Emerging Evidence on COVID-19

Summary of Public Health Intervention Research

Introduction

Measuring the effectiveness of large-scale public health interventions is crucial for the design and implementation of efficient responses against current and future epidemics. This report briefly summarizes the COVID-19 literature on public health interventions up to April 7, 2020.

What's New This Week?

- 59 new publications on public health intervention efficacy in the last week.
- A phased lift of control strategy is proposed to achieve herd immunity at the population level. This requires successive parts of the country to release all interventions so the epidemic can rage locally, while strict control in the remaining parts wait for their turn. On average individuals will experience ~14 months of intensive control and at the end, 56% of the population will have immunity.
- A "shield immunity" strategy is suggested that involves identifying and deploying recovered individuals who have protective antibodies to SARS-CoV-2 in the community so the majority of community interactions are with recovered individuals. For a population with 10,000 people and R0=2.33, the final number of deaths will be reduced from 71,000 at baseline to either 58,000 or 20,000 depending on intermediate or enhanced shielding, respectively.
- Linear mixed models revealed that the presence of mandated Bacillus Calmette-Guérin (BCG) vaccination policies was associated with a significant flattening of the exponential increase in both confirmed cases and deaths during the first 30-day period of country-wide outbreaks.
- Reducing interstate traffic alone in the USA will make very little difference once the epidemic has spread across the country.
- A multivariate analysis demonstrates that face mask use in public was negatively associated with the number of COVID-19 cases/inhabitant (coef. -326, 95% CI: -601- -51, P=0.021).
- A multi-stage quarantine release strategy will be effective in keeping ICU demand below capacity in New Zealand. This strategy begins with quarantining everyone over 50 years old from day 65-160 and then everyone over 60 years old from day 160-255. The strategy captures a large enough portion of the population to achieve herd immunity while reducing fatalities.
- A single age group engaging in "salutary sheltering" while the rest of the population does not is not effective. A combination of partial salutary sheltering in a single age group and physical distancing by the rest of the age groups is more effective and the largest impact is seen with 50% salutary sheltering of the 30-49 age group.
- A COVID-19 Drive Through Test Site (DTTS) in a large church parking lot in Alabama successfully identified 70/2216 positive patients, which represents 33% of the statewide cases as of Mar 21.

Key Points

- Public health interventions are most effective when combined.
- There a lack of evidence on the effectiveness of airport screening for identifying COVID-19 cases, which is in line with existing evidence during the SARS and Ebola epidemics.
- Quarantine, isolation, and social distancing interventions are more effective than traffic restrictions.
- To achieve herd immunity, far fewer people would need to be reached with testing and isolation in comparison to vaccination.
- Timing of public health interventions is important and has direct implications on the effectiveness of the intervention.
- Various travel restrictions have delayed the movement of COVID-19 to other locations, but this intervention alone is not effective in halting transmission.
- Lockdowns and social distancing will need to last for months to be effective.

Overview

To date, there have been 245 publications on efficacy of COVID-19 public health interventions. The majority of these publications are mathematical models using epidemiological data from the outbreak to estimate the effectiveness of public health interventions. Publications that are new since the last report are marked (*) beside the reference.

This report presents outcomes from 8 categories of interventions: travel restrictions (61 publications), general or combined (86), quarantine, isolation, and contact tracing (49), social distancing and self-protection (43), screening, testing, and surveillance (15), vaccination and herd immunity (9), management of medical waste (1), and public awareness (3). Applicable reviews (3) are also included. Some publications fall into more than one category.

CONTENTS

TRAVEL RESTRICTIONS

Sixty-one publications have analyzed the efficacy and timing of travel restrictions on the dispersal of SARS-CoV-2. Examples include restricting most forms of transportation and city lockdowns.

TABLE 1: SIXTY-ONE PUBLICATIONS EVALUATING THE EFFICACY AND TIMING OF IMPOSED TRAVEL RESTRICTIONS ON SARS-COV-2

Type of Analysis or Model	Main Outcomes	Reference
TRAVEL RESTRICTIONS *(India)*		
SEIQR model	The effects of city lockdown, social distancing, and quarantine measures in Bangladesh are explored. In the absence of intervention measures, R0 is estimated to be 5.93. A one, two, or three week lockdown is predicted to reduce R0 to 3.77, 2.12, and 0.945, respectively. Other results in social distancing and quarantine sections.	(Chowdhury, Kabir, & Tanimoto, 2020)*
TRAVEL RESTRICTIONS *(Italy)*		
Analysis	Using a large-scale dataset on geo-located smartphone users, authors estimate a reduction of 50% of the total trips between Italian provinces following the lockdown on Mar 7. Half of the population travelled less than 2km a week, whereas before the outbreak it was more than 5.7km a week. In addition, the proximity network among individuals based on the potential encounters each individual could have in one hour dropped by 17% at a national level.	(Pepe et al., 2020)
SEIR model	The effects of the nationwide lockdown in Italy implemented on Mar 10 were gradual, R0 decreased from 3.31 (95% CI: 3.13-3.45) to 2.53 (95% CI: 2.2-2.9). When the government introduced even stricter measures on Mar 20 (banning open-air sports and closing parks/green spaces) R0 decreased to 0.69 (95% CI: 0.15-1.32).	(De Brouwer, Raimondi, & Moreau, 2020)*
TRAVEL RESTRICTIONS *(Japan)*		
SIR model	In the absence of intervention measures in Tokyo with an estimated R0 of 2.86 (95% CI: 2.73-2.97), medical services is predicted to collapse on Apr 26 and total deaths will be ~500,000 by the end of the pandemic. If a lockdown is implemented on Apr 6 and more than 60% of trips outside the home were restricted voluntarily, the collapse of medical services can be avoided and 250,000 lives saved.	(Sugishita, Kurita, Sugawara, & Ohkusa, 2020)*
TRAFFIC RESTRICTIONS (*South Korea*)		
Analysis	The decrease in Rt coincides with the decrease in metro traffic volume. In Daegu, Rt dropped below 1 and in Seoul Rt remained around 1. Authors believe this is because this intervention measure were less intense in Seoul.	(Park, Sun, Viboud, Grenfell, & Dushoff, 2020)
TRAFFIC RESTRICTIONS (*Spain*)		
Stochastic SEIR meta-population model	If all private cars remained contained in their corresponding province in Spain, the peak of the epidemic would be delayed about 7 days. If there was a 90% reduction in overall traffic, the peak would be	(Aleta & Moreno, 2020)

	delayed ~20 days. In comparison, isolation is more effective than traffic restrictions.	
TRAFFIC RESTRICTIONS ***(USA)***		
Network-driven epidemic dynamics model	Without any interventions in the USA, the epidemic peak is estimated to arrive on June 3, with daily active cases ≈ 7.16% of total population. As of Mar 16, it was already too late for traffic restrictions in the USA to be effective in in containing the epidemic spread. A 90% mobility reduction from traffic restrictions implemented two weeks earlier (Mar 2) would have delayed the epidemic peak by 30%.	(P. Liu, Beeler, & Chakrabarty, 2020)
SEIAR model	Reducing interstate traffic alone in the USA will make very little difference once the epidemic has spread across the country.	(S. Chen, Li, Gao, Kang, & Shi, 2020)*
TRAVEL RESTRICTIONS ***(International - travel restricted to and from China)***		
Global meta-population disease transmission model	Two scenarios where travel restrictions produced a 40% and 90% traffic reduction to and from China were analyzed. The simulated scenarios show that even a 90% traffic reduction to and from China will only delay the epidemic by no more than 2 weeks unless this intervention is combined with a 50% or higher reduction of transmission in the community.	(Chinazzi et al., 2020)
Stochastic process model	It was estimated that 226 cases (95% CI: 86-449) were prevented from being exported across the world due to travel restrictions to and from China, corresponding to a 70.4% reduction in incidence. Using data from COVID-19 cases diagnosed outside of Canada, the model estimates travel restrictions reduced the probability of a major epidemic in Japan by 7-20%, which results in a delay of 2 days in the time to a major epidemic.	(Anzai et al., 2020)
Mathematical model	This model attempted to quantify the impact of flight suspensions to and from China on direct COVID-19 importation risk. With this intervention, the change in effective distance from China remains small in countries such as Singapore, Thailand, and the United States. In contrast, countries such as Ethiopia and Qatar see a large increase in their effective distance.	(Adiga et al., 2020)
Mathematical model	Early travel restrictions from China to the USA slowed the outbreak in the USA by ~26 days.	(Odendaal, 2020)
SEIR model	The scale of the outbreak in the USA from imported Wuhan cases with and without interventions (travel restrictions in Wuhan) is estimated. With no intervention and estimates of R0=2.4 and z=2.5 (zoonotic force), there would be 9,484 (90% CI: 2,054-24,241) cases in the USA by Mar 1. With the travel restrictions in Wuhan reducing transmission by 25% and the same estimates (R0=2.4, z=2.5), there would be 1,013 (90% CI: 107-2,474) cases in the USA by Mar 1.	(Dalin Li et al., 2020)
Mathematical model	This model estimates how control measures might work in countries other than China by comparing the outbreak size in those countries with the local reproduction number (Rloc) is 1.6 (baseline), 1.4, and 1.1. When Chinese cases grow to 600,000 in the Rloc =1.6 scenario, foreign outbreaks are very likely. In countries with low connectivity to	(Boldog et al., 2020)

