Wuhan lockdown: drastic but live-saving

Educator guide

PAPER DETAILS

Original title: An investigation of transmission control measures during the first 50 days of the COVID-19 epidemic in China

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DISCUSSION QUESTIONS

	LEARNING STANDARDS
1. Are human mobility control measures essential to bringing the outbreak of an infectious disease to an end? What criteria should we take for evaluating a control measure? What other [confounding] factors, besides those studied by the authors might have been responsible for controlling the spread of Covid-19 in China?	Cause and effect SP3
2. What control measures have the authors studied for their effectiveness in combating COVID-19? Can all measures taken be studied through correlational studies like the present one?	Cause and effect RST.9-10.2 RST.11-12.2
3. What did the authors do to investigate the effectiveness of Wuhan lockdown in delaying the spread of COVID-19? What tools did they use to demonstrate that their results are statistically significant?	SEP5 RST.9-10.6 & RST.11-12.6 DAT-1.B & DAT-1.D UNC-4.S, UNC-4.AC, & UNC-4.AG VC2 NS1
4. What methods did the authors use to study the effectiveness of control measures? How was the statistical significance of the results shown?	SEP5 RST.9-10.6 & RST.11-12.6 DAT-1.B & DAT-1.D UNC-4.S, UNC-4.AC, & UNC-4.AG VC2 NS1
5. What would be reason for the slow spread of COVID-19 across China in the first two weeks after its first report in Wuhan, especially considering the quickly rising number of cities reporting cases after this period?	RST.9-10.9 RST.11-12.9
6. Consider the SEIR epidemic model used for this study, why did the author choose this model for the simulation? How close are the results derived using the model to the reality of COVID-19?	SEP2 RST.9-10.9 RST.11-12.9 SP1 NS4
7. Could the Wuhan lockdown or the control measures implemented throughout China alone overturn the growth of COVID-19? What would be the contributions for each of the two?	SEP4 Cause and effect RST.9-10.5 RST.11-12.5 SP5
8. China has kept Covid-19 at very low levels since, even as new and more transmissible variants emerged especially the Delta variant. Can a “zero covid” policy be sustained, or will China need an exit strategy from this – from zero covid to low covid -- and “learn to live with the virus”? What about in New Zealand?	SEP4 SEP7 Cause and effect

ACTIVITIES FOR INTERACTIVE ENGAGEMENT

LEARNING STANDARDS

Science in the news

Students explore news stories in the Related Resources tab and evaluate the stories for tone, accuracy, missing information, etc. They may then write their own news stories on the article.

RST.9-10.5
RST.11-12.5
RST.9-10.6
RST.11-12.6
RST.9-10.8
RST.11-12.8

Drawing a timeline

Students draw a timeline for control measures against COVID-19 taken in their countries along with the trend of the case number. With this timeline, they are encouraged to identify potentially effective measures and then design and conduct level-appropriate research to investigate the effectiveness.

SEP2
SEP4
SEP7
RST.11-12.8
SP1
SP4
SP5
VC1
NS1

Searching for other researchers

Students search for similar studies on effective control measures against COVID-19 in the context of other countries, synthesize the findings, identify widely recognized effective measures and try to explain any consistency or discrepancy they will have found.

Two companion articles:

- M. U. G. Kraemer et al., *Science* 10.1126/science.abb4218 (2020).
- M Zeller et al., *Cell* 10.1016/j.cell.2021.07.030 (2021).

