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Research Provides No Basis for Pandemic Travel Bans

By **David J. Bier**

In response to the first confirmed cases of COVID-19 in the United States, President Trump restricted most travel from China on February 2, 2020, while exempting U.S. citizens and their families. The next month, he expanded it to include Iranians and most Europeans. By the end of March, the U.S. State Department largely ceased issuing visas to anyone.[1] These bans have remained in effect even as the United States has become the leading source for COVID-19 infections worldwide.[2]

President Trump and his advisors repeatedly touted these actions as demonstrating that they would keep the country safe from the virus.[3] However, a review of the research about pandemics prior to COVID-19 with disease profiles similar to influenza shows that the government should have known how ineffective travel restrictions would be at protecting the country.

The research available in January 2020 shows that extreme travel restrictions imposed before a pandemic reached the United States could have theoretically delayed its introduction by a few days or weeks, but that travel restrictions like those the Trump administration did impose could not stop the spread of a disease like COVID-19, even in theory. Rather than pinning all of those hopes on a Chinese travel restriction, the U.S. government should have spent those early moments preparing a vigorous domestic response to the virus—which it failed to do.[4]

INTRODUCTION

Cato's Alex Nowrasteh has reviewed the research regarding travel restrictions and COVID-19, concluding that "travel restrictions likely delay the spread of COVID-19 in modeled simulations by up to a few weeks."[5] The COVID-19 studies so far have focused mainly on China's exit restrictions and restrictions imposed by other countries like Japan and Australia.[6] Importantly, those papers present theoretical models and do not empirically test their predictions against real-world results.

The following post reviews a dozen pre-COVID-19 studies that analyze the effects of international travel restrictions—or international *and* domestic travel restrictions—on influenza pandemics globally or in the United States.[7] Given the similarities to COVID-19, the influenza research would have been the most relevant research available to the government in January 2020.

A broader view of the pre-COVID-19 evidence supports the World Health Organization's (WHO) position that travel restrictions are only effective before a pandemic has spread and only serve to delay the spread by a few days or weeks.[8] Multiple meta-analyses and reviews by the WHO, U.S. Homeland Security Council in 2006, and United Kingdom (UK) Department of Health in 2018 also back this conclusion.[9]

The consensus of researchers is that stopping all travel is impossible, unenforceable, and politically unrealistic—an assumption that held in the COVID-19 case—and that if it were even possible to selectively stop it (e.g. excluding all nationals of an affected country), doing so will only delay transmission until the disease spreads beyond the initial selection.[10] With any travel, the risk of infiltration grows proportionately to the spread abroad such that even a "tenfold reduction in numbers of visitors delays arrival of infection for approximately as long as it takes global prevalence to increase tenfold to compensate."[11]

These dozen studies are unanimous that anything less than an immediate total travel restriction has only a "modest," "little," "low," "negligible," or no effect at all on the spread of a pandemic.[12] If a ban delays the introduction of the virus into the high flu season, it can actually worsen a pandemic.[13] Even the most extreme restrictions on travel delay the introduction or progression of flu pandemics by at most a few weeks. For context, the U.S. Homeland Security Council in 2006 expected that pandemic influenza would reach the United States "within 1 to 2 months," which happened in the case of COVID-19.[14]

The research also indicates that there is no benefit to international travel restrictions once an outbreak has already become an epidemic inside the destination country.[15]

RESEARCH ON PANDEMIC SPREAD

1. A World Health Organization expert consultation (1959) reviews the evidence relating to the effects of travel restrictions from the 1957 flu pandemic.[16] It finds that the "most striking example of the possibilities of quarantine was Israel where the restriction or complete absence of international travel between that country and neighboring States (due, not to deliberate quarantine restrictions, but to the political situation) seems to have resulted in a delay of about two months in

the onset of the epidemic." It finds "less convincing" evidence that showed that South Africa's shipping restrictions may have caused "some delay" in the pandemic there, but in all other countries, "no effect was detected." They conclude, "If such measures are to be effective, they must be very severe…. a high price to pay for a few additional weeks' freedom from the disease. Such action could only be justified on technical grounds if the extra time permitted the application of effective specific prophylactic measures."

