students more than once per week. It is unclear how practices on recording self-reported tests varied between institutions.
eFigure 8 examines total campus cases by the number of residential students each semester. In both semesters, institutions with more residential students had more total campus cases. However, among institutions with high absolute number of total cases, the proportion of cases occurring among residential students was not uniform. While high case counts for Quinnipiac University and Fairfield University in the spring semester were driven by a high proportion of residential student cases, these cases only accounted for approximately half of total campus cases in the three schools with the highest case counts in the fall semester (Sacred Heart University, Fairfield University, and Quinnipiac University, respectively).
eFigure 1. Connecticut Institutions of Higher Education Studied in This Analysis
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Fall 2020 includes data from full weeks between move-in and move-out, while spring 2021 includes data from move-in through the last week of March when college-age individuals became eligible to receive the COVID-19 vaccine in Connecticut.
eFigure 7. Residential Student Testing Rate and Percent of Residential Cases Detected Through University Testing Program, by Semester

Semesters include data from full weeks between move-in and move-out.
Total campus cases include reported cases among residential students, commuter students, and staff/faculty. Semesters include full weeks between move-in and move-out.
eTable 1. University Characteristics, Residential Enrollment, and COVID-19 Plans and Policies for Residential Students During the 2020-2021 Academic Year

Bacc. = Baccalaureate; Quar. = quarantine

| Institution                     | Institution Type       | Highest Degree | Residential Enrollment | Repopulation                  | Monitoring                                      | Sources                                                                 |
|---------------------------------|------------------------|----------------|------------------------|--------------------------------|------------------------------------------------|------------------------------------------------------------------------|
| Albertus Magnus College          | Private (Catholic)     | Masters        | 235 203                | Test <7 days prior, day of arrival; No quar. data | 5-10% tested weekly; Daily health check        | Gstalder,6 2021; Barr,7 2020; Heitz,8 2021                                |
| Central Connecticut State University | Public               | Masters        | 992 743                | Test <14 days prior; 14 day quar. from high-risk areas | 5-10% tested weekly; Daily health check        | Cintorino,9 2020; Cintorino, 202010                                      |
| Connecticut College             | Private                | Bacc.          | 1358 1150              | Test <7 days prior, day of arrival; 14 day quar. before/after arrival | All tested 2x weekly; Daily health check        | Arcelus,11 2020; Arcelus,12 2020; “Campus Life”,13 2021; COVID-19 Response Team,14 2021 |
| Eastern Connecticut State University | Public               | Masters        | 1830 1579              | Test <14 days prior; 14 day quar. from high-risk areas | 5-10% tested weekly; No daily health check     | DeLisa,15 2020; DeLisa,16 2020; “Housing and Student Life”,17 2021        |
| Fairfield University            | Private (Catholic)    | Masters        | 3119 2894              | Test <14 days prior; 14 day quar. from high-risk areas | 5-10% tested weekly; Daily health check        | Lawlor,18 2020; “Return to Campus”,19 2020; Donoghue,20 2021             |
| Institution                          | Type       | Degree | Intake 1  | Intake 2  | Test Policy                                                                 | Quarantine Policy                                      | Testing Frequency                   | Health Check Frequency               | Authors, Year |
|------------------------------------|------------|--------|-----------|-----------|------------------------------------------------------------------------------|--------------------------------------------------------|--------------------------------------|--------------------------------------|----------------|
| Mitchell College                   | Private    | Bacc.  | 553       | 325       | Test <5 days prior; No quar. data                                              | Test <3 days prior; 15-20 day quar.                   | 5% tested weekly; Daily health check | All tested weekly; Daily health check | Wright, 2021; “MiniMester”, 2021; “Returning to Campus”, 2020 |
| Quinnipiac University              | Private    | Masters | 3845      | 3750      | Test <7 days prior, 6-12 days after; 14 day quar. from high-risk areas         | Test 10 days prior, day of arrival; 11 day quar.      | 15% tested weekly; Daily health check | All tested weekly through Feb, then 20%; Daily health check | Zemba, 2020; Drucker, 2021; “8 new things”, 2021 |
| Sacred Heart University            | Private (Catholic) | Masters | 3037      | 2690      | Test <14 days prior; 14 day quar. from high-risk areas                         | Test <7 days prior, day of arrival; 14 day quar.      | 5-10% tested weekly; Daily health check | All tested weekly through Feb; Daily health check | MacNamara, 2020; “Community Updates”, 2021 |
| Southern Connecticut State University | Public | Masters | 1433      | 1042      | Test <14 days prior; 14 day quar. from high-risk areas                         | Test <14 days prior, day of arrival; 7 day quar.      | 5-10% tested weekly; Daily health check for first 7 days | All tested first week, then 5-10% weekly; Daily health check for first 7 days | Richardson, 2020; Richardson, 2021 |
| Trinity College                    | Private    | Bacc.  | 1670      | 1614      | Test <5 days prior; 14 day quar. before or after*                             | Test <7 days prior, day of arrival; >7 day quar.      | All tested 2x weekly for first 3 weeks, then weekly; Daily health check | All tested 2x weekly; Daily health check | Berger-Sweeney, 2020; DiChristina, 2020; DiChristina, 2021; “CoVerified”, 2021 |
| University of Bridgeport           | Private    | Masters | 520       | 580       | Test <14 days prior; 14 day quar. from high-risk areas                         | Test <5 days prior, 6-10 days after initial test; No quar. data | 5-10% tested weekly; Daily health check | All tested weekly; Daily health check | Schmidt, 2020; “FAQ”, 2021; Sanders, 2021 |
| University of Connecticut          | Public     | Doctoral | 4603      | 4492      | Test day of arrival; 14 day quar.                                              | Test 5-7 days prior, day of arrival; 14 day quar.      | 5-10% tested weekly; Daily health check for first 7 days | All tested weekly through Feb; No daily health check | Jordan, 2020; Jordan, 2021 |

