"Return to University Campuses Associated with 9% Increase in New COVID-19 Case Rate"

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Abstract

The vast majority of colleges and universities across the United States are bringing students back for in-person instruction in the midst of the COVID-19 pandemic, despite the absence of an effective vaccine or other anti-viral therapeutic treatment. Using data from the New York Times and the American Community Survey, we assess the effect of this return to campus on viral case growth in counties with a significant college student population ("college counties") relative to non-college counties. We find a significant surge in new cases in a 21-day time frame in college counties, a finding consistent across U.S. Census divisions. These results suggest the need for institutions of higher education and the communities where these institutions reside work together quickly and effectively to mitigate viral transmission and to prevent overwhelming local healthcare infrastructure in college counties.

Introduction

In March of 2020, institutions of higher education across the United States pivoted abruptly to remote teaching in response to the COVID-19 pandemic[1]. These institutions complied with the shelter-in-place policies and public health guidance that sought to "flatten the curve," and slow the speed of virus transmission.[2]

Throughout the summer that followed, colleges and universities nationwide began to formulate plans to reopen in the fall, or to remain closed to in-person student life and instruction. While the approaches taken by these postsecondary institutions to promote public health and safety have varied, the commonality shared across schools with any in-person instruction is the significant influx of students to the communities where these institutions are located.

According to the most recent data tracked by Davidson College's College Crisis Initiative, only 191 of 2,958 colleges and universities are fully online for fall semester 2020.[3] This means that the vast majority of U.S. institutions of higher education are bringing students back to campus in some way, and that this fall's return to campus is occurring without a vaccine to prevent or effective therapeutic to treat the Sars-CoV-2 virus.

This return to campus in the midst of an ongoing global pandemic brings together a disease that spreads rapidly through

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respiratory droplets and a population that is prone to spending substantial time in large groups, especially at bars and parties, which are high risk scenarios for COVID-19 transmission.[4,5] Indeed, despite the best laid plans for a "safe" return to campus, already some institutions of higher education are ceasing or substantially decreasing in-person activities and pivoting back to remote instruction. Others soldier on, despite alarming increases in cases among the study body and surrounding community.

Our goal in this data analysis is to describe the initial return to campus rise in COVID-19 cases in college counties across the United States during late August and early September 2020. We present a novel measure of the "return to campus COVID19 new case rate" and provide descriptive evidence of how and where outbreaks are emerging in college counties. We estimate that counties where 10 percent or more of the population is enrolled in college experience a 9 percent increase in the new COVID19 case rate during the return to campus period as compared to other counties. This significant rise in COVID19 case rates associated with the return of college students to college towns has substantial implications for public health, especially in rural communities with already strained healthcare infrastructure and worrisome health disparities.

Study Data & Methods

Our data come from two publicly available sources. Census divisions, the percent of the population aged 18 to 24, and total county population data come from the U.S. Census Bureau.[6] COVID19 case counts and deaths come from the New York Times COVID19 database.[7] COVID-19 case data are available at the county-day level, which is the unit of analysis. The observation time frame extends retrospectively, twelve weeks from the most recent case reporting available at the time of our writing, from June 14 through September 6, 2020. The county day sample size is 3,118 records.

The main outcome of interest is what we term the *new case rate,* where the number of new cases in the last three weeks prior to September 6 (August 16) was divided by the cases in the twelve weeks prior to this date (June 14). To produce a comparable scale with the main variable of interest (percentage college students), this ratio is multiplied by 100. If cases were distributed evenly, we would expect a rate of 25%, as three weeks is one-quarter of the twelve-week study period. A higher number would thus indicate a surge of new cases, while a lower one would indicate a tapering off of cases.

The independent variable of interest is a dichotomous indicator of whether the county is defined as a "college county." To

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operationalize this hypothesis, we use data from the 2014-18
American Community Survey showing the number of individuals ages
18 to 24 currently enrolled in public college or graduate
school. We rely on the New York Times decision rule of assigning
a value of "1" to a county if at least 10% of the county's total
population is comprised of college students ages 18-24 (n=135);
counties that do not meet this criterion are assigned a "0" val-
ue (n=2,983). In addition to the new case rate and the college
county indicator, we use the geographic areas defined as the
nine U.S. Census divisions to control for regional variation. We
also control for total county population.

