In this pre-vaccine, mid-pandemic world, policy makers have resorted to imposing mask orders as well as social distancing measures and restrictions. From the perspective of viral transmission only, lockdown measures have worked remarkably well, demonstrating flattened curves and rates of transmission below 1 for the lockdown’s duration [[2](https://rt.live/)].

One case study which underscores the dangers of mass gatherings provides a chilling accounting of one three-dayslong religious gathering’s impact on the spread of COVID-19 in Malaysia. At the time of its publishing (April 18, 2020) Malaysia held the highest recordings of COVID-19 incidence in Southeast Asia: contact tracing directly attributed 35% of the total COVID-19 cases in Malaysia to that gathering [[1](https://poseidon01.ssrn.com/delivery.php?ID=270087070007121069000067066023013026019020004044012020102115093077081100074005091087126002106037044112055114065006117117019067030009070086068017105102031081076026091073066035120122110103068013070010118087081007067014068094031093122023113069113029121087&EXT=pdf%20https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7188142/)]. The Malaysian case study acutely demonstrates that a single mass gathering can significantly impact the infection rates.

While the US struggled to keep infection rates under control, mass protests broke out across the country in honor and outrage of the brutal murder of George Floyd late May/early June. Blind to purpose and injustice, infections spiked in cities boasting protests in the tens of thousands [[3](https://academic.oup.com/jpubhealth/advance-article/doi/10.1093/pubmed/fdaa127/5880636), [4](https://pdfs.semanticscholar.org/0ecc/653991dc5919a6817931e9eac5d87d698363.pdf?_ga=2.24931640.306705625.1597888815-1091882099.1595780748)].

As a case study, we will consider the state of Texas. Houston, TX was George Floyd’s hometown and the protests were (remain) sizeable and sustaining across the state. It has been estimated that the June 2 protest in Houston, TX alone brought out 60,000 persons [[5](https://www.chron.com/news/houston-texas/slideshow/Scenes-from-the-Houston-march-for-George-Floyd-202972.php)]. As opposed to other cities such as Seattle and NYC whose protests followed an infection surge months prior, Texas' curve had been pretty flat and low, leaving the vast majority of its citizens susceptible during these mass gatherings. In addition to less of a herd immunity buffer, there was likely less social awareness of the dangers of COVID-19 as compared to e.g. Seattle and NYC which also had protests but whose spikes following the protests were less significant [3].

Texas implemented lockdown restrictions between April 1 and May 1, by some estimations sustaining an Rt below 1.0 for the lockdown period [[2](https://rt.live/)]. On May 7 (one week after reopening), there were 968 new cases reported with an Rt above 1.0. June 7 there were 1425 new cases reported. July 7 there were over 10,000 new cases, peaking July 17 with 14,916 new cases reported (out of 67,466 tests collected). Masks were not enforced until July 2.

At the time of the mass protests which started a month after lockdown restrictions were lifted, any potential outbreak would freely throughout propagate Texas’ population and indeed Texas has experienced (and continues to experience) a surge in COVID-19 infections. The question remains as to whether the protests indeed had any significant impact on Texas’ infection curves or whether Texas’ infection trajectory is a pure consequence of a virus unchecked.[[1]](#footnote-1)

Q: Using the SIr model, simulate the effect of a mass protest versus no mass protest on infection curves. For initial conditions S0, I0, r0, use aggregate data as of May 1, the day the lockdown was lifted.

1. What- if any- is the significant difference between a mass gathering and no mass gathering? Consider the difference in those removed after a long time-horizon.
2. Can a time-to-surge of infections be predicted from mass gatherings from the SIr model? Do the curves peak on different days?

Initial conditions (May 1, 2020 [[8](https://weizmannacil-my.sharepoint.com/personal/renee_zacharowicz_weizmann_ac_il/Documents/SysMed/8.%09https:/en.wikipedia.org/wiki/COVID-19_pandemic_in_Texas)]):

**Active infections *I0*** **1.22E-3**: 35390 active cases/29E6 TX population

**Removed *r­­0* 6.69E-4**: (973 deaths + 18440 recovered)/29E6

**Susceptible *S­0* 9.98E-2**: 1.0 - (I0 + r0)

Parameters:

**Replication number *R0*** **3.15**: mean of day-over-day case increases between May 2 and May 14 [[8](https://weizmannacil-my.sharepoint.com/personal/renee_zacharowicz_weizmann_ac_il/Documents/SysMed/8.%09https:/en.wikipedia.org/wiki/COVID-19_pandemic_in_Texas)]