2. In *Plos Med*, Brownstein, et al. (2006) use the natural experiment of the flight ban and subsequent 27 percent decline in international and domestic air traffic following the September 11, 2001 terrorist attack to evaluate the effect of air travel on the flu season. They find that "the decrease in air travel was associated with a delayed and prolonged influenza season," with a the epidemic peak 13 days later than average.[17] They conclude, "Though our results suggest a possible benefit of airline travel restrictions, without early detection and immediate action, such measures may be ineffective at stemming the spread or mitigating the impact of an oncoming pandemic."

3. Bajardi, et al. (2011) model the 2009 H1N1 pandemic's growth from Mexico in *PLoS Med* and find that the "40% drop in travel flows [to and from Mexico] observed in reality only led to an average delay in the arrival of the infection in other countries (i.e. the first imported case) of less than 3 days. . . . too small a magnitude to impact the international spread."[18] They use this model to test the effect of a 90 percent reduction and find that "the resulting delay would be on the order of 2 weeks." They conclude, "It is unlikely that given the ever-increasing mobility of people travel restrictions could be used effectively in a future pandemic event."

4. Hollingsworth, et al. (2006) use a simplified global model in *Nature Medicine* to estimate that for an influenza pandemic creating 100 cases per day, "travel reductions of the order of 80%, for example, only increase the interval between exports [from the affected countries] by days." Increasing the restrictions to greater than 99 percent raise the interval "to the order of weeks" even with additional exit screening that excluded all symptomatic passengers.[19] They summarize, "Once case numbers exceed a few hundred in source areas, only rapidly implemented and almost total restriction of international travel can prevent the export of cases and the triggering of new epidemics in unaffected areas." They conclude, "Our analysis also indicates that restrictions on travel will be of limited benefit in slowing global spread of a pandemic influenza outbreak that is not contained at its source. There may be a role for travel restrictions applied to the source country while containment efforts are underway."

5. Cooper, et al. (2006) model a flu pandemic in *PLoS Med* and find that "even large and widely enforced travel restrictions would usually delay epidemic peaks by only a few days; to have a major impact, restrictions would have to be almost total and almost instantaneous."[20] They estimate that even a 99.9 percent reduction in air traffic would not protect most cities from a pandemic. They conclude, "Interventions to reduce local transmission of influenza are likely to be more effective at reducing the rate of global spread and less vulnerable to implementation delays than air travel restrictions."

6. In *Proceedings of the National Academy of Sciences*, Germann, et al. (2006) model the U.S. response to an influenza outbreak that has already seeded from abroad.[21] They find "a total reduction in long-distance travel, to 10% of normal frequency" would "slow the virus spread by only a few days to weeks (depending on R_0), without reducing the eventual size of the outbreak." Indeed, their simulations indicate that long-distance travel restrictions do not reduce the total number of infections.[22] Table 1 below shows their results for travel restrictions compared to other interventions. They conclude, "travel restrictions alone do not appear to be an effective control strategy, due to the implausibly early and drastic measures required to significantly reduce the large number of local outbreaks that are likely to emerge around the country."

Table 1

Simulated mean number of ill people (cumulative incidence per 100) and, for socially targeted antiviral prophylaxis (TAP), the number of antiviral courses required for various interventions and R0

Intervention	R0 = 1.6	R0 = 1.9	R0 = 2.1	R0 = 2.4
Baseline (no intervention)	32.6	43.5	48.5	53.7
Unlimited TAP (no. of courses)*	0.06 (2.8M)	4.3 (182M)	12.2 (418M)	19.3 (530M)
Dynamic vaccination (one-dose regimen) † , ‡	0.7	17.7	30.1	41.1
Dynamic child-first vaccination † , ‡	0.04	2.8	16.3	35.3
Dynamic vaccination (two-dose regimen) ‡ , §	3.2	33.8	41.1	48.5
Dynamic child-first vaccination ‡ , §	0.9	25.1	37.2	47.3
School closure ¶	1	29.3	37.9	46.4
Local social distancing ¶	25.1	39.2	44.6	50.3
Travel restrictions during entire simulation ‖	32.8	44	48.9	54.1
Local social distancing and travel restictions ¶ , ‖	19.6	39.3	44.7	50.5
TAP,* school closure,** and social distancing**	0.02 (0.6M)	0.07 (1.6M)	0.14 (3.3M)	2.8 (20M)
Dynamic vaccination, † , ‡ social distancing,¶ travel restrictions,¶‖ and school closure**	0.04	0.2	0.6	4.5
TAP,* dynamic vaccination, † , ‡ social distancing, ¶ travel restrictions,¶‖ and school closure**	0.02 (0.3M)	0.03 (0.7M)	0.06 (1.4M)	0.1 (3.0M)
Dynamic child-first vaccination, † , ‡ social distancing, ¶ travel restrictions, ¶ , ‖ and school closure**	0.02	0.2	0.9	7.7