SEP4
EK4.A.5
Cause and effect
SP5

ARTICLE OVERVIEW

Article summary (recommended for educator use only)

This study aims to reveal the impacts of the Wuhan travel ban and public health responses in China during the early stage of the COVID-19 outbreak, which overlapped with the 2020 Spring Festival holiday. Cities implemented the highest state of emergency (Level 1) with hopes to prevent and control COVID-19 transmission. The authors performed regression analysis using case reports, human movement data, and the timeline of activating interventions. They found that the efficient blocking of human flow into and out of Wuhan, the city that reported the first case, delayed the arrival of COVID-19 at other cities of China by 2.91 days. The further growth of this epidemic was hampered by other transmission prevention measures, particularly suspending intracity public transport, closing entertainment venues, and disallowing gathers which showed statistically significant correlations with the reduction in case numbers. Further reduction in the case number has also been seen by cities that responded earlier. The synergetic effect of the Wuhan travel ban and other preemptive interventions was suggested as key to overturning the epidemic in China. However, contributions from other unstudied factors cannot be excluded.

Importance of this research

The last year and a half have been deeply disturbed by the surging and resurgence of COVID-19 worldwide, with millions of lives taken. In the early stage of the outbreak, China imposed stringent and swift measures to stop the spreading of this infectious disease — banning travels from or to Wuhan, where cases were firstly reported, suspending transportation, closing entertainment venues, and requesting social distancing. Despite these actions' well-perceived and evident effectiveness, their contribution to combating COVID-19 has not been investigated. This study aims at fitting the gap with quantitative correlational analysis.

The importance of restricting human mobility has been demonstrated in a collection of works on the previous waves of emerging infectious diseases. Studying the power of such measures is essential for countries to make informed decisions in response to the emergence of more contagious variants and unseen epidemics in the future.

Correlational in nature, this study can only investigate the interventions taken differently, either spatially or temporally; other actions that have been introduced simultaneously across China are thus out of the scope of this study. Contributions by those elements are worthwhile to be further studied. This study also concentrates on China, the country that was struck firstly by this epidemic. The effectiveness of the measures needs to be examined in other countries before a generalized conclusion can be drawn.

Experimental methods

- Comparison of travel data from Wuhan during the spring festival in three years. To demonstrate the effectiveness of the Wuhan travel ban in stopping the human outflow from the city.
- Correlational analysis between the number of confirmed cases reported in other regions of China and the inflow of people from Wuhan before the travel ban was implemented, with other geometric factors considered: to examine the necessity of restraining human mobility from infected regions.

- Linear regressions: (1) with the arrival time of COVID-19 in other cities as the dependent variable and the shutdown of Wuhan as one of the independent variables along with other factors considered: to study the effect of Wuhan lockdown on delaying the spreading of COVID-19; (2) with the arrival time of COVID-19 as the dependent variable and the implementation of different interventions along with the timing of introduction as independent variables: to investigate the associations between control measures and the spreading of COVID-19.
- Epidemic modeling: (1) to study changes in the basic reproduction rate due to the implementation of different interventions; (2) to uncover the effectiveness of the Level 1 responses and Wuhan travel ban, introduced either separately or concurrently, by simulating the projected growth pattern of COVID-19.
- Could not do a "controlled experiment" during a real epidemic, relied on the analysis of routine data to draw inferences.

Conclusions

- The Wuhan travel ban slowed the breakout of COVID-19 in other cities by 2.91 days, which bought time for action in urban centers across China.
- The transmission control measures impeded the fast spreading of COVID-19, and earlier implementations by some cities resulted in a further 33% reduction in the number of laboratory-confirmed cases.
- Both the Wuhan travel ban and the Level 1 responses were critical to the earlier overturn of the epidemic and the lower peak number, resulting in 96% fewer cases than the projected situation with no control. China showed that it was possible to stop SARS Cov-2 transmission with forceful ("drastic") interventions.

LEARNING STANDARDS ALIGNMENT

The following tables provide an overview of the learning standards covered by this article, including the A Framework for K-12 Science Education (Framework), Common Core State Standards English Language Arts-Literacy (CCSS ELA), Common Core State Standards Statistics and Probability (CCSS HSS), AP Science Practices, and Vision and Change for Undergraduate Education. Where applicable, activities and information will be marked with specific standards to which they are linked.