	China, but a high Rloc, a further reduction in their importation numbers by entry screening or travel restrictions is necessary to reduce the risk of an outbreak. In the two other scenarios, outbreaks are somewhat likely (Rloc = 1.4) or unlikely (Rloc = 1.1.) in other countries when the Chinese outbreak reaches 1 million.	
SEIR model	The travel ban in China successfully delayed the onset of widespread transmission in Australia by four weeks. Without the travel ban, by Mar 2 Australia would have received over 70 imported cases compared to the 15 they actually received, a 79% reduction in expected cases.	(Adekunle, Meehan, Rojaz Alvarez, Trauer, & McBryde, 2020)
TRAVEL RESTRICTIONS ***(China - location not specific or combined efforts)***		
Epidemiological data	There is a difference in the lag time between primary and secondary cases based on the timing of implementation of effective local control measures (e.g. city lockdown, traffic control). The mean lag time was ~1 week, with lower values in Jiangsui (~4 days) and Henan (~5 days), and higher in Heilongjiang (~13 days) and Tianjin (~14 days).	(Ying et al., 2020)
Mathematical model	A mathematical model estimated a negative growth rate after the implementation of travel restrictions in China. In Hubei, the decline in growth rate was sharp (r_H^{post}= -0.64 [-0.85, -0.48]) and was more gradual for the rest of China (r_C^{post}= -0.19 [-0.54, 0.00]).	(Pinotti et al., 2020)
Regression model	Timing is important for the efficacy of intervention efforts. It was estimated that if control efforts (Wuhan lock-down combined with nationwide traffic restrictions and stay-at-home movement) were implemented 3 days in advance, the estimated number of cases will be reduced by 30.74% (21,245 cases) under normal implementation and 48.59 (15,768 cases) under strict implementation.	(Yuan & Yuan, 2020)
SIR meta-population model	By reducing 90% of passengers through strict border control, an extra 32.5, 20, and 10 days of outbreak arrival time can be gained under an R0 of 1.4, 1.68, and 2.92 respectively.	(Hossain et al., 2020)
Epidemiological data	Without any border or travel restrictions, 779 cases (95% CI: 632-967) would have been exported by Feb 15. The travel restrictions enforced by the Chinese government prevented 70.5% (95% CI: 68.8-72%) of these cases. These measures decreased the daily rate of exportation by 81.3% (95% CI: 80.5-82.1%) in the first 3.5 weeks of implementation. When compared to airport screening, travel restrictions were more effective (see in Table 2).	(Wells et al., 2020)
Susceptible, asymptomatic, infected, recovered, death (SAIRD) model	Implementing measures to lock down cities in China lead to higher mortality rates in these cities due to reduced mobility. When city lockdowns were coupled with the addition of a large number of hospital beds cure rates were improved and mortality rates were reduced. However, infection rates could not be significantly reduced. The sooner these measures are implemented, the more effective they are at controlling the epidemic. Medical resources should be increased for cities under lockdown.	(P. Shao, 2020)

SEIRD model	By reducing population mobility (i.e. city lockdown, traffic restrictions), the proportion of individuals with asymptomatic infection will be reduced significantly. This will only be significant if implemented early.	(P. Shao & Shan, 2020)
Analysis	This analysis explores the relationship between mobility patterns and epidemic spread in 350 Chinese cities outside of Hubei. Local travel restrictions in cities outside Hubei after the Wuhan lockdown have contributed to the control of the epidemic and have averted 1,960 (95% CI: 1,474-2,447) infections, taking 22.4% (95% CI: 16.8-27.9%) of observed ones. A further decrease in the number of confirmed cases by 15.7% (95% CI: 15.4-16.0%) or 1,378 (95% CI: 1,353-1,402) cases can be achieved with a more synchronized implementation. The cumulative confirmed cases in the two weeks post Wuhan lockdown was mainly impacted by three patterns of inter-city population movement, while those in the third and fourth weeks after was significantly influenced by intra-city population movement.	(H. Liu et al., 2020)*
TRAVEL RESTRICTIONS (*Hubei Province)*		
SEIR model	The travel shutdown effectively cut R0 in half and moved the predicted COVID-19 outbreak peak to Mar 10 +/-20 days in Wuhan and Mar 31 +/-16 in Beijing.	(Li, Zhao, & Sun, 2020)
Mathematical model	When compared to no intervention, the current travel lockdown strategy in Hubei province will reduce approximately 62.5% and 59.9% of COVID-19 infections and deaths, respectively.	(Shen, Peng, Guo, Xiao, & Zhang, 2020)
Flow-SEIR model	Traffic blockage in Hubei province will reduce the peak number of COVID-19 infections by 21.06% -22.38%. When compared to using quarantine as a control measure, restricting traffic is a less effective control strategy.	(Deqiang Li et al., 2020)
TRAVEL RESTRICTIONS (*Wuhan City*)		
Epidemiological and human mobility data	The travel shutdown slowed the movement of COVID-19 cases from Wuhan to other cities in China by 2.91 days (95% CI: 2.54-3.29).	(Tian, Li, et al., 2020; Tian, Liu, et al., 2020b)
Global meta-population transmission model	The travel shutdown in Wuhan corresponds to a modest delay of the epidemic trajectory of 1 to 6 days from Wuhan and other locations in China.	(Chinazzi et al., 2020)
Epidemiological data	There was significant correlation between the export population of Wuhan and reported cases in various regions in China, confirming that the travel shutdown has reduced the dispersal of SARS-CoV-2.	(Jin, Yu, Han, & Duan, 2020)
Bayesian model	This analysis provided some evidence that the travel shut down following the public confirmation of human-to-human transmission was effective.	(Q. Zhao, Chen, & Small, 2020)
SEIR meta-population transmission model	By reducing air traffic to and from Wuhan by 50%, 80%, 90%, 95%, and 99%, the model predicts that COVID-19 infections will be reduced by 12.6%, 20.1%, 22.6%, 23.9%, and 24.9% respectively, by Feb 4. This suggests that travel restrictions from Wuhan will delay the epidemic reaching other locations, but is unlikely to be effective in halting transmission across China.	(Read, Bridgen, Cummings, Ho, & Jewell, 2020)