Source: Timothy C. Germann, Kai Kadau, Ira M. Longini Jr., and Catherine A. Macken. "Mitigation Strategies for Pandemic Influenza in the United States." Proceedings of the National Academy of Sciences 103, no. 15 (April 11, 2006): 5935–40.
Notes: M = million.
*60% TAP, 7 days after pandemic alert, antiviral supply of 20 M courses unless stated.
†10 million doses of a low-efficacy vaccine (single-dose regimen) per week.
‡Intervention continues for 25 weeks, beginning such that the first individuals treated develop an immune response on the date of the first U.S. introduction.
§10 million doses of a high-efficacy vaccine (two-dose regimen) per week.
¶Intervention starting 7 days after pandemic alert.
‖Reduction in long-distance travel, to 10% of normal frequency.
**Intervention starting 14 days after pandemic alert.
††Exhausted the available supply of 20 M antiviral courses.

7. Epstein, et al. (2007) model a flu pandemic in *PLoS ONE* and find, "When travel restrictions are imposed, the [First Passage Times to the U.S.] increases by two to three weeks when the outbreak originates in Hong Kong (from 18 days to 31 days) or Sydney (from 7 days to 27 days)."[23] This paper's important contribution is testing the effect of seasonality on the efficacy of a travel restriction. They write, "if travel restrictions are not combined with other measures, local epidemic severity may increase, because restriction-induced delays can push local outbreaks into high epidemic season." They conclude, "From a public health perspective, it becomes clear that the main purpose of travel restrictions is to delay dissemination of the disease until targeted medical and other interventions can be developed and deployed."

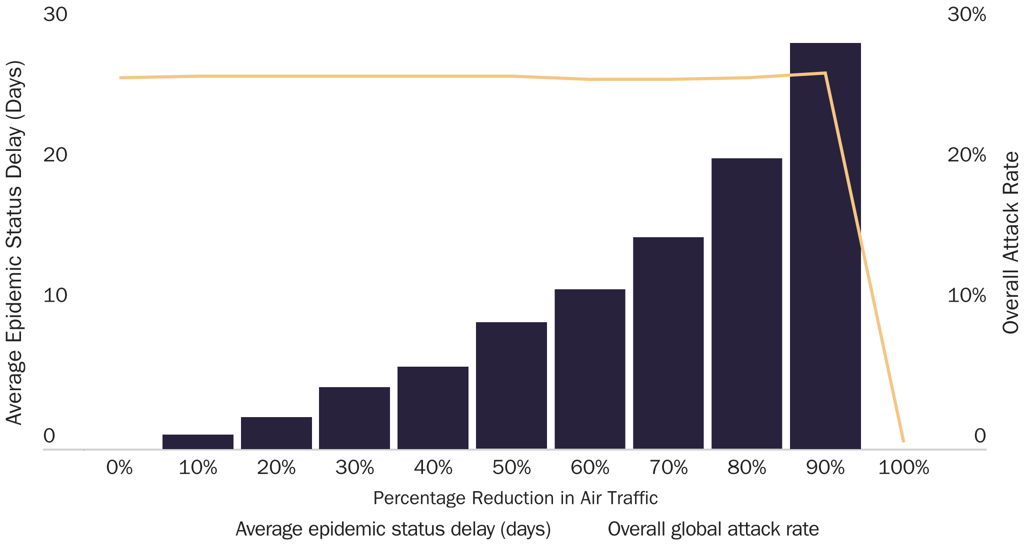
8. Ferguson, et al. (2006) model an influenza virus spread in *Nature* and show that "a 90%, 99% or 99.9% reduction in imported infections might delay the peak of the US pandemic by 1.5, 3, or 6 weeks, respectively."[24] They note for context that SARS reduced Hong Kong travel by 80 percent. They estimate that a tenfold reduction in travel translates to a 12.5-day delay in epidemic progression. They conclude, "For the high transmissibility scenario only policies using >99% border controls can delay spread by enough to enable pandemic vaccine to reduce attack rates substantially (vaccine is assumed to be produced from month 4 of the global epidemic)."