　　We estimated descriptive statistics for all variables and
include those in Exhibit 2. We then estimated a regression model
using the return to campus new case rate as the outcome of in-
terest. As a sensitivity analysis, we also estimated an alterna-
tive outcome using a rate that is the return to campus new cases
(the most recent 21 days) divided by total cases since the be-
ginning of the pandemic. We also created a linear model for just
college counties including the percentage of college students
along with census division and total population. All estimates
were conducted using R v.3.6.0.

[Exhibit 1: U.S. Map of Census Divisions & COVID19 Case Growth
here.]

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Study Results

Descriptively, the new case rate varies notably within most census divisions, as shown in Exhibits 1, 2, and 3. In all but the Mountain Division, college counties have median rates higher than other counties. As Exhibit 2 shows, those differences range from 3.4% in the Pacific Division to 18.9% in the West North Central Division. The median new case rate is higher than 25% for college counties in all divisions except the Pacific and Mountain Divisions, indicating a surge in recent cases, with a maximum value of 54.6% in the West North Central Division. This may be partly due to a high new case rate for non-college counties (36%). Yet as the boxplots illustrate, this is only slightly higher than the neighboring East North Central Division (33%). In that division, new case rates for college counties are only 37%, 18% lower than in the West North Central Division.

Exhibit 1 visualizes this through a map of county rates, with college counties highlighted as circles. The dark colors for many counties in the East and West North Central Divisions show the general surge of cases there, but almost all college counties have values at the high end of the classification range. In the East South Central and South Atlantic Divisions, new case rates are lower, but the college counties in these areas are still high relative to non-college counties.

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The total population of college counties is consistently

higher than non-college counties, with the only exception being

the Middle Atlantic Division. This is largely due to the rural

nature of most counties nationally. The median percentage of

college students ranges from 1.7% to 2.4% in non-college coun-

ties. Lastly, college counties are most numerous in the West

North Central and South Atlantic Divisions (25 in each) and

least numerous in New England (4), though the rate in the latter

(6% of 67 total counties) is higher than in the former (4% in

each).

[Exhibit 2: Box Plot of Difference in Median Return to Campus
Case Rate Change by Census Division here.]

[Exhibit 3: Table of Descriptive Statistics here.]

The results of our primary model (model 1, shown in Exhibit

4) indicate that college counties have a significant, positive

association with higher new case rates, one that is 9.2% higher

than other counties in their divisions, controlling for popula-

tion size. This coefficient is slightly smaller (8.5%) in model

2, where the new case rate uses all reported cases as a baseline

rather than the last 12 weeks.

The coefficient for total population is negative in both

these models, which indicates that the new case rate is higher

in counties with smaller population. The magnitude and direction

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of this coefficient is similar (-0.39, significant) even when
the college county variable is removed. The control variables
for division are significant in both models 1 and 2 in the West
and East North Central, East South Central, and Middle Atlantic
Divisions (the Pacific Division is used as a reference). These
coefficients are mostly positive, as both Exhibits 1 and 2 show
recent surges in the first three divisions. The R^2 shows a modest
fit (0.153) for these models.

When considering just college counties (model 3), model fit
is much stronger ($R^2=0.346$), as many counties with high rates but
few college students have been removed. The coefficient for the
rate of college students is positive and significant (0.97), in-
dicating that new case rates increase approximately 1% for each
additional 1% of college students in the population. Thus, case
surges in college counties are greater in towns with a greater
percentage of students.

[Exhibit 4: Model Results here.]

[Exhibit 5: Graph of Model 3 Goodness of Fit here.]

Discussion
We find support for the hypothesis that the return to col-
lege and university campuses across the United States is associ-
ated with significant increases in county-level new case rates,

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controlling for the county population and Census division. Col-
lege counties (those with >10% of their population enrolled in
colleges or universities) show significant increases in new case
growth relative to counties not in this category. These findings
serve as preliminary evidence of the effect of in-person return
to college campuses on COVID19 viral transmission in the coun-
ties where these postsecondary institutions are located.