Mathematical model	The closure of Wuhan dropped the R0 of COVID-19 from 4.38 (95% CI: 3.63-5.13) to 3.41 (95% CI: 3.16-3.65).	(J. Li et al., 2020)
SIR model	Simulations suggest that after two weeks, the lockdown would only reduce the number of active cases by less than 10% among half of the provinces, and 25% in Qinghai and Fujian.	(Ku, Ng, & Lin, 2020)
Deterministic SEIR model	Under the current control efforts in Wuhan, this model estimates the daily incidence of COVID-19 will drop to 0 in Wenzhou by Mar 3-9.	(Xu et al., 2020)
Epidemiological data	There is a significant positive association between number of cases and population movement from Wuhan to other provinces in China. If the city closure in Wuhan was implemented 2 days earlier, 1,420 (95% CI: 1,059-1,833) cases may have been prevented. If this intervention was implemented 2 days later, there may have been 1462 (95% CI: 1,090-1,886) more cases.	(Ai et al., 2020)
Epidemiological and human mobility data	There is a significant positive correlation between population influx from Wuhan and confirmed COVID-19 cases in other cities across China (R^2=0.85, p<0.001). If there was no travel ban in Wuhan, it is estimated this may have increased the number of overall cases by 118% (91-172%), resulting in 13,857 (10,920-20,574) more cases. In addition, implementing the travel ban 3 days earlier would reduce 47% (26-58%) of cases, resulting in 3,103 (1732-3820) less cases.	(C. Zhang et al., 2020)
Stochastic SEIR-meta-population model	Two scenarios were compared, one with no travel restrictions and another where mobility is reduced by the travel ban in Wuhan. Results show that the expected number of infected individuals in most of the regions in mainland China decreased, indicating that these travel restrictions are efficacious in the short term.	(Aleta, Hu, Ye, Ji, & Moreno, 2020)
Human mobility data and mathematical modeling	Control measures in Wuhan were successful in mitigating the spread of COVID-19 in China. Following the implementation of control measures, the correlation of COVID-19 growth rates and human mobility from Wuhan becomes negative in most locations.	(Kraemer et al., 2020)
SEIR model	The government control measures in Wuhan had a moderate effect on the incubation rate, but the recovery rate endured a several fold increase. In the event of no government interventions, this model estimates the cases in Wuhan would reach 7.78 billion (70% of population) with a mortality rate of 4.1% (319,000 deaths).	(Xinkai Zhou et al., 2020)
Geolocation data and mathematical model	Nationwide mobile phone geolocation data was used to track and model population outflow from Wuhan before and after the outbreak. The efficacy of the lockdown in Wuhan on Jan 23 was seen in a 47% and 36% drop of inter- and intra- provincial population outflow compared to Jan 22. The cumulative number of infections is highly correlated with cumulative population outflow from Wuhan over time.	(J. S. Jia et al., 2020)
Epidemiological data	Prior to any public health interventions, R0 in Wuhan was estimated to be 5.20 (95% CI: 5.04-5.47). After the travel restrictions and interventions implemented on Jan 23, R0 declined to 5.12 (95% CI: 4.98-5.26) between the period of Jan 23-Feb 1 and declining R to 0.58 (95% CI: 0.51-0.64) from Feb 2-11.	(Mizumoto, Kagaya, & Chowell, 2020)

SEIR model	Without any interventions, there would have been 165,744,000 (± 156,000) confirmed COVID-19 outside of Wuhan on day 50 of the epidemic (Feb 19). By itself, the Wuhan travel ban would have reduced this number to 202,000 (± 10,000) and by itself, the national emergency response would reduce case numbers to 199,000 (± 8500). Together, these control measures reduced the total number of cases by 96% of what was expected without interventions for a total of 29,839 (fitted model estimate 28,000 ± 1400 cases).	(Tian, Liu, et al., 2020a)
SEIMO model	Thirty days after the lockdown in Wuhan, R0 dropped from 2.65 to 1.98. If this lockdown was implemented 7 days earlier than Jan 23, the number of infected people would drop from 77,453 to 21,508. If the lockdown was delayed by 1-6 days, the infection scale would expand 1.23 times (95,273 cases) to 4.94 times (382,695 cases).	(T. Qiu & Xiao, 2020)
ARMIA model	The volume of traffic from Wuhan outbound was positively associated with COVID-19 incidence in all provinces, with correlation coefficients between 0.22-0.78 ($p<0.05$). The estimated lag times between traffic volume and COVID-19 incidence was <1 week, 1 week, and 2-3 weeks in 42%, 39%, and 19% of provinces respectively. The travel ban in Wuhan prevented ~19,768 (95% CI: 13,589-25,946) cases outside of Wuhan by Feb 29.	(Shi & Fang, 2020)
Epidemiological data	After imposing a lockdown in Wuhan, there was a significant increase in doubling time from 2 days (95% CI: 1.9-2.6) to 4 days (95% CI: 3.5-4.3). The correlation between COVID-19 spread and domestic air travel also became weaker after the lockdown was implemented (before lockdown: R0=0.98, 0<0.05, after lockdown: R0=0.91, p=NS).	(Lau et al., 2020)
Epidemiological data	Before the lockdown of Wuhan, the time-varying reproduction number (Rt) in Hangzhou ranged from 1.9-3.8. After the lockdown, Rt dropped steadily and was 1.14 (95% CI: 1.04-1.25) on Feb 4 and continued to drop below 1 on Feb 10, indicating the outbreak was controlled in Hangzhou. Rt was kept below 1.0 in Shenzhen through time.	(Chong et al., 2020)
SEIRD model	Due to the implementation of public health interventions in Wuhan, R0 decreased from 3.8 to 0.5 by Feb 12-Mar 5.	(W. Wang et al., 2020)
CDIM model	After the lockdown of Wuhan on Jan 23, R0 decreased significantly in Wenzhou from 4.5 to 0.5 (95% CI: 0.435-0.556).	(Xiao et al., 2020)
Mathematical model	The stringent quarantine, and massive city lockdown measures imposed in late Jan effectively reduced the contained the outbreak by early Feb in China, especially for cities outside Hubei province.	(Y. Qiu, Chen, & Shi, 2020)
Analysis	The number of cases in Chinese provinces on Jan 23 and the final outbreak size (as of Mar 9) were compared. There is a statistically significant relationship between the number of cases on the day of the lockdown in Wuhan and the number of cases by the end of the epidemic. These results illustrate the importance of implementing public health intervention strategies prior to confirmation of a large number of cases.	(Drake, 2020)

Analysis	After an analysis of the incidence, severity, deaths, and recovered cases across China between Jan 23-Mar 1, authors conclude the lockdown of Wuhan was effective in controlling the spread of the epidemic. After Jan 23, the number of daily confirmed cases continued to increase until the inflection point on Feb 4. Since then, the number of new cases falls sharply until Mar 1 (decreases by 85% in whole country, 83.2% in Hubei, and 92.8% in other provinces).	(F. Wang et al., 2020)
Mathematical model	The lockdown of Wuhan reduced population inflow into Wuhan by 76.64%, population outflows from Wuhan by 56.35%, and within-city movements by 54.15%. Without this lockdown, cases would have been 64.81% higher in the 347 cities outside Hubei, and 52.64% higher in the 16 cities inside Hubei (excluding Wuhan). In addition, 63 other cities outside of Hubei implemented similar, but less strict mobility restrictions which were also effective in reducing the impact of population inflows and the spread of the virus into other cities.	(H. Fang, Wang, & Yang, 2020)
SEIR model	This model estimated the effective infection rate for Wuhan decreased from 8.1 on Jan 23 to <1 on Feb 17 as a result of intervention measures applied in China.	(J. Hou et al., 2020)
SIR model	The effectiveness of city lockdown and intensive community screening in China was assessed using the α value as 1 at the beginning of the epidemic, which means no limitation of spread. After the lockdown in Wuhan, α value of Wuhan and China (excluding Hubei) decreased from 0.905 to 0.814 and 0.926 to 0.254 between Jan 23-Feb 16, respectively. Authors speculate this is because the rapid spread from Wuhan to other cities was effectively suppressed, but local spread in Wuhan was not. Results of screening in screening section.	(Peng, Liu, Ni, Cui, & Du, 2020)*
SEIR-HC model	The sudden decrease in the number of exposed individuals in Wuhan on Jan 23 and Feb 12 were due to the strict control measures implemented.	(H. Zhu, 2020)*
SEIQR model	This model reproduced the dynamics of the Wuhan outbreak with two peaks occurring on Feb 4 and 12. The prevention measures implemented on Jan 23 determined the timing of the first peak and an 87% reduction in R0 from 3.09 (95% CI: 2.10-3.63) to 0.41 (95% CI: 0.18-0.66). The second peak on Feb 12 was due to improved diagnostic testing capabilities. After the detection kits were released on Jan 26 the proportion of documented infections increased from 23% (95% CI: 20-26%) to 37% (95% CI: 33-41%), and later up to 73% (95% CI: 64-80%) once the diagnostic criteria were improved.	(Liang & Yuan, 2020)*
SEIR model	In China, the lockdown of all public transportation in Wuhan on Jan 23 resulted in a 61% decrease of R0 bringing it from 4.94 (95% CI: 4.80-4.99) to 1.90 (95% CI: 1.84-2.0). When more stringent measures such as closing all non-essential companies and manufacturing plants in Hubei province were introduced, R0 dropped to 0.055.	(De Brouwer et al., 2020)*
SIQR model	In the absence of the transportation suspension in Wuhan on Jan 26, the number of infections would be 117,842 (95% CI: 102,051-	(H. Zhang et al., 2020)*