9. Colizza, et al. (2007) model avian flu pandemic across 220 different countries using airline data in *PLoS Medicine*.[25] For a pandemic starting in Hanoi in October, they find that halving the number of air travelers from the infected area does "not appear to be efficient neither in reducing the epidemic impact, nor in delaying the prevalence peak," nor does it "contain the pandemic at the source." They add that the moment that the epidemic has spread from its source, "the travel limitations are no longer able to considerably slow down the pandemic evolution." They conclude, "We showed that travel restrictions, which are both economically disruptive and difficult to implement, achieve very modest results, slowing down by only a few days or weeks the overall evolution of the pandemic."

10. In *Vaccine*, Flahault, et al. (2006) model a pandemic influenza outbreak starting in Hong Kong on 52 cities, which would reach all 52 cities in 5 months without interventions.[26] A 50 percent reduction in air traffic "bought an average delay to reach epidemic status of 9 days compared with the baseline scenario." A 60 percent restriction in combination with isolating 10 percent of cases would add 19 days to the baseline transmission estimate but the epidemic peak would be higher.[27] Figure 1 shows the effects at varying degrees of travel restrictions. Only a 100 percent travel ban has a significant effect on the global attack rate, and even a 90 percent closure delayed the epidemic by less than a month.

FIGURE 1

Impact of reductions in air traffic on an influenza pandemic in 52 major cities



Source: Digitized from Figure 2a in Flahault, Antoine, Elisabeta Vergu, Laurent Coudeville, and Rebecca F. Grais. “Strategies for Containing a Global Influenza Pandemic.” Vaccine 24, no. 44-46 (November 10, 2006): 6751–55.
Notes: Univariate sensitivity analysis. Outbreak starts in Hong Kong. "Average epidemic status delay" refers to the average number of additional days for the attack rate to reach epidemic threshold (1/100,000) in a city as a result of travel reductions. Overall attack rate refers to the percentage of infected persons in the 52 cities analyzed.

11. Tomba and Wallinga (2008) model infectious disease transmission in *Mathematical Biosciences*.[28] They use a “simple formula” to demonstrate that with an R_0 of about 2 and a generation time of 2.6 days, average delays caused by reductions of importation by 90%, 99% and 99.9% are . . . 11.5, 23.0, and 35.0 days, respectively.” They state that they focus on the reductions in first importation because “later importations will of course occur, but these will have a minor importance.” They describe this formula as a “simple explanation for the low impact of border control as a countermeasure to the spread of an infectious disease.”

12. Keirnéis, et al. (2008) model pandemic influenza progression on 52 major world cities in *PLoS ONE*, varying their estimates based on the profile of the virus (e.g. “a fast, massive pandemic and a slow building, long-lasting one”).[29] They find a slight correlation between very early travel restrictions and the number of cities that the pandemic reaches but state, “Regardless of the [virus] profile, restricting air travel (either expressed by the proportion and the date of introduction of transport limitation) had no impact on the global burden of the pandemic.” Compared to other interventions, they find that “travel restriction was the only measure without any measurable effect” on pandemic outcomes. They conclude, “Our results also suggest that travel restrictions would have a limited impact on the spatial and temporal diffusion of an influenza pandemic. . . . Such restrictions have significant logistical, ethical and economic implications and their impact on an influenza pandemic is currently debated.”