Our response to the pandemic as a society has rapidly
evolved from full-scale lockdown in the first wave of infec-
tions, to a fully reopened economy during the summer that has
remained open despite new waves of infections. In the beginning
of the pandemic in the United States, many local and state ju-
risdictions adopted and implemented shelter-in-place (SIP) poli-
cies. These policies required that individuals stay at home un-
less conducting essential tasks (such as grocery shopping or
picking up prescriptions) or performing essential work functions
(such as healthcare provision).

During this time period, which spanned from mid-March to
late April, over 94% of the American population was under a SIP
order.[8] The SIP policies and the weeks that followed their imple-
mentation meant that most individuals were socially isolated,
with implications for individuals and households in experiencing
increased loneliness and decreases in mental wellbeing.[9,10] This

also applied to students in the postsecondary education popula-
tion. Colleges and universities shut down in-person operations
and moved classes to virtual delivery.

After months of SIP policies, followed by a mixed landscape
of less formal recommendations at state and local levels to
maintain social distancing standards and to avoid large groups,
colleges and universities have brought millions of students back
to campuses across the country. The students could have a sig-
nificant pent-up demand for social engagement and a desire for a
return to normalcy, despite the persistence of the pandemic.
Preliminary evidence of the effects of the pandemic and SIP
policies show that "quarantine fatigue" was evident as early as
mid-April.[11] By the fall 2020 return to campus, quarantine and
pandemic fatigue are likely much worse.

The success of limiting viral transmission rests on our
ability and willingness as a society to comply with public
health mitigation efforts, included but not limited to consis-
tent mask wearing, social distancing, avoiding large groups (es-
pecially indoors), access to testing with timely results, com-
pliance with contact tracing, and quarantine and isolation when
exposed or testing positive. Policies within institutions/sys-
tems of higher education as well as college counties should at-
tend to the specific developmental stage of young adulthood and

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leverage incentives for compliance accordingly.[12,13] As many are now discovering, simply cajoling young people to stay home and not spend significant time with their peers is ineffectual and developmentally inappropriate.

Limitations

Interpretation of our findings requires some caution. First, we would expect that part of the case increase in counties with institutions of higher education is simply a direct function of the population of those counties increasing with the return to campus. Second, there is significant variation in local and state-level policy response to the pandemic that is a potential source of omitted variable bias in our analysis. Third, post-secondary institutions are taking myriad approaches to their return to campus.

The work of Chris Marsicano and colleagues have documented the various approaches to this policy landscape. These range from full scale returns to campus with in-person instructions, to hybrid models combining the return to in-person combined with virtual learning, to completely moving instructions and university operations online for the duration of the 2020-2021 academic year.[14] We are unable to account for the nuances of the variation in instructional model, in addition to the various ap-

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proaches that are being taken to testing, contact tracing, and other pandemic mitigation strategies.

Conclusion

Our analysis reveals a strong association between student return to campus and new case growth, specifically in "college counties" in the United States. For these counties, where at least 10% of the county population is comprised of college students, we see an average increase of 9% in the new case rate relative to non-college counties. These findings are consistent across the country at the U.S. Census Division level, with the Mountain Division as the only exception.

Return to campus case rates grow significantly in college counties when controlling for both the county population and the college or university population, and the findings are robust whether we estimate the models across the total pandemic observation period and the 60 days prior to campus return. These findings suggest that despite the efforts of colleges and universities to prepare for a safe return to campus, virus transmission has persisted among college students and is rapidly evolving in ways that has already created new "hot spots." The science on COVID19 transmission is still developing, but thus far it has been established that the spread is a function of

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respiratory droplets from infected persons coming into contact with non-infected persons.

Given this reality, colleges and universities and the communities in which they are embedded must act quickly to intervene to slow the transmission before seasonal change and colder weather brings flu season. While it is expensive for postsecondary institutions to pivot and forgone revenue will come with its own host of consequences for both these institutions and the counties where they are located, COVID-19 transmission has already reached levels that could lead to overwhelm the healthcare systems of these college counties. Prioritizing public health demands that until effective vaccines or other anti-viral therapeutics are developed, policy approaches of postsecondary institutions and local county governments will have to become more collaborative and aggressive to control viral transmission.