	137,856) by Feb 4. This intervention resulted in a 28% (95% CI: 22-40%) reduction in infections, effectively preventing 33,719 (95% CI: 26,440-47,474) infections	
TRAVEL RESTRICTIONS *(General)*		
Mathematical model	Both traffic control and social distancing alone significantly reduce the cumulative case growth rate, effectively controlling the development of the epidemic. However, the coefficient of social distancing is larger, demonstrating it is more effective than traffic control. These two interventions are complementary and work best when combined. Two factors impact the effectiveness of these measures, the control capacity of the city (GDP per capita) and difficulty of epidemic control (population size). Traffic control measures work best in regions with high GDP and population size.	(S. Lin, Huang, He, & Zhan, 2020)
SIR model	The most effective interval for imposing a limited-time lockdown is one where the midpoint of the lockdown coincides with the actual peak of the epidemic in the absence of a lockdown. Using an example of a 15-day lockdown where the peak occurs at day 45, implementing an early lockdown from day 20-35 is ineffective. The disease will remain contained during the lockdown, but will explode after the lockdown is lifted. Similarly, a lockdown that is too late (implemented after the peak) will also be ineffective.	(Shayak, Sharma, Rand, Singh, & Misra, 2020)*
SIR model	This model demonstrates the effectiveness of a dynamic lockdown of a high-risk group (individuals >70 years old), which decreases the maximum number of infected cases from 1.7 million to 800,000.	(Baerwolff, 2020)*
Mathematical model	In the scenario where contact tracing is effective, but the healthcare system is close to being overwhelmed, moderate travel restrictions can have a large effect on the probability of an epidemic. Reducing the inflow of travelers can also reduce the chance of a second wave of COVID-19.	(Malmberg & Britton, 2020)*

SCREENING, TESTING, AND SURVEILLANCE

The effectiveness of screening and testing interventions, such as airport exit and entry screening and mass screening for detecting COVID-19 cases, and general surveillance has been evaluated in fifteen publications, Table 2. In combination with airport screening, one study also looked at traveller sensitization, which aims to trigger rapid self-isolation and reporting of symptom onset resulting in SARS-CoV-2 identification and subsequent contact tracing.

TABLE 2: FIFTEEN PUBLICATIONS EVALUATING THE EFFICACY OF SARS-COV-2 SCREENING AND TESTING INTERVENTIONS

Type of Publication	Main Outcomes	Reference
AIRPORT SCREENING		

Mathematical model	46 out of 100 infected travellers will enter undetected, indicating airport screening is unlikely to detect a sufficient portion of SARS-CoV-2 infected travellers.	(Quilty, Clifford, Flasche, & Eggo, 2020)
Mathematical model	In the best-case scenario, airport screening would detect less than half of SARS-CoV-2 infected travellers.	(Gostic, Gomez, Mummah, Kucharski, & Lloyd-Smith, 2020)
Report	Active screening for COVID-19 is conducted at Thailand international airport, and 21,374 travelers have already been screened. So far, 4 imported cases of COVID-19 have been detected at health screening points at immigration posts at international airports.	(Sookaromdee & Wiwaniveitkit, 2020)
Epidemiological data	Without any border or travel restrictions, 779 cases (95% CI: 632-967) would have been exported by Feb 15. The travel restrictions enforced by the Chinese government prevented 70.5% (95% CI: 68.8-72%) of these cases. It was estimated that 64.3% (95% CI: 55.4-71.3%) of exported cases were pre-symptomatic upon arrival at the airport. Using symptom based screening, this means only 82 (95% CI: 72-95) cases imported from mainland China would be detected in comparison to 549 (95% CI: 451 to 670) cases being averted from travel restrictions.	(Wells et al., 2020)
AIRPORT SCREENING and TRAVELLER SENSITIZATION		
Mathematical model	In 75% of simulations, a combination of these interventions (airport screening and traveller sensitization) will result in an outbreak delay of at least 9 days under the assumption of 10 infected travellers per week, or 111 days under the assumption 1 infected traveller per week.	(Clifford et al., 2020)
SYMPTOM-BASED SCREENING		
Commentary with primary research	Symptom-based screening was ineffective in detecting SARS-CoV-2 infection in 2/126 passengers who were evacuated by aircraft from Wuhan to Germany. The two passengers who had evidence of SARS-CoV-2 confirmed by throat swab were subsequently isolated and remain well 7 days after admission.	(Hoehl et al., 2020)
Analysis	Using data on the COVID-19 outbreak, this study analyzed conditions where a symptom-based mass screening and testing intervention (MSTI) requiring the testing all individuals with symptoms at a healthcare facility would be beneficial. Results suggest that MSTI can be beneficial if the probability of transmission at the testing sites is less than the probability that a symptomatic person is infected with COVID-19.	(Ge, McKay, Sun, Zhang, & Handel, 2020)
MASS SCREENING		
Analysis	This analysis shows how the implementation of mass testing for COVID-19 in South Korea resulted in a decrease in the number of new infections over time. Although other factors could be involved, authors believe mass testing allowed for fewer new infections because they could easily identify and contain those who were infected.	(Balilla, 2020)
Mathematical model	This model suggests that the implementation of a large-scale and standardized clinical testing platform with nucleic acid testing, high-throughput sequencing, and immunoprotein assessment capabilities will	(Xie et al., 2020)

	maximize the effect of quarantine and reduce its cost and length. If this testing platform was run at its full capacity, over 22,800 cases could be diagnosed on time, the peak of suspected cases would be reduced by at least 44%, and the quarantine cost could be reduced by 72%. If daily testing capacity of 10,500 occurred right after Hubei lockdown, daily settlement (no suspected cases each day) for all cases achieved immediately.	
Mathematical model	Both social distancing and mass testing can contain or reduce the number of infections and deaths when compared with no mitigation strategies. Mass-testing with subsequent isolation of detected cases can be an effective mitigation strategy alone and in combination with social distancing. However, these measures only delay the main outbreak and would need to be maintained at a reduced intensity to avoid subsequent waves of infection until a suitable therapeutic or vaccine is implemented. Authors conclude that testing every individual without symptoms every ~10 days would reduce R0 to 1 and stabilize the pandemic.	(Jenny, Jenny, Gorji, Arnoldini, & Hardt, 2020)
SIR model	This model assessed the effectiveness of city lockdown and intensive community screening in China using the α value as 1 at the beginning of the epidemic, which means no limitation of spread. Although the α value decreased with the city lockdown, intensive community screening caused this to drop significantly. The nationwide intensive community screening that was implemented on Feb 16 caused a decrease of α value in Wuhan and China (excluding Hubei) from 0.814 to 0 and 0.254 to 0 between Feb 16-Mar11, respectively. In the same time frame, the number of infected cases in Wuhan and China (excluding Hubei) decreased significantly from 36,385 to 13,462 and 8,153 to 493, respectively.	(Peng et al., 2020)*
Observational study	This study tested the concept of a mass testing strategy in Birmingham, Alabama. This COVID-19 Drive Through Test Site (DTTS) in a large church parking lot involved collecting nasopharyngeal swabs for PCR screening in children and adults self-reporting symptoms suggestive of SARS-CoV-2 infection. In this program 70/2216 patients tested positive and the screening yield was similar in all age groups. The number of cases identified by the DTTS represented 33% of the statewide cases reported to the Alabama Department of Public Health as of Mar 21.	(Rogers et al., 2020)*
SURVEILLANCE		
Bayesian model	This model estimated the ability of various countries to detect imported COVID-19 cases from Wuhan in comparison to Singapore, which is known historically to have strong surveillance and contact-tracing capacity. The global ability to detect imported cases is 38% (95% HPDI (highest posterior density interval): 22-64%) of Singapore's capacity. If all countries had the same detection capacity as Singapore, they estimate that 2.8 (95% HPDI: 1.5-4.4) times the current number of cases could be detected. It was estimated that the ability to detect imported cases from Wuhan among high surveillance countries is 40% (95% HPDI: 22-67%), among intermediate surveillance countries it is 37% (95% HPDI: 18-68%), and among low surveillance countries it is 11% (95% HPDI 0-42%).	(Niehus, De Salazar, Taylor, & Lipsitch, 2020)