CONCLUSION

The pre-COVID-19 research is unanimous that governments cannot expect to rely on travel restrictions to prevent the spread of pandemics similar to influenza. Travel restrictions do not prevent the spread of disease and may only delay it for a few days or weeks if implemented prior to the international transmission of the disease. The Trump administration’s travel restrictions waited until after the virus had already entered the United States, and they exempted many travelers from China, not to mention the rest of the world.[30]

The research shows that the Trump administration should have known that it needed to focus on domestic measures to stop the disease, not international ones, yet it did not.[31] Cato’s Alex Nowrasteh argues that the “travel ban created a false sense of security that delayed other more effective methods of containing COVID-19, such as instituting social distancing sooner.”[32] In 2014, the CDC has also cited the concern that travel bans could incentivize foreign governments not to report or underreport cases.[33] While its motivations remain unclear, China did in fact downplay the extent of the crisis in both the case of SARS and COVID-19—decisions that remain far more damaging than any other.[34]

The research also shows that the international travel restrictions have virtually no effect today once the outbreak has become an epidemic here. There is no basis in the research for continuing a blanket ban on travel between countries.

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[1] **David J. Bier, "Timeline and List of U.S. Immigration Actions on COVID-19," Cato Institute, March 19, 2020**v.

[2] **"Coronavirus Map: Tracking the Global Outbreak,"** ***New York Times*****, April 15, 2020**.

[3] **Katie Rogers, "Trump Defends Closing Borders to Travelers to Fight Coronavirus,"** ***New York Times*****, February 2, 2020**.

Kalev Leetaru, "Virus Experts' Early Statements Belie 'Prescient' Portrayal," Real Clear Politics, April 3, 2020.

[4] **Eric Lipton, David E. Sanger, Maggie Haberman, Michael D. Shear, Mark Mazzetti and Julian E. Barnes, “He Could Have Seen What Was Coming: Behind Trump’s Failure on the Virus,”** ***New York Times*****, April 11, 2020**.

[5] **Alex Nowrasteh, "Travel Restrictions and the Spread of COVID-19 – What Does the Research Say?" Cato Institute, March 23, 2020**.

[6] Five studies relating to COVID-19:

1. **Anzai, Asami, Tetsuro Kobayashi, Natalie M Linton, Ryo Kinoshita, Katsuma Hayashi, Ayako Suzuki, Yichi Yang, et al. "Assessing the Impact of Reduced Travel on Exportation Dynamics of Novel Coronavirus Infection (COVID-19)." *Journal of Clinical Medicine* 9, no. 2 (February 24, 2020)**.
2. **Chinazzi, Matteo, Jessica T Davis, Marco Ajelli, Corrado Gioannini, Maria Litvinova, Stefano Merler, Ana Pastore Y Piontti, et al. "The Effect of Travel Restrictions on the Spread of the 2019 Novel Coronavirus (COVID-19) Outbreak." *Science*, March 6, 2020**.
3. **Wells, Chad R, Pratha Sah, Seyed M Moghadas, Abhishek Pandey, Affan Shoukat, Yaning Wang, Zheng Wang, Lauren A Meyers, Burton H Singer, and Alison P Galvani. "Impact of International Travel and Border Control Measures on the Global Spread of the Novel 2019 Coronavirus Outbreak." *Proceedings of the National Academy of Sciences* 117, no. 13 (March 31, 2020): 7504–9**.
4. **Tian, Huaiyu, Yonghong Liu, Yidan Li, Chieh-Hsi Wu, Bin Chen, Moritz U. G. Kraemer, Bingying Li, et al. "The Impact of Transmission Control Measures during the First 50 Days of the COVID-19 Epidemic in China." *medRxiv*, March 10, 2020**.
5. **Costantino, Valentina, David Heslop, and Raina Macintyre. "The Effectiveness of Full and Partial Travel Bans against COVID-19 Spread in Australia for Travellers from China." *MedRxiv*, March 12, 2020**.

[7] It excludes 12 pre-COVID-19 studies focused solely on other countries, other diseases, or narrower or solely domestic restrictions. Here are the excluded studies:

1. **Lam, Elson Hy, Benjamin J Cowling, Alex R Cook, Jessica Yt Wong, Max Sy Lau, and Hiroshi Nishiura. "The Feasibility of Age-Specific Travel Restrictions during Influenza Pandemics." *Theoretical Biology and Medical Modelling* 8, no. 1 (November 11, 2011): 44**.
2. **Pandemic Influenza Preparedness Team. Scientific Summary of Pandemic Influenza and its Mitigation, Scientific Summary of Pandemic Influenza and its Mitigation § (2011)**.
3. **Marcelino, Jose, and Marcus Kaiser. "Critical Paths in a Metapopulation Model of H1N1: Efficiently Delaying Influenza Spreading through Flight Cancellation." *PLoS Currents* 4 (April 2012)**.
4. **Chun Chong, Ka, and Benny Chung Ying Zee. "Modeling the Impact of Air, Sea, and Land Travel Restrictions Supplemented by Other Interventions on the Emergence of a New Influenza Pandemic Virus." *BMC Infectious Diseases* 12, no. 1 (November 19, 2012): 309**.
5. **Ciofi degli Atti, Marta Luisa, Stefano Merler, Caterina Rizzo, Marco Ajelli, Marco Massari, Piero Manfredi, Cesare Furlanello, Gianpaolo Scalia Tomba, and Mimmo Iannelli. "Mitigation Measures for Pandemic Influenza in Italy: An Individual Based Model Considering Different Scenarios." *PLoS ONE* 3, no. 3 (March 12, 2008)**.
6. **Eichner, Martin, Markus Schwehm, Nick Wilson, and Michael G Baker. "Small Islands and Pandemic Influenza: Potential Benefits and Limitations of Travel Volume Reduction as a Border Control Measure." *BMC Infectious Diseases* 9, no. 1 (September 29, 2009): 160**.
7. **Wood, James G., Nasim Zamani, C. Raina Macintyre, and Niels G. Becker. "Effects of Internal Border Control on Spread of Pandemic Influenza." *Emerging Infectious Diseases* 13, no. 7 (July 2007): 1038–45**.
8. **Bolton, Kirsty, James Mccaw, R. Moss, Roger Stewart Morris, S. Wang, Alexanderyn Burma, B. Darma, D. Narangerel, Pagbajab Nymadawa, and Jodie McVernon. "Likely Effectiveness of Pharmaceutical and Non-Pharmaceutical Interventions for Mitigating Influenza Virus Transmission in Mongolia." *Bulletin of the World Health Organization* 90, no. 4 (January 18, 2012): 264–71**.
9. **Min Lee, Jung, Donghoon Choi, Giphil Cho, and Yongkuk Kim. "The Effect of Public Health Interventions on the Spread of Influenza among Cities." *Journal of Theoretical Biology* 293 (January 21, 2012): 131–42**.
10. **Poletto, Chiara, Marcelo Ferreira da Costa Gomes, Ana Pastore y Piontti, Loic Rossi, Livio Bioglio, Dennis L Chao, Ira M Longini, M. Elizabeth Halloran, Vittoria Colizza, and Alessandro Vespignani. "Assessing the Impact of Travel Restrictions on International Spread of the 2014 West African Ebola Epidemic." *Eurosurveillance* 19, no. 42 (October 23, 2014)**.
11. **Levente Hufnagel, Dirk Brockmann, and Theo Geisel. "Forecast and Control of Epidemics in a Globalized World." *Proceedings of the National Academy of Sciences* 101, no. 42 (October 19, 2004): 15124–29**.
12. **Ruan, Zhongyuan, Chaoqing Wang, Pak Ming Hui, and Zonghua Liu. "Integrated Travel Network Model for Studying Epidemics: Interplay between Journeys and Epidemic." *Scientific Reports* 5, no. 1 (June 15, 2015): 11401**.

[8] **"Key considerations for repatriation and quarantine of travellers in relation to the outbreak of novel coronavirus 2019-nCoV." World Health Organization, February 11, 2020**.

"Updated WHO Recommendations for International Traffic in Relation to COVID-19 Outbreak." World Health Organization. World Health Organization, February 29, 2020.

[9] Meta-analysis: "[I]nternational travel–related NPIs . . . implemented at the early phase might delay the start of a local epidemic by a few days or weeks." Quoted from: **Ryu, Sukhyun, Huizhi Gao, Jessica Y. Wong, Eunice Y.c. Shiu, Jingyi Xiao, Min Whui Fong, and Benjamin J. Cowling. "Nonpharmaceutical Measures for Pandemic Influenza in Nonhealthcare Settings—International Travel-Related Measures." Emerging Infectious Diseases 26, no. 5 (May 2020)**.