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Exhibit 1. U.S. Map of New Case Rate by County and Census Division.

New case rate

- < 15%
- 15% - 25%
- 26% - 40%
- 41% - 60%
- > 60%

Census Divisions

1: New England
2: Middle Atlantic
3: East North Central
4: West North Central
5: South Atlantic
6: East South Central
7: West South Central
8: Mountain
9: Pacific (includes AK & HI)

College counties shown as circles

New case rate: Cases in last 3 weeks / Cases in last 12 weeks
Data: New York Times, 2014-2018 ACS, U.S. Census
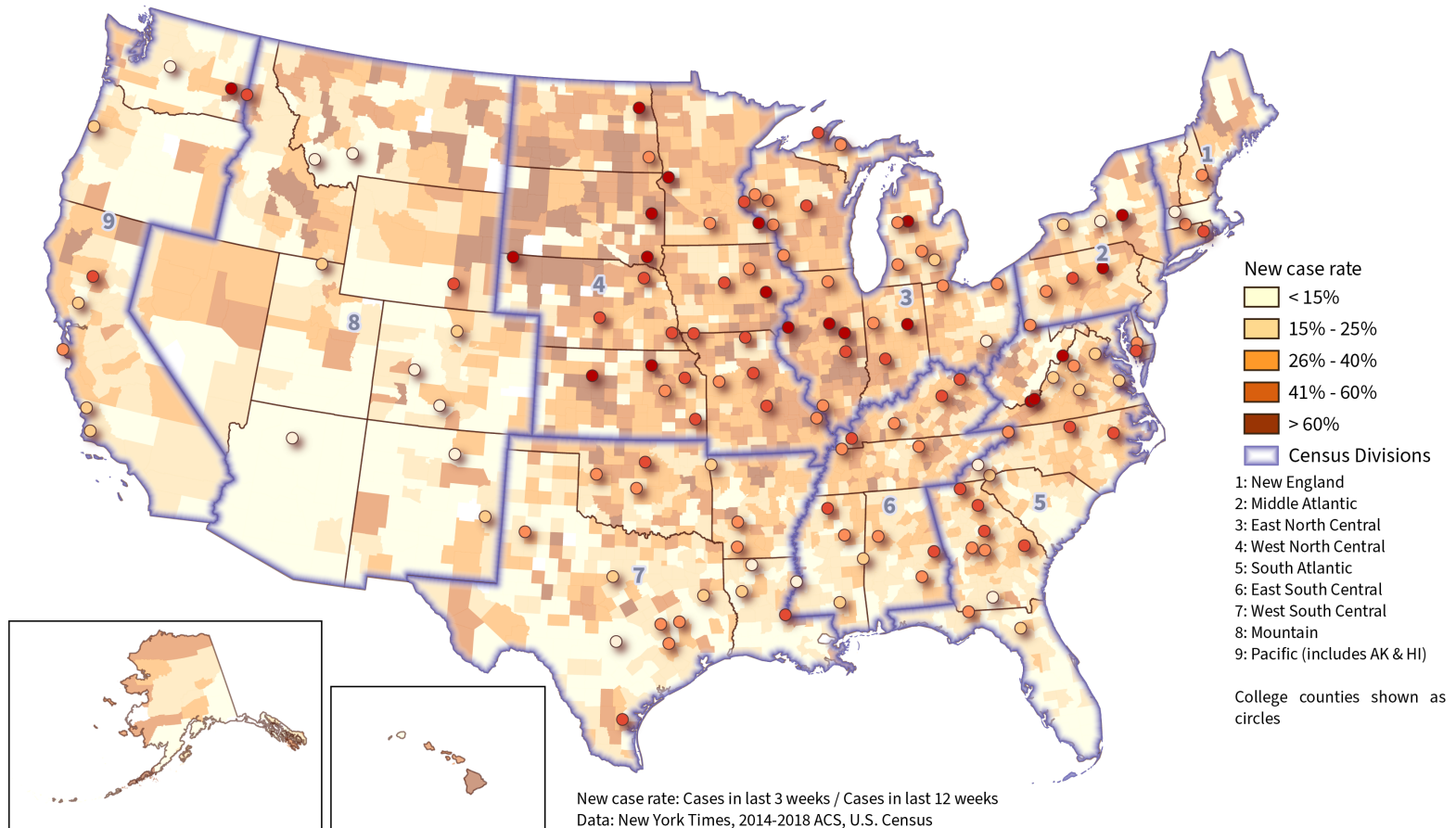
Exhibit 2. Box Plot of New Cases in College Counties vs. Non-College Counties by Census Division.