Mathematical model	The probability that an imported case is followed by sustained human-to-human transmission is 0.41 (credible interval [0.27-0.55]). With intense surveillance efforts reducing the mean time from symptom onset to hospitalization by half, the probability is only 0.012 (credible interval [0-0.099]).	(Thompson, 2020)
Analysis	The effectiveness of surveillance and subsequent containment efforts in Singapore were measured by analyzing the first 100 COVID-19 patients and calculating the 7-day moving average of the interval from symptom onset to isolation or quarantine. This was 5.6 days and declined after ~ 1 month, which indicated significant decreasing trends for both local and imported cases. Of these 100 cases, 16 patients were identified through advanced surveillance and 11 by laboratory testing based on providers' clinical discretion. If other countries had similar detection capacity as Singapore, the number of global imported cases detected would be 2.8 times higher than the current observed number.	(Ng et al., 2020)

These analyses underscore the reality that respiratory viruses are difficult to detect if a large proportion of infected people show mild, indistinct, or no symptoms, and if incubation periods are long. These predictions are in line with existing evidence on the lack of effectiveness of airport screening during the SARS and Ebola epidemics.

QUARANTINE, ISOLATION, AND CONTACT TRACING

Informed by the latest evidence on transmission of SARS-CoV-2, forty-nine publications assessed the ability of quarantine, isolation, and contact tracing to control SARS-CoV-2, Table 3. This also includes quarantine measures implemented on cruise ships.

TABLE 3: FORTY-NINE PUBLICATIONS EVALUATING THE ABILITY OF ISOLATION, QUARANTINE, AND CONTACT TRACING TO CONTROL SARS-COV-2

Analysis or Model	Main Outcomes	Reference
CONTACT TRACING and ISOLATION		
Stochastic transmission model	In an epidemic scenario with under 50% of contacts successfully traced and an R0 of 1.5, the epidemic was controllable. However, for a R0 of 2.5 and 3.5, more than 70% and 90% of contacts would have to be traced to control the majority of outbreaks, respectively.	(Hellewell et al., 2020)
Stochastic transmission model	The transmissibility and duration of the latent period relative to the duration of incubation period has a strong impact on the controllability of the disease. If the diagnosis delay is short (<3 days) and a large proportion of non-household contacts are traced and isolated (>70%), there will be substantial reductions in the epidemic grown rate (more than 0.1 per day to well under 0.1 per day) and epidemic doubling time (~ 6 days to more than ~14 days). Isolation and contact tracing can be effective in controlling early epidemics when R0 is in the lower range or reported values.	(Kretzschmar, Rozhnova, & van Boven, 2020)
CONTACT TRACING and QUARANTINE		

Model (type not reported)	The exponential growth rate of COVID-19 was decreased from 0.29 per day to 0.14 per day (CI: 0.12 to 0.15 per day) due to quarantine and contact tracing.	(Sanche et al., 2020)
Stochastic branching model	This model compares the ability of individual quarantine and active monitoring based on contact tracing to reduce the effective reproductive number of COVID-19 below one. Individual quarantine may contain an outbreak of COVID-19 with a short serial interval (4.8 days) only in settings with high intervention performance where at least 75% of infected contacts are individually quarantined. As COVID-19 continues to grow, these interventions will not be feasible alone. Active monitoring or individual quarantine was shown to contribute synergistically with social distancing.	(Peak et al., 2020)
Epidemiological analysis	If a case is identified through contact tracing within 5 or 10 days after exposure, the likelihood of that case traveling during the incubation period would be reduced by 24.7% (95% CI: 20.1-31.8%) and 5.3% (95% CI: 4.7-6.7%) respectively.	(Wells et al., 2020)
CONTACT TRACING		
Mathematical model	The efficacy of the current UK definition of a close contact (within 2 meters for 15 minutes or more) was assessed using survey information on social encounters in combination with predictive models. Using this definition and the assumption that contact tracing can be performed rapidly, each new case requires an average of 36 individuals to be traced. This tracing will reduce the R0 from 3.11 to 0.21, enabling the outbreak to be contained. We are unlikely to control an outbreak if we relax this definition of a close contact to require more than four hours of contact.	(Keeling, Hollingsworth, & Read, 2020)
SEIR model	With limited testing, isolation, and quarantine, it is estimated that at the peak of the epidemic 107,000 (95% CI: 60,760-149,000) cases would be in the hospital and 55,500 (95% CI: 32,700-75,200) cases in ICU in Ontario, Canada. Three intervention strategies were all projected to delay the epidemic peak and reduce the number of cases requiring ICU care: 1) enhanced testing and contact tracing, 2) restrictive social distancing, 3) a combination of enhanced testing and contact tracing and social distancing (but less restrictive than in 2). Restrictive social distancing had the largest effect. The longer the duration of the intervention, the more effective. When the intervention was 6 months or less, there was no difference on the final attack rate. With 12-18 months of interventions, the proportion of the population at the end of the 2-year period was reduced. The combination intervention was projected to substantially reduce the attack rates when implemented for 18 months.	(Tuite, Fisman, & Greer, 2020)
ISOLATION		
Stochastic SEIR meta-population model	This model analyzed the efficacy of isolation measures in Spain, where the average number of days that an individual is able to go unnoticed and infect others was reduced from 5.1 to 4, 3, 2, and 1 days. By reducing the time from symptom onset to isolation to under 3 days, the epidemic was predicted to disappear. When compared to traffic measures and self-protection measures, isolation is a more effective control measure.	(Aleta & Moreno, 2020)