Meta-analysis: "In isolation, travel restrictions might delay the spread and peak of pandemics by a few weeks or months." Quoted from: **Mateus, Ana LP, Harmony E Otete, Charles R Beck, Gayle P Dolan, and Jonathan S Nguyen-Van-Tam. "Effectiveness of Travel Restrictions in the Rapid Containment of Human Influenza: a Systematic Review."** ***Bulletin of the World Health Organization*** **92, no. 12 (September 29, 2014): 849–924**.

WHO: "Screening and quarantining entering travelers at international borders did not substantially delay virus introduction in past pandemics, except in some island countries, and will likely be even less effective in the modern era." Quoted from:

World Health Organization Writing Group. "Nonpharmaceutical Interventions for Pandemic Influenza, International Measures." ***Emerging Infectious Diseases*** **12, no. 1 (2006): 81–87**.

United Kingdom Department of Health: "[R]elatively high levels of travel restrictions would only delay an epidemic for a few weeks." Quoted from: **Scientific Pandemic Influenza Group on Modelling, SPI-M Modelling Summary § (2018)**.

Homeland Security Council: "Current models suggest that highly restrictive border measures could delay a pandemic by a few weeks." Quoted from: **Homeland Security Council, National strategy for pandemic influenza: implementation plan, National strategy for pandemic influenza: implementation plan § (2006)**.

[10] "[W]e assume that impenetrable borders are either prohibitively expensive or impossible to create. Travel restrictions alone do not appear to be an effective control strategy, due to the implausibly early and drastic measures required to significantly reduce the large number of local outbreaks that are likely to emerge around the country." Quoted from: **Timothy C. Germann, Kai Kadau, Ira M. Longini Jr., and Catherine A. Macken. "Mitigation Strategies for Pandemic Influenza in the United States."** ***Proceedings of the National Academy of Sciences*** **103, no. 15 (April 11, 2006): 5935–40**.

"The logarithmic relation also explains more realistic situations in which the epidemic origin is characterized by spatial heterogeneity and intra-region mobility that is not subject to travel restrictions (see Text S1 for the complete analytic treatment in this case). This is the case of the H1N1 pandemic, which initially diffused within Mexico before reaching international hubs and propagating internationally." Quoted from: **Bajardi, Paolo, Chiara Poletto, Jose J. Ramasco, Michele Tizzoni, Vittoria Colizza, and Alessandro Vespignani. "Human Mobility Networks, Travel Restrictions, and the Global Spread of 2009 H1N1 Pandemic."** ***PLoS ONE*** **6, no. 1 (January 31, 2011)**.

"Travel restrictions with >99% effectiveness are needed to increase the time between exports to the order of weeks (Supplementary Note). Even at this level, travel restrictions only slow the exportation of cases rather than halting spread. Compliance with travel advisories and effectiveness of screening are major issues in implementing such a stringent policy." Quoted from: **Hollingsworth, T Déirdre, Neil M Ferguson, and Roy M Anderson. "Will Travel Restrictions Control the International Spread of Pandemic Influenza?"** ***Nature Medicine*** **12, no. 5 (June 2006): 497–99**.

[11]"A tenfold reduction in numbers of visitors delays arrival of infection for approximately as long as it takes global prevalence to increase tenfold to compensate—12.5 days using the global model assumed here." Quoted from: **Ferguson, Neil M., Derek A. T. Cummings, Christophe Fraser, James C. Cajka, Philip C. Cooley, and Donald S. Burke. "Strategies for Mitigating an Influenza Pandemic."** ***Nature*** **442, no. 7101 (April 26, 2006): 448–52**.

"The exponential increase of cases in the outbreak region explains the negligible impact of travel restrictions over the course of the pandemic." Quoted from: **Bajardi, Paolo, Chiara Poletto, Jose J. Ramasco, Michele Tizzoni, Vittoria Colizza, and Alessandro Vespignani. "Human Mobility Networks, Travel Restrictions, and the Global Spread of 2009 H1N1 Pandemic."** ***PLoS ONE*** **6, no. 1 (January 31, 2011)**.

