School Closures' Potential Effects on COVID-19 Deaths

Original paper:
https://www.bsg.ox.ac.uk/sites/default/files/2020-04/BSG-WP-2020-031-v4.0_0.pdf
Data:
https://covidtracker.bsg.ox.ac.uk/
Full code:
https://colab.research.google.com/drive/1z_9obvCFl2gAxk3ckVRC-ncMwexVz0Hl

Introduction

Researchers Hale, Petherick, Phillips, and Webster at the Blavatnik School of Government, University of Oxford, have gathered daily data on 147 countries' government responses to the COVID-19 pandemic since January 1, 2020. They measure "common policy responses" in 13 areas, including limits on various types of public gatherings, fiscal measures, and coronavirus testing; they also note whether certain measures are targeted or general.

The researchers then issue an overall stringency index for each country's response, provided enough data has been collected. Their publication has focused on tracking and plotting this overall stringency index related to the number of confirmed coronavirus cases and deaths in certain countries (https://covidtracker.bsg.ox.ac.uk/stringency-scatter).

S1 School Closing	0 - No measures 1 - Recommend closing 2 - Require closing	0 - Targeted 1- General
S2 Workplace closing	0 - No measures 1 - recommend closing 2 - require closing	0 - Targeted 1- General
S3 Cancel public events	0 - No measures 1 - recommend closing 2 - require closing	0 - Targeted 1- General
S4 Close public transport	0 - No measures 1 - recommend closing 2 - require closing	0 - Targeted 1- General
S5 Public info campaigns	0 -No COVID-19 public information campaign 1 - COVID-19 public information campaign	0 - Targeted 1- General

S6 Restrictions on internal movement	0 - No measures 1 - recommend movement restriction 2 - restrict movement	0 - Targeted 1- General
S7 International travel controls	0 - No measures 1 - Screening 2 - Quarantine on high-risk regions 3 - Ban on high-risk regions	
S8 Fiscal stimuli	Value of fiscal stimuli, including spending or tax cuts	
S9 Monetary policy interventions	Value of interest rate	
S10 Emergency investment in healthcare	Value of new short-term spending on health	
S11 Investment in vaccines	Value of investment	
S12 Testing policy	0 - No testing policy 1 - only testing those who both (a) have symptoms, and (b) meet specific criteria (eg key workers, admitted to hospital, came into contact with a known case, returned from overseas) 2 - testing of anyone showing COVID19 symptoms 3 - open public testing (eg "drive through" testing available to asymptomatic people)	
S13 Contact tracing	0 - no contact tracing 1 - limited contact tracing – not done for all cases 2 - comprehensive contact tracing	

The researchers have not, however, published any statistics about the relationships of individual categories of policy responses and the numbers of COVID-19 cases or deaths.

Because the original Imperial College study of social distancing measures indicates on page 10 that the lowest number of critical cases would result from social distancing measures in combination with schools remaining open, not closed, I explored the relationship between the measures taken by governments around school closures (S1) and the number of coronavirus deaths.

The timing is early in the pandemic, fewer than 200 days, so like the Oxford researchers, I have not been able to draw sweeping conclusions from statistical analysis of the data. As new data is gathered daily, this same research may yield more conclusive results over time.

Hypotheses

H_o: Nations with strict school closure policies and those with no school closures do not have significantly different coronavirus death rates.

H_a: Different school closure policies are correlated with different coronavirus death rates.

Data and Methods

To begin, I reformatted and added to the data provided by the researchers so that the school data was summarized in a single column entitled school_stringency, as follows:

No measures	0
Recommend closing, targeted	1
Recommend closing, general	2
Require closing, targeted	3
Require closing, general	4