SIR model	Case isolation, home quarantine, and social distancing reduced R0 by 0.4, 0.5, and 0.5 respectively. When all three interventions are conducted at the same time, R0 reduced by 1.4.	(Ganhdi, Murthy, Prasada Rao, & Casella, 2020)
SEIR model	With no intervention measures, Spain could reach 1.4 million infections and 100,000 deaths by Apr 27. By drastically increasing the isolation measures by a factor of 10 could reduce the number and peak of infections to 100,000 and 30,000 deaths by the beginning of Apr. Each day of delay in implementing this intervention represents a 90% increase in the infected population at the peak.	(Lopez & Rodo, 2020)
SEIR model	This model provides evidence that symptom-based isolation policies could reduce the attack rates of both influenza and COVID-19 outbreaks. For COVID-19 transmission, implementing a one-day post-fever isolation would reduce the attack rate from 79% to 71% in the scenario that 50% of the cases detect fever. There is a possible benefit of isolation for six days in this scenario. The peak number of infected is reduced by 20% and the duration increases by 6 days, therefore flattening the curve. There is no benefit from increasing the post-fever isolation period beyond one-day. In the scenario that 88% of the cases detect fever, a one-day or six-day post fever isolation would reduce the attack rate to 50% or 43%, respectively.	(Burns & Gutfraind, 2020)
SIR model	Authors demonstrate general social distancing could extend the duration of the epidemic and results in insufficient overall immunity in the population. A more efficient and robust strategy would be targeted isolation of the vulnerable subpopulation. This strategy has a lower economic and social cost and would take less time.	(Neufeld & Khataee, 2020)
SEIR model	When contact rates are reduced to 50%, the final cumulative incidence in Mexico decreases to low levels. The time it takes to implement the intervention and the time it takes to get to the desired contact rate reduction are both important. Using an example with a desired decrease in contact rate of 60%, if the time it takes to reduce the contact rates is 7, 15, or 30 days, the cumulative incidence 16 weeks after the arrival of the first imported case will be 6,532, 8,909, or 14,980 respectively. If the time to get to the desired contact rate of 60% is 7 days and is implemented one or two weeks later (Mar 30 or Apr 6) implementation are Mar 23, Mar 30, and Apr 6, the cumulative incidence would increase by 12,058 and 45,118 cases, respectively.	(Acuna-Zegarra, Comas-Garcia, Hernandez-Vargas, Santana-Cibrian, & Velasco-Hernandez, 2020)*
SIR model	With 20-30% population isolation and no additional intervention measures implemented in Portugal, the predicted peak is ~2-2.5 million cases by the beginning of May and total mortality between 41,594-44,421. Increasing isolation to 50-60% will reduce the peak to ~1-1.5 million cases in June/July with total mortality between 18,141–27,406. The last simulation increasing isolation to 70-75% results in a reduction of peak cases to ~41-44K in Oct-Jan with a total mortality between 2,723–7,623.	(Pais & Taveira, 2020)*
SEIR model	With no intervention measures in Israel, 2.4 million will become infected and ~200,000 people will die after 114 days. This model compared two 14 day intervention strategies: 1) global isolation of the whole population	(Shlomai, Leshno, Sklan,

	and 2) focused isolation of people at high risk of exposure with extensive testing. At the end of 200 days, strategy 1 will reduce the number of cases and deaths to 14,995 and 389, respectively. Strategy 2 will reduce the number of cases to 16,658 and deaths to 432. Therefore, global isolation is more effective but the incremental cost-effectiveness ratio (ICER) will be between $22.5-280 million per one death avoided.	& Leshno, 2020)*
SIR model	This model compares the effect of a complete lockdown versus isolation through partitioned lock down. Partial lock down involves providing individuals with time slots during the week when they can freely venture out, allowing them to meet with others but not the whole population in general. Results show that a partitioned lock down provides a lower rate of transmission, which results in less cases and ultimately reduces the death rate. Authors suggest this strategy could be used prior and after a full lockdown to delay, and isolate the second wave of pandemic.	(Prasad & Mohapatra, 2020)*
CONTACT TRACING, ISOLATION, and QUARANTINE		
Mathematical model	The potential merit of a mobile phone algorithm-based application for first degree contact tracing with subsequent isolation and quarantine to help reduce the spread of SARS-CoV-2 is explored. Results suggest a mobile phone app for first-degree instantaneous contract tracing could dramatically reduce onward transmission to a level that will stop SARS-CoV-2 from spreading in a population.	(Ferretti et al., 2020)
SEIR model	The time evolution of the SARS-CoV-2 outbreak in Italy is proposed using preliminary data up until Mar 11. This model based on Wuhan data indicates the effects of intensive public health interventions such as quarantine, isolation, and contact tracing will drastically reduce the infectious population Italy.	(Traini, Caponi, & De Socio, 2020)
ISOLATION, QUARANTINE, and PUBLIC CLOSINGS		
Model (type not reported)	The model estimates the impact of public health measures such as isolation, quarantine, and public closings. All of which were shown to greatly reduce the final size of the epidemic, and make the turning point ~24 days earlier than without these measures.	(Z. Liu, Magal, Seydi, & Webb, 2020)
ISOLATION and QUARANTINE		
Mathematical model	This model demonstrates isolation and quarantine lead to a substantial decrease in the final size and peak incidence, especially when performed prior to symptom onset. By combining the use of an antiviral drug with contact tracing, quarantine, and isolation, a significant decrease of the final size and peak incidence. This combination increase the probability that the outbreak will fade out.	(Torneri et al., 2020)
SEQIJR model	This model demonstrates the quarantine-isolation policy in Israel effectively decreased R0 in the first two weeks. However, despite authorities cancelling public parades, there were many religious gatherings and private parties to celebrate the Jewish holiday Purim during Mar 9-11. This short lapse in public responsiveness drove Israel from a controlled regime to an exponential growing regime (R0=2.18 as of Mar 20).	(Klausner, Fattal, Hirsch, & Shapira, 2020)

Stochastic agent-based model	This model finds the isolation and quarantine response will avert 1,696 or 1,990 cases (based off two scenarios) and is the most cost effective (US $12,428 or $58,555). However, the less cost effective strategy of personal protection combined with isolation and quarantine is the optimal strategy as more infections will be averted.	(Q. Wang et al., 2020)
SEIR model	This model tests the effectiveness of five levels of control strategies in New Zealand. With no control measures R0=2.5. R0 will be reduced to 2.3, 2, 1.75, 1.2, and 0.75 by 1) closing schools and universities, 2) case isolation, 3) case isolation and quarantine, 4) case isolation, quarantine, and population-wide social distancing, 5) all of the above. However, when these controls are lifted after 400 days, an outbreak occurs with a similar peak size as for an uncontrolled epidemic demonstrating these strategies can delay but not prevent the epidemic. Another strategy shows that alternating periods of strong/weak control for ~750 days could prevent hospital capacity from being exceeded as long as R0 remains close to 1 during the periods of strong control.	(James, Hendy, Plank, & Steyn, 2020)
SEIR and SIR model	This model demonstrates the success in halting the spread of infection in countries where rapid government interventions for quarantine and isolation were implemented such as Wuhan, Italy, and South Korea. This information was used to model the current growth in the USA in the presence of control measures. The spread of infection will come to a halt in the USA by Apr 20. However, relaxing or reversing these control measures right now will lead to an exponential growth in cases reaching ~1 million by mid-Apr.	(Dandekar & Barbastathis, 2020)*
QUARANTINE		
SEIR model	This model utilizes multi-source data sets that take into account the effects of recently implemented public heath prevention measures by including quarantined and suspected cases to effectively predict the trend of the COVID-19 epidemic. The trend of the epidemic mainly depends on quarantined and suspected cases and the epidemic peak is coming soon. By continuing to increase detection rates through quarantine and suspected cases, the epidemic peak can be reached quicker.	(B. Tang, F. Xia, S. Tang, et al., 2020)
EIR model	Researchers simulated and compared the epidemic spreading processes of two scenarios, with and without quarantine control measures in Wuhan, China. With a quarantine rate of 63% implemented on Jan 23, the peak confirmed infected population is estimated to be 49,093 on Feb 16.	(Xiong & Yan, 2020)
Flow-SEIR model	Adhering to quarantine measures in Hubei province can reduce the number of cases by 89.68%. When compared to restricting traffic in the province, this is a more effective control strategy.	(Deqiang Li et al., 2020)
SEIR model	This model predicted the impact of various quarantine rates on the number of cases per day. With other variables remaining constant, results indicate every 5% increase in the quarantine rate will reduce the number of confirmed cases by approximately 313 on the peak day. By setting the quarantine rate to 45%, the number of cases would be reduced by 939 on the peak day when compared with a quarantine rate of 30%.	(Pan et al., 2020)