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| Institution                          | Type      | Program  | Campus  | City   | State | Start Test Date | Duration of Quarantine | Weekly Testing Requirement | Daily Health Check | References                           |
|-------------------------------------|-----------|----------|---------|--------|-------|----------------|--------------------------|----------------------------|---------------------|--------------------------------------|
| University of Hartford              | Private   | Doctoral | 2325    | 2050   | CT    | <14 days prior; 14 day quar. from high-risk areas | Test <7 days prior, day of arrival; 8-11 day quar. | 5-10% tested weekly; Daily health check | All tested weekly; Daily health check | Nicklin, 2020; “Testing for COVID-19”, 2021; Office of Marketing and Communication, 2021 |
| University of New Haven             | Private   | Masters  | 2679    | 2289   | CT    | <5 days prior; 14 day quar. from high-risk areas | Test 5 days prior, within 9 days of arrival; 7-9 day quar. | 5% tested weekly; Daily health check | All tested weekly; Daily health check | McGee, 2020; McGee, 2021; McGee, 2021 |
| University of Saint Joseph          | Private   | Masters  | 296     | 239    | CT    | <14 days prior; 14 day quar. from high-risk areas | No data available | 5-10% tested weekly; Daily health check | No data available | Free, 2020; DiSalvo, 2021 |
| Wesleyan University                 | Private   | Bacc.    | 2516    | 2446   | CT    | <3 days prior*; 7-14 day quar. | Test <7 days prior, day of arrival; 14 day quar. | All tested 2x weekly; No daily health check | All tested 2x weekly; No daily health check | Culliton, 2020; “All About Testing”, 2021; Whaley, 2020; “Safety Guidelines”, 2021; “Prepare for Arrival”, 2021 |
| Western Connecticut State University| Public    | Masters  | 805     | 686    | CT    | <14 days prior; 14 day quar. from high-risk areas | Test <14 days prior; No quar. data | 5-10% tested weekly; Daily health check for first 7 days | 25% tested weekly; Daily health check for first 7 days | Koukopoulos, 2020; Koukopoulos, 2020 |
| Yale University                     | Private   | Doctoral | 1829    | 2065   | CT    | <14 days prior, day of arrival; 14 day quar. | Test <14 days prior, day of arrival; 8-10 day quar. | All tested 2x weekly; Daily health check | All tested 2x weekly; Daily health check | Spangler, 2020; Boyd, 2020; Chen, 2021; “Yale Community Compact”, 2021 |

*recommended policy
eTable 2. Linear Regression Estimates and 95% Confidence Intervals Describing the Negative Association Between Residential Test Rate (per Student per Week) and Residential Case Rate (per Student per Week), Adjusted for Town Case Rate per Person

|                          | Estimate | 2.5%  | 97.5% |
|--------------------------|----------|-------|-------|
| Intercept                | 0.00411  | 0.00211 | 0.00611 |
| Residential test rate    | -0.00141 | -0.00281 | -0.00001 |
| Town case rate           | 0.43244  | -0.50911 | 1.37399 |
eTable 3. Linear Regression Estimates and 95% Confidence Intervals Describing the Association Between Residential Case Rate (per Student per Week) and Town Case Rate (per Person per Week)

The association is estimated to be positive during fall 2020, and not significantly different from zero during spring 2021.

|                        | Estimate | 2.5%   | 97.5%   |
|------------------------|----------|--------|---------|
| Intercept              | 0.00182  | 0.00169| 0.00195 |
| Fall 2020 residential case rate | 0.08446  | 0.06065| 0.10827 |
| Spring 2021 residential case rate | 0.01871  | -0.00228| 0.03970 |
eTable 4. Association Between Tests per Student per Week and Cases per Student per Week, by Test Frequency

| Tests per student per week | Estimate  | 2.50%   | 97.50%  |
|----------------------------|-----------|---------|---------|
| (0,0.25]                  | -0.00062  | -0.00195| 0.00070 |
| (0.25,0.5]                | 0.00145   | -0.00012| 0.00303 |
| (0.5,0.75]                | 0.00279   | 0.00070 | 0.00489 |
| (0.75,1]                  | 0.00327   | 0.00187 | 0.00466 |
| (1,1.25]                  | 0.00501   | 0.00288 | 0.00713 |
| (1.25,1.5]                | 0.00023   | -0.00319| 0.00365 |
| (1.5,1.75]                | -0.00069  | -0.00326| 0.00188 |
| (1.75,2]                  | 0.00122   | -0.00066| 0.00311 |
| (2,∞]                     | 0.00042   | -0.00296| 0.00381 |
| town case rate            | 1.40494   | 1.00252 | 1.80736 |
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