Orange counties = college counties
Grey counties = all other counties
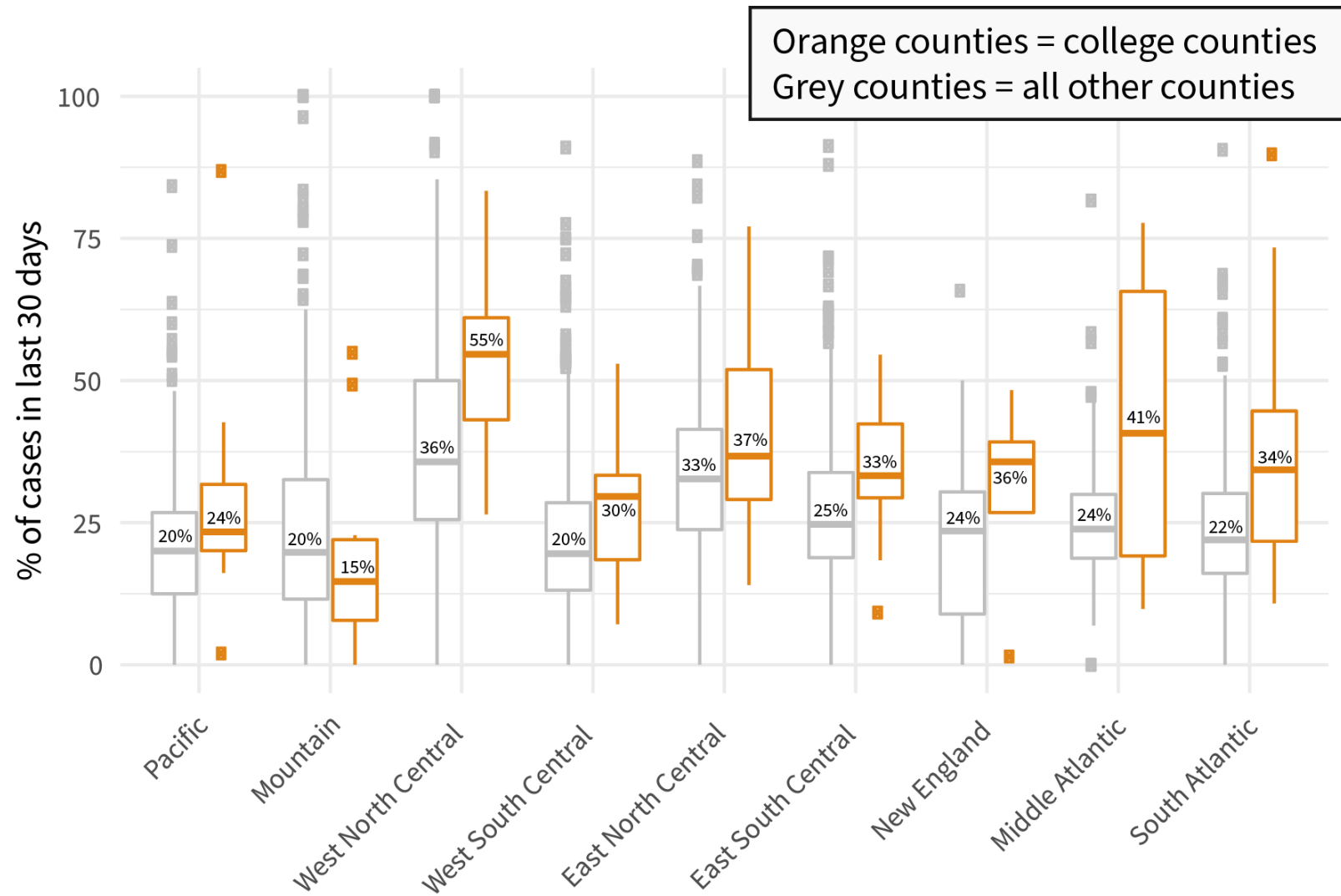
Exhibit 3. Descript