**Removal parameter 14­-1 days-1**: persons are now considered non-infectious 10 days after symptom onset [[9](https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/end-home-isolation.html)] following an incubation period with a median of 5 days (exhibiting symptoms on the 5th day) [[10](https://www.acc.org/latest-in-cardiology/journal-scans/2020/05/11/15/18/the-incubation-period-of-coronavirus-disease)]

**Transmission parameter 0.225 days-1**: R0 \*

Time horizon: **150 days**

A screenshot of a video game

Description automatically generated

A screenshot of a video game

Description automatically generatedA close up of a logo

Description automatically generated

With the aforementioned parameters and no further restrictions or stresses imposed on the system, SIr predicts a peak day of infections 49 days out, July 19. Unperturbed, this model’s peak day prediction is still quite close to the actual peak date of July 17. Its peak rate of 31.82% (or 9.23E6/29E6 persons) is quite an over-reaching estimation. At the end of the time horizon of 150 days, it is expected that 94.97% of the population would have been infected.

**Modeling a months-long mass gathering**

Ostensibly, mass gatherings increase the transmission parameter (and replication number in turn). We will consider of 0.29 (1.29x) throughout the month of June.[[2]](#footnote-2) Though June’s protests extended through August, a mask order was put into place July 2 which should have limited transmission even in close contact. Thus, we will impose a higher transmission parameter for 32 days only (May 31-July 2) and observe the consequences.

A screenshot of a video game

Description automatically generated

A picture containing screenshot

Description automatically generatedA screen shot of a computer

Description automatically generated

As modeled, this SIr model accounts for 32 days of elevated transmissions without mask impositions or gathering restrictions. This model’s peak prediction is 46 days out (July 16) with a predicted peak infection rate of 39.73%. and a total 97.38% of the population infected at the end of the 150 day time-horizon.

Ostensibly, the simple SIr is not an accurate predictor of COVID-19 transmissions and seemingly grossly overpredicts rates of infection (considering the cumulative case count as of September 1,2020, 92 days post-May 1, is 617,333 or 2.13% of the state’s population. One glaring assumption is the imposition of statewide parameters while evidently different counties have very different landscapes [13]. However, it would be remiss to model one county (e.g. Houston, TX) in isolation as counties are in close contact with one another and protests specifically attracted demonstrators from neighboring counties (and states).

Notably, though the replication rate seems to be tapering off, the case count continues to rise and it is not yet clear that Texas has cleared its infection surge hurdle.

With overestimation caveats in place, the difference in percentage removed between the Unperturbed and Mass Gathering models is 2.59%. With a 1% death rate in a population of 29 million, this translates to more than 7500 deaths in excess.

Evidently, restrictions and measures designed to reduce points of contact such as lockdowns and mask orders have significantly reduced viral transmission. Contrapositively, recent surges in COVID-19 cases and replication rates across multiple states in the US indicate that there have been a loosening of restrictions. One cause for increased points of contact may be mass gatherings of protest which have ignited all over the country in co-occurrence with the pandemic. As per this writeup, reports shortly following mass gatherings could be prematurely conclusive as even an exponential rise requires a few generations’ transmission for an evident and undeniable surge: this SIr estimation indicates a peak would emerge well over a month following loosening of restrictions (with unspeakable death counts following in its wake). Thus, it behooves the international community to respect the rampant violence of an unchecked virus and adopt as many measures of restriction as possible until a safe and effective vaccine is available. It is further incumbent upon political leaders not to turn a blind eye to the apolitical virus, to put the safety of their citizens first, and provide remote means for their constituents to exercise their democratic voice and freedoms.

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1. Curiously, Texas’ death curve is temporally translated from its infection curve by about a month, or 2-4 generations of transmission. This phenomenon is not seen in curves of states whose infection peak hit a few months prior (eg NY). In corroboration to the alternative hypothesis, it may be the case that the spike of cases in Texas were largely in the younger population and it took 2-4 generations of transmissions to infect more vulnerable populations. Notably, the protesters themselves [skewed young](https://www.pewresearch.org/fact-tank/2020/06/24/recent-protest-attendees-are-more-racially-and-ethnically-diverse-younger-than-americans-overall/) with a [low risk of dying](https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-age.html) [[6](https://www.pewresearch.org/fact-tank/2020/06/24/recent-protest-attendees-are-more-racially-and-ethnically-diverse-younger-than-americans-overall/),[7](https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-age.html)]. [↑](#footnote-ref-1)
2. Admittedly a heuristic to define a ‘mass protest’, 0.29 has been estimated as the secondary attack rate of an infected individual among close contacts [11] [↑](#footnote-ref-2)