Time delay dynamic model	A time delay dynamic model was used to predict the spread of COVID-19 in Japan. If no effective quarantine measures are implemented, the number of COVID-19 cases will grow exponentially. If Japan implements the same quarantine measures as Shanghai in a timely manner, the number of infected people will be relatively small. As an example, by delaying the implementation of this intervention by a week, from Feb 22-29, the scale of the intervention will increase from 150,000 to 450,000.	(N. Shao et al., 2020)
SEIQ model	The aggressive quarantine strategy of building square cabin hospitals has effectively decreased the basic transmission rate by 81.5%.	(K. K. Zhang et al., 2020)
SIR meta-population model	If an individual is quarantined one day after the person became infectious, an extra 44, 24.1, and 10 days of outbreak arrival time can be gained under an R0 of 1.4, 1.68, and 2.92 respectively.	(Hossain et al., 2020)
QSEIR model	If strict quarantine measures are retained, the peak value of confirmed cases in China would be between 52,438-64,090 between Feb 7-19. With this, the epidemic could be controlled between Mar 19-30.	(X. Liu et al., 2020)
SIIE model	This model is characterized by three parameters: average incubation period, contact rate (rC), and exclusion rate (rE). To contain exponential epidemic growth, rC/rE must be reduced to 1. Authors estimate that quarantine measures placed in China (strict) and Italy (mild) resulted in about a 25-fold and 4-fold reduction of rC/rE quotient, respectively. For Italy, they would need a further 3-fold reduction to terminate exponential growth. A four-fold reduction in contact rate is required to contain the epidemic in Germany, France, UK, Spain, and the USA.	(Kochanczyk, Grabowski, & Lipniacki, 2020)
Mathematical model	In the context of India, this model assumed that symptomatic quarantine would identify and quarantine 50% of symptomatic individuals within 3 days of developing symptoms. If R0=1.5 or 4.0, this control measure would reduce cumulative incidence by 62% or 2%, respectively. On its own, this preventative measure is insufficient to delay the outbreak.	(Mandal et al., 2020)
SUQC model	Before Jan 30, all regions except Beijing had an R0 >1, and after Jan 30 they all had an R0<1, indicating quarantine and control measures were effective. Specifically, a quarantine rate of 51.2% reduced R0 from 1.52 to 0.58 with 19% baseline quarantine in China (excluding Hubei), a 48.8% quarantine rate reduced R0 from 5.93 to 0.61 with 5% baseline quarantine in Hubei (excluding Wuhan), and a 39.2% quarantine rate reduced R0 from 4.71 to 0.76 with 6% baseline in Wuhan.	(S. Zhao & Chen, 2020)
Deterministic compartmental model	This model simulates scenarios with different quarantine compliance rates (70%, 80%, or 90%) among international students. Findings demonstrate when incoming international students show strict compliance with quarantine, epidemics were less likely to occur in Seoul, South Korea.	(Ryu, Ali, Lim, & Chun, 2020)
C-SEIR model	If quarantine measures were adopted in Wuhan 2 days earlier or later, there would have been an almost double decrease or increase in the number of infected individuals. After the epidemic reaches its peak, if the quarantine measures are cancelled completely, there is the possibility of a second peak occurring. To reduce the chances of a second peak, the	(B. Chen et al., 2020)

	quarantine needs either to be partially relaxed or continued for awhile after the epidemic reaches its peak.	
SEIR model	This model simulated the impact of a host-based early warning system on different disease outbreak scenarios to mitigate pathogen transmission during an outbreak. Five different interventions were compared and contrasted: 1) self-monitoring and reporting (baseline SEIR model), 2) quarantining the entire population, 3) quarantine-on-alert (with high sensitivity early warning), 4) quarantine-on-alert (with high specificity early warning), and 5) quarantine-on-alert (ideal early warning). The quarantine-on-alert policy coupled with near-ideal early warning reduces quarantine needs with only a small increase in additional infections.	(Hernandez et al., 2020)
SEIRD model	The number of infected individuals changes significantly after the implementation of quarantine measures at four time points. The sooner these measures are implemented, the shorter the time it takes for the proportion of infected people to decrease to zero.	(P. Shao & Shan, 2020)
SIR model	Case isolation, home quarantine, and social distancing reduced R0 by 0.4, 0.5, and 0.5 respectively. When all three interventions are conducted at the same time, R0 reduced by 1.4.	(Ganhdi et al., 2020)
Analysis	The spatio-temporal propagation of the COVID-19 virus in China is compared to other global locations. A strong correlation between the number of infected individuals in each province and the population migration from Hubei to this province was found suggesting disease propagation is due to human mobility. Quarantines were effective and prevented infected individuals spreading the disease to other cities.	(Gross et al., 2020)
SEIR model	In an uncontrolled epidemic, it is estimated that 9 million Iranians will become infected and 900,000 will die. Complete isolation of identified cases was not effective. Also, social distancing alone cannot be an effective policy at this stage unless at least 80% of the population confine themselves for an extended period of time. If half of the individuals confine themselves, ~ 3 million individuals will get infected and 50,000 will die. The best-case scenario was a combination of interventions that assumed 50% of the population quarantine, while the testing and identification process intensifies by 10 fold. If implemented immediately, the maximum number of cases will reach its maximum at 175,000 on May 9 and deaths will remain below 5,000 by end of June. This scenario is even more effective if extended for an additional 30 days.	(Einian & Tabarraei, 2020)
SEIR model	A simulation for Lombardy Italy demonstrates that a single age group engaging in "salutary sheltering" while the rest of the population does not is not effective. If 100% of single age group engages in salutary sheltering, this leaves 60% of the population still infected. A combination of partial salutary sheltering in a single age group and physical distancing by the rest of the age groups is a more effective strategy with a much larger impact. Using this strategy, the fraction of the infected population drops to 50% or below depending on which age group, and what percentage is engaging in salutary shelter within four months from the beginning of the	(Wilder et al., 2020)*

	outbreak. The largest impact is seen with 50% salutary sheltering of the 30-49 age group.	
SIR model	A multi-stage quarantine release strategy will be effective in keeping ICU demand below capacity in New Zealand. This strategy begins with quarantining everyone over 50 years old from day 65-160 and then everyone over 60 years old from day 160-255. Over this period of time, the population under 50 are not under quarantine but moderate social distancing for 3 months is required. The strategy of an age cut of 50 captures a large enough portion of the population to achieve herd immunity while reducing fatalities when compared to cut offs at 60 or 70.	(Jamieson-Lane & Cytrnbaum, 2020)*
SEIQR model	This model explores the effects of city lockdown, social distancing, and quarantine measures in Bangladesh. In the absence of intervention measures, R0 is estimated to be 5.93. Quarantining 10% of the population results in an R0 of 2.47 whereas quarantining 60% of the population results in a reduction of R0 to 0.905. City lockdown and social distancing results can be found in their respective sections.	(Chowdhury et al., 2020)*
CRUISE SHIP QUARANTINE		
Mathematical model	At the early stage on the Diamond Princess cruise ship, R0 was estimated to be 2.28 (95% CI: 2.06-2.52) and the cumulative cases would reach 1514 (1384-1656) by day ten. If the crew takes preventative measures to control the spread and reduce R0 by 25% and 50%, the estimated number of cumulative cases by day 10 would be reduced to 1081 (981-1177) and 758 (697-817), respectively.	(S. Zhang et al., 2020)
Analysis	Back calculation and forecasting methods show that the number of cases on the Diamond Princess cruise ship on Feb 24 without any intervention would be 1373 (95% CI: 570-2176) with close contact and 766 (95% CI: 587-946) without close contact. The movement restriction intervention was put into place on Feb 4 and actual cases were 102 with close contact and 47 without close contact.	(Nishiura, 2020)
SEIR model	Without any intervention measures (quarantine/isolation) on the Diamond Princess cruise ship, 2920/3700 (79%) of the crew and passengers would have been infected by Feb 19. The actual number that tested positive on Feb 20 was 619/3700 (17%). Isolation and quarantine measures decreased R0 from 14.8 to 1.78.	(Rocklöv, Sjödin, & Wilder-Smith, 2020)
CLOSED vs OPEN ENVIRONMENT		
Epidemiological data	The odds that a primary case transmitted COVID-19 in a closed environment was 18.7 times greater compared to an open-air environment (95% CI: 6.0-57.9). These findings are in line with declining incidence in China after gathering in closed environments was prohibited.	(Nishiura et al., 2020)

SOCIAL DISTANCING AND SELF-PROTECTION

Forty-three publications analyzed the efficacy of various forms of social distancing (such as school closures) to mitigate the effects of SARS-CoV-2.