CountryName	Date	S1_School closing	S1_IsGeneral	S1_Notes	ConfirmedCases	ConfirmedDeaths	StringencyIndex	StringencyIndexForDisplay	date_formatted	school_stringency
Azerbaijan	20200313	2.0	1.0	NaN	13.0	0.0	52.38	52.38	2020-03-13	4
Azerbaijan	20200314	2.0	1.0	NaN	NaN	NaN	61.90	61.90	2020-03-14	4
Azerbaijan	20200315	2.0	1.0	NaN	19.0	0.0	61.90	61.90	2020-03-15	4
Azerbaijan	20200316	2.0	1.0	NaN	19.0	0.0	61.90	61.90	2020-03-16	4
Azerbaijan	20200317	2.0	1.0	NaN	19.0	0.0	61.90	61.90	2020-03-17	4
Azerbaijan	20200318	2.0	1.0	NaN	28.0	0.0	61.90	61.90	2020-03-18	4
Azerbaijan	20200319	2.0	1.0	NaN	34.0	0.0	61.90	61.90	2020-03-19	4
Azerbaijan	20200320	2.0	1.0	School closures extended to 20/04 (https://web...	44.0	0.0	61.90	61.90	2020-03-20	4
Azerbaijan	20200321	2.0	1.0	NaN	44.0	1.0	61.90	61.90	2020-03-21	4
Azerbaijan	20200322	2.0	1.0	NaN	53.0	1.0	66.67	66.67	2020-03-22	4

I added population statistics (total population and density) from the [UN's Department of Economic and Social Affairs], and I calculated the death rate per 100,000 population for each country.

I plotted the death rate over time alongside the pattern of school stringency for several nations:

I then isolated all the data from April 6, the last day that a large majority of nations provided information to Oxford, resulting in a dataframe with 122 countries. Looking at plots like those above, I realized most nations settled into a certain school stringency level, some after an initial period, and they have held this school stringency level until the present. I therefore broke the dataframe down into four subgroups based on whether the nation had settled into level 0, 2, 3, or 4 school stringency as of April 6. (There were no nations practicing level 1 stringency as of April 6.)

Group 0 contains the following countries:

	CountryName	Date	S1_School closing	S1_IsGeneral	ConfirmedDeaths	date_formatted	school_stringency	PopTotal	PopDensity	Deaths_per_100,000
9	Burundi	20200406	0.0	1.0	0.0	2020-04-06	0	118.90781	463.037	0.000000
28	Cuba	20200406	0.0	1.0	8.0	2020-04-06	0	113.26616	106.413	0.070630
43	Gambia	20200406	2.0	1.0	1.0	2020-04-06	0	24.16664	238.801	0.041379
62	Kenya	20200406	2.0	1.0	4.0	2020-04-06	0	537.71300	94.478	0.007439
74	Mozambique	20200406	2.0	1.0	0.0	2020-04-06	0	312.55435	39.746	0.000000
77	Malawi	20200406	2.0	1.0	0.0	2020-04-06	0	191.29955	202.906	0.000000
82	Nicaragua	20200406	0.0	1.0	1.0	2020-04-06	0	66.24554	55.049	0.015095
100	Singapore	20200406	0.0	1.0	6.0	2020-04-06	0	58.50343	8357.633	0.102558
107	Sweden	20200406	0.0	1.0	401.0	2020-04-06	0	100.99270	24.612	3.970584

Group 2:

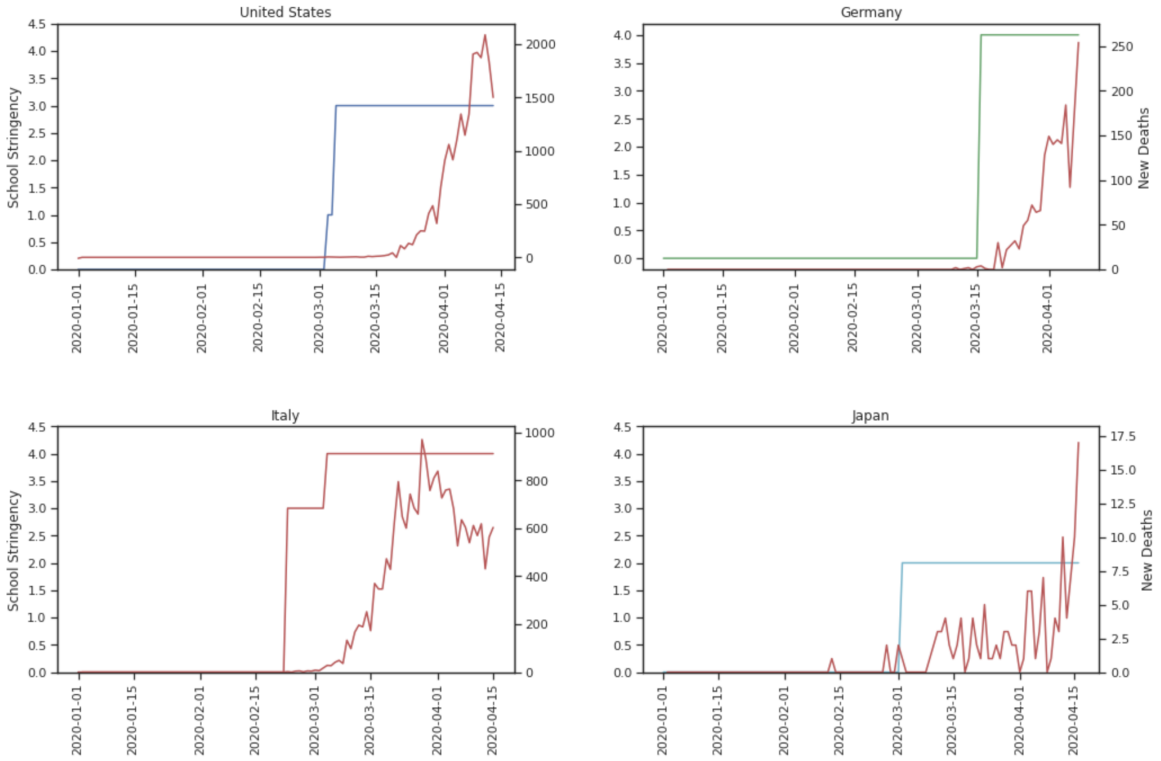
	CountryName	Date	S1_School closing	S1_IsGeneral	ConfirmedDeaths	date_formatted	school_stringency	PopTotal	PopDensity	Deaths_per_100,000
33	Dominican Republic	20200406	1.0	1.0	82.0	2020-04-06	2	108.47904	224.501	0.755906
60	Japan	20200406	1.0	1.0	73.0	2020-04-06	2	1264.76458	346.934	0.057718

Group 3:

	CountryName	Date	S1_School closing	S1_IsGeneral	ConfirmedDeaths	date_formatted	school_stringency	PopTotal	PopDensity	Deaths_per_100,000
6	Australia	20200406	2.0	0.0	36.0	2020-04-06	3	254.99881	3.319	0.141177
18	Brazil	20200406	2.0	0.0	486.0	2020-04-06	3	2125.59409	25.431	0.228642
24	China	20200406	2.0	0.0	3335.0	2020-04-06	3	14393.23774	153.312	0.231706
72	Myanmar	20200406	2.0	0.0	1.0	2020-04-06	3	544.09794	83.286	0.001838
98	Rwanda	20200406	2.0	0.0	0.0	2020-04-06	3	129.52209	525.019	0.000000

The remaining 106 countries fall into the group having school stringency level 4.

Finally, I used the Kruskal-Wallis test for non-normally-distributed data to test for significant differences between the confirmed deaths per 100,000 population of the groups.




```
print(stats.kruskal(group_0['Deaths_per_100,000'], group_2['Deaths_per_100,000'], group_3['Deaths_per_100,000'], group_4['Deaths_per_100,000']))
```

```
KruskalResult(statistic=4.904254796533922, pvalue=0.17894383892899424)
```

Results

The resulting p-value of 0.179 is too high to indicate a significant difference in the distributions of death rates based on the stringency of school closure. This means that, as of April 6, there is no significant difference in coronavirus death rates between nations who have no school closure vs complete school closure. However, this is a very narrow slice of data and a very

complex issue, and many more tests could be conducted to study the relationships between school closure and coronavirus death rates, particularly as time goes on.

Discussion & Recommendations

There are many more factors that could be studied relative to school closures and coronavirus deaths. First, the same test should be run regularly over the next months as more data is collected and sample sizes become larger. Second, rather than grouping the data by day and by school stringency measures, date from first death and date from implementation of stringency measures could be taken into account. Population density could be included in calculations. Urban and rural areas could be separated; where available, the ages of those dying from coronavirus could be studied.

The measures leading to any change in coronavirus deaths over time are complex, as partially reflected in the thirteen measures used by the Oxford researchers in their study and incorporated into a more general Stringency Index. As the pandemic progresses, this research may become more useful as part of a larger effort which includes analyzing all thirteen measured factors against new coronavirus deaths, probably with more complex statistical methods. That might lead to more comprehensive data-driven recommendations for governments during future viral outbreaks.