"[T]o have a major impact, restrictions would have to be almost total and almost instantaneous.... The relative ineffectiveness of travel restrictions for controlling pandemic influenza is a consequence of the rapid initial rate of growth of the epidemic in each city and the large number of people infected. For example, with a serial interval of 3 d, ignoring depletion of susceptibles, an Rt of two would cause a 128-fold increase in new cases within 21 d (128 = 221/3). This means that if travel from the first affected city was restricted to 1/128 of its former value on (and after) day 1, there would be approximately the same number of influenza cases leaving the city on day 21 + t as there would have been on day t had there been no intervention; even such an extreme intervention would therefore buy only about 3 wk." Quoted from: **Cooper, Ben S, Richard J Pitman, W. John Edmunds, and Nigel J Gay. "Delaying the International Spread of Pandemic Influenza."** ***PLoS Medicine*** **3, no. 6 (May 2, 2006)**.

"The size of this gain [from travel restrictions] depends on the functional form of ʌ(t). There are many possible choices, but the most relevant to our purposes here is the form ʌ (t) = aebt, representing an exponentially increasing "outside' epidemic, which is what is expected in the early phase of pandemic spread, when border control measures such as those considered here might be put in place." Quoted from **Scalia Tomba, Gianpaolo, and Jacco Wallinga. "A Simple Explanation for the Low Impact of Border Control as a Countermeasure to the Spread of an Infectious Disease."** ***Mathematical Biosciences*** **214, no. 1-2 (2008): 70–72**.

[12] “[T]ravel restrictions alone do not appear to be an effective control strategy.” Quoted from: **Timothy C. Germann, Kai Kadau, Ira M. Longini Jr., and Catherine A. Macken. “Mitigation Strategies for Pandemic Influenza in the United States.” *Proceedings of the National Academy of Sciences* 103, no. 15 (April 11, 2006): 5935–40**.

“Our results also suggest that travel restrictions would have a limited impact on the spatial and temporal diffusion of an influenza pandemic. Indeed, regardless of the pandemic profile, travel restrictions, which are both economically disruptive and difficult to implement, achieve very modest results, slowing down by only a few days or weeks the overall evolution of the pandemic. ” Quoted from: **Colizza, Vittoria, Alain Barrat, Marc Barthelemy, Alain-Jacques Valleron, and Alessandro Vespignani. “Modeling the Worldwide Spread of Pandemic Influenza: Baseline Case and Containment Interventions.” *PLoS Medicine* 4, no. 1 (January 23, 2007).**

Scalia Tomba, Gianpaolo, and Jacco Wallinga. “A Simple Explanation for the Low Impact of Border Control as a Countermeasure to the Spread of an Infectious Disease.” *Mathematical Biosciences* 214, no. 1-2 (2008): 70–72.

“Air traffic restrictions were seen to have little impact until traffic was almost completed stopped.” Quoted from: **Flahault, Antoine, Elisabeta Vergu, Laurent Coudeville, and Rebecca F. Grais. “Strategies for Containing a Global Influenza Pandemic.” *Vaccine* 24, no. 44-46 (November 10, 2006): 6751–55**.

“The exponential increase of cases in the outbreak region explains the negligible impact of travel restrictions over the course of the pandemic.” Quoted from: **Bajardi, Paolo, Chiara Poletto, Jose J. Ramasco, Michele Tizzoni, Vittoria Colizza, and Alessandro Vespignani. “Human Mobility Networks, Travel Restrictions, and the Global Spread of 2009 H1N1 Pandemic.” *PLoS ONE* 6, no. 1 (January 31, 2011)**.

“[R]estricting air travel in our model has little effect on the global burden of the pandemic. Such restrictions have significant logistical, ethical and economic implications and their impact on an influenza pandemic is currently debated.” Quoted from: **Kernéis, Solen, Rebecca F. Grais, Pierre-Yves Boëlle, Antoine Flahault, and Elisabeta Vergu. “Does the Effectiveness of Control Measures Depend on the Influenza Pandemic Profile?” *PLoS ONE* 3, no. 1 (January 23, 2008).**

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"Travel from the United States to China had dropped by well more than 50 percent, and this is with the sort of market response that Joel referenced by the airlines and the voluntary actions taken by travelers. I would note for you all that it's not a lot of data, but over the last five days, the number of American citizens traveling from China back to the United States has been rising. So even while the total number is going down, it does look to us, initially, like Americans, at least some of them, are returning back home." Quoted from: **"Press Briefing by Members of the President's Coronavirus Task Force," White House, January 31, 2020**.

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