Division	Type	Count	New case rate		Total population		Pct population in college			Difference_ncr
			Median	IQR	Median	IQR	Median	IQR		
Pacific	Non-college	153	20.0	14.3	62,921	196,758	2.3	2.2		3.4
	College	8	23.4	11.7	218,906	196,842	14.3	7.3		
Mountain	Non-college	264	19.8	21.0	14,158	39,342	1.7	1.6		-5.1
	College	11	14.7	14.2	37,944	94,230	13.7	4.3		
West North Central	Non-college	589	35.7	24.5	10,250	18,777	1.7	1.2		18.9
	College	25	54.6	18.0	44,873	52,952	16.4	9.1		
West South Central	Non-college	450	19.6	15.4	20,430	38,958	2.1	1.4		10.1
	College	17	29.6	14.9	48,443	163,303	14.6	5.1		
East North Central	Non-college	412	32.7	17.6	36,561	59,712	2.1	1.0		4.0
	College	25	36.7	22.9	102,388	109,540	15.6	6.9		
East South Central	Non-college	350	24.7	15.0	24,354	33,974	2.3	1.1		8.6
	College	14	33.3	13.0	51,068	51,832	13.6	5.9		

New England	Non-college	63	23.5	21.5	70,926	204,284	2.4	1.3		12.2
	College	4	35.7	12.4	139,074	27,535	12.9	4.0		
Middle Atlantic	Non-college	139	23.9	11.2	107,088	249,486	2.4	1.6		16.9
	College	6	40.7	46.5	65,494	19,911	12.3	2.2		
South Atlantic	Non-college	563	22.0	14.1	32,037	75,218	2.3	1.2		12.3
	College	25	34.3	22.9	53,064	86,914	18.0	10.6		

ive Statistics.

Exhibit 4. Mod

	Model 1: Case ratio (last 12 weeks)	Model 2: Case ratio (all dates)	Model 3: Case ratio (12 weeks, college counties)
College county (dichotomous)	9.237***	8.520***	
	(-1.378)	(-1.29)	
% college students, 18-24			0.973***
			(-0.23)
Total population (in 100k)	-0.385***	-0.439***	-1.366
	(-0.089)	(-0.084)	(-1.929)
Divisions			
Mountain	1.289	-0.238	-10.623
	(-1.567)	(-1.468)	(-8.195)
West North Central	15.793***	11.427***	20.194***
	(-1.41)	(-1.32)	(-7.336)
West South Central	-0.345	-0.132	-1.007
	(-1.446)	(-1.354)	(-7.453)
East North Central	11.330***	6.072***	10.829
	(-1.456)	(-1.363)	(-6.98)
East South Central	4.781***	3.377**	3.827
	(-1.501)	(-1.405)	(-7.853)

New England	-0.118	-11.137***	3.315
	(-2.277)	(-2.132)	(-10.365)
Middle Atlantic	4.178**	-7.175***	14.3
	(-1.794)	(-1.679)	(-9.393)
South Atlantic	1.69	-0.777	1.927
	(-1.405)	(-1.316)	(-7.175)
Observations	3118	3118	135
R²	0.153	0.147	0.346
Residual Std. Error	15.647 (df = 3107)	14.650 (df = 3107)	16.726 (df = 124)
F Statistic	56.172*** (df = 10; 3107)	53.753*** (df = 10; 3107)	6.567*** (df = 10; 124)

el Results.

Exhibit 5. Goodness-of-fit plot.