A Framework for K-12 Science Education		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (SEP2) Construct models to represent an existing system, use models to explain phenomena and make predictions, refine models based on the difference between the predictions and real-world observations, and acknowledge the assumptions and limitations of the present model. **Analyzing and Interpreting (SEP4)** Organize and interpret data through proper presentations, analyze data systematically for patterns, and evaluate the strength of conclusions drawn from the data. **Using mathematics and Computational Thinking (SEP5)** Translate relationships into mathematical expressions for modeling, conduct computational simulations based on mathematical models, and compare results from simulations with the 'real world'. **Engaging in Argument from Evidence (SEP7)** Construct an argument to explain how data support a claim, recognize the weakness of the argument, as well as acknowledge and/or rule out other interfering factors.	**ETS2.A Interdependence of Science, Engineering, and Technology** Technological advancements allow scientists to investigate the world from multiple facets. Scientific findings enable further development of technology. Both science and technology have marked impacts on society.	**Cause and Effect** Differentiate causations and correlations, propose mechanisms and explanations for how one event leads to another, and verify such claims with empirical evidence when experiments are possible and ethical. **Systems and System Models** Define a system with appropriate boundaries for the study and develop models to describe and/or predict the behavior of a system.

Science in the Classroom AAAS

Common Core State Standards English Language Arts-Literacy		
Key Ideas and Details	Craft and Structure	Integration of Knowledge and Ideas
RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. **RST.9-10.2** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. **RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. **RST.11-12.2** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.	**RST.9-10.4** RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics. **RST.9-10.5** Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy). **RST.9-10.6** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address. **RST.11-12.4** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. **RST.11-12.5** Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas. **RST.11-12.6** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.	**RST.9-10.8** Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. **RST.9-10.9** Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. **RST.11-12.8** Evaluate the hypotheses, data, analyses, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. **RST.11-12.9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. .

Science in the Classroom AAAS

AP Science Standards	
AP Science Practices	AP Statistic Content Standards
Science Practice (SP1) The student can use representations and models to communicate scientific phenomena and solve scientific problems. **Science Practice (SP3)** The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the course. **Science Practice (SP4)** The student can plan and implement data collection strategies in relation to a particular scientific question. (Note: Data can be collected from many different sources, e.g., investigations, scientific observations, the findings of others, historic reconstruction and/or archived data.) **Science Practice (SP5)** The student can perform data analysis and evaluation of evidence.	**Essential knowledge DAT-1.B (DAT-1.B)** Essential Knowledge (DAT-1.B) Determine the correlation for a linear relationship. **Essential knowledge DAT-1.D (DAT-1.D)** Calculate a predicted response value using a linear regression model. **Essential knowledge 4.S (UNC-4.S)** Interpret a confidence interval for a population mean, including the mean difference between values in matched pairs. **Essential knowledge UNC-4.AC (UNC-4.AC)** Essential Knowledge (UNC-4.AC) Identify an appropriate confidence interval procedure for a slope of a regression model. **Essential knowledge UNC-4.AG (UNC-4.AG)** Interpret a confidence interval for the slope of a regression model.

Connections to the Nature of Science	
Vision and Change for Undergraduate Biology Education Core Competencies and Disciplinary Practices	A Framework for K-12 Science Education Understandings About the Nature of Science
Ability to apply the process of science (VC1) Observational strategies. Biology is an evidence-based discipline. **Ability to use modeling and simulation (VC2)** Apply quantitative analysis to interpret biological data: developing and interpreting graphs, applying statistical methods to diverse data, mathematical modeling, managing and analyzing large data sets	**Scientific investigations use a variety of methods (NS1)** Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. New technologies advance scientific knowledge. **Science models, laws, mechanisms, and theories explain natural phenomena (NS4)** Science knowledge is based on empirical evidence. Science disciplines share common rules of evidence used to evaluate explanations about natural systems. Science includes the process of coordinating patterns of evidence with current theory. Science arguments are strengthened by multiple lines of evidence supporting a single explanation.