TABLE 4: FORTY-THREE PUBLICATIONS EVALUATING SOCIAL DISTANCING TO CONTROL SARS-COV-2

Analysis or Model	Main Outcomes	Reference
SOCIAL DISTANCING		
SEIQR model	With 30 days of substantial social distancing, R0 in Wuhan and Hubei was reduced from 2.2 (95% CI: 1.4-3.9) to 1.58 (95% CI: 1.34-2.07) and in other provinces from 2.56 (95% CI: 2.43-2.63) to 1.65 (95% CI: 1.56-1.76). Implementing the intervention earlier could reduce the number of infections by up to 98.9% and the number of deaths by 99.3% as of Feb 23. However, this effect would be neutralized by an early epicenter lockdown. The most effective course of action would be early social distancing in the epicenter city, followed by the province, and then national in the absence on an epicenter lockdown.	(Y. Zhang, Jiang, Yuan, & Tao, 2020)
SEIR model	Intense control measures for social distancing (school closure and 10% of workforce in public spaces working) in Wuhan will reduce the final size and peak incidence of the outbreak. The model suggests a variation across age categories, where the reduction in incidence is highest among school children and older individuals and lower in working-aged adults. The number of infections in mid-2020 could be reduced by more than 92% (interquartile range: 66-97%) if the return to work was staggered and starts at the beginning of Apr.	(Prem et al., 2020)
SIR model	The effectiveness of cancelling all sports and entertainment events (voluntary event cancellation - VEC) in Japan for two weeks between Feb 26-Mar 11 was predicted in this model. Results indicate this intervention decreased R0 from 2.50 (95%CI: 2.43-2.55) to 1.88 (95%CI: 1.68-2.02). This 35% decrease does not bring R0 below 1; therefore, it will not contain the outbreak in Japan completely.	(Sugishita, Kurita, Sugawara, & Ohkusa, 2020)
Mathematical model	A one-time period of social distancing will not sufficient to prevent critical care capacities from being overwhelmed by the epidemic in the USA. While seasonal variation in transmission will facilitate epidemic control in the summer, there will be a rebound in transmission after the end of the period, which will lead to an epidemic that exceeds this capacity. For example, with a 20-week period of social distancing with 60% reduction in R0, the resurgence peak size is nearly the same as the peak size of the uncontrolled epidemic. The social distancing is so effective that virtually no population immunity is built. With the current critical care capacity, this epidemic could last until 2020, requiring the implementation of social distancing measures place between 25% and 70% of that time.	(Kissler, Tedijanto, Lipstich, & Yonatan, 2020)
Stochastic transmission model	Three scenarios of social distancing interventions in Georgia, USA initiated on Mar 12 are investigated, where initial cases are 8, 64, or 128 on Mar 1. Results indicate social distancing interventions will slow the trajectory of the epidemic in Georgia.	(Drake & Rohani, 2020)
SEIR model	Social distancing starting on Mar 10 through Apr 7 will slow the rate of growth on the Snohomish County, Washington, USA epidemic but only large changes in contact rates can interrupt ongoing transmission rates. With no social distancing, 25000 infections and 400 deaths are estimated. If social distancing reduces transmission by 25%, 50%, or 75% the number	(Klein et al., 2020)

	of estimated infections will be 9700, 4800, or 1700, and the number of estimated deaths are 160, 100, and 30, respectively.	
SIR model	Case isolation, home quarantine, and social distancing reduced R0 by 0.4, 0.5, and 0.5 respectively. When all three interventions are conducted at the same time, R0 reduced by 1.4.	(Ganhdi et al., 2020)
Analysis	The deaths for COVID-19 cases in China are compared to eight other countries: Italy, Spain, France, USA, UK, Germany, Netherlands, and South Korea. Although each country has varying intensities and timing of social distancing interventions, the countries all appear to be converging onto the same trajectory of decline in the daily growth rate of deaths similar to what was seen in China after their aggressive social distancing policy. Authors imply this may mean there is a threshold of intervention that is sufficient to achieve the desired downward trajectory.	(Pike & Saini, 2020)
Markov chain model	This model assumes a population size of 60 million and social distancing is implemented on day 55 of the outbreak. If social distancing is perfect (R0=0), the mortality rate is 0.04% (21,474 deaths) and will be resolved in 1.5 months. Using the UK as an example of a semi-lockdown with many people still going to work and using public transportation, R0=0.5 and the mortality rate is 0.13% (79,781 deaths) and it will take 4.5 months to resolve. If the UK relaxes its current social distancing as people start to take the lockdown less seriously (R=0.75) they will see mortality rates of 0.55% (330,964 deaths) and it will take >6 months to resolve.	(Bendtsen Cano, Cano Morales, & Bendtsen, 2020)
SEIR model	Targeting specific age groups will have a smaller effect than combined. With a low (25%) or high (95%) compliance to these social distancing measures in the younger-adults group, there would be 20,000 (68% less) or 27,000 (92% less) fewer cases respectively, compared to baseline. However, once these interventions efforts are lifted new epidemic curves may emerge.	(Matrajt & Leung, 2020)
Mathematical model	This model assumes that 70% of cases are diagnosed due to a shortage of test kits, 20% of cases are hospitalized with moderate to severe illness, and 80% of patients with mild illness are home in the USA. To contain transmission the public must limit the average number of contacts per person to less than 7 unique individuals over each 5 day period to increase the average social distance between individuals to 10 degrees of separation.	(P. J. Zhao, 2020)
SEIR model	With limited testing, isolation, and quarantine, it is estimated that at the peak of the peak of the epidemic 107,000 (95% CI: 60,760-149,000) cases would be in the hospital and 55,500 (95% CI: 32,700-75,200) cases in ICU. Three intervention strategies were all projected to delay the epidemic peak and reduce the number of cases requiring ICU care: 1) enhanced testing and contact tracing, 2) restrictive social distancing, 3) a combination of enhanced testing and contact tracing and social distancing (but less restrictive than in 2). Restrictive social distancing had the largest effect. The longer the duration of the intervention, the more effective. When the intervention was 6 months or less, there was no difference on the final attack rate. With 12-18 months of interventions, the	(Tuite et al., 2020)

	proportion of the population at the end of the 2-year period was reduced. The combination intervention was projected to substantially reduce the attack rates when implemented for 18 months. Dynamic interventions were also explored where interventions were turned on and off over a longer period of time. Social distancing, when implemented on and off for a period of 13 months, would reduce the mean overall attack rate to 2% and maintain ICU capacity. This represents a more effective, sustainable control strategy that would allow the maintenance of health system capacity and allow periodic psychological and economic respite for populations.	
SEIR model	In an uncontrolled epidemic, it is estimated that 9 million Iranians will become infected and 900,000 will die. Complete isolation of identified cases was not effective. Also, social distancing alone cannot be an effective policy at this stage unless at least 80% of the population confine themselves for an extended period of time. If half of the individuals confine themselves, ~ 3 million individuals will get infected and 50,000 will die. The best-case scenario was a combination of interventions that assumed 50% of the population quarantine, while the testing and identification process intensifies by 10 fold. If implemented immediately, the maximum number of cases will reach its maximum at 175,000 on May 9 and deaths will remain below 5,000 by end of June. This scenario is even more effective if extended for an additional 30 days.	(Einian & Tabarraei, 2020)
Mathematical model	Both social distancing and mass testing can contain or reduce the number of infections and deaths when compared with no mitigation strategies. Mass-testing with subsequent isolation of detected cases can be an effective mitigation strategy alone and in combination with social distancing. However, these measures only delay the main outbreak and would need to be maintained at a reduced intensity to avoid subsequent waves of infection until a suitable therapeutic or vaccine is implemented. Authors conclude that testing every individual without symptoms every ~10 days would reduce R0 to 1 and stabilize the pandemic.	(Jenny et al., 2020)
Mathematical model	Both traffic control and social distancing alone significantly reduce the cumulative case growth rate, effectively controlling the development of the epidemic. However, the coefficient of social distancing is larger, demonstrating it is more effective than traffic control. These two interventions are complementary and work best when combined. Two factors also impact the effectiveness of these measures, the control capacity of the city (GDP per capita) and difficulty of epidemic control (population size). Social distancing measures are effective in cities with high or low GDP and high population size, but traffic control measures work best in regions with high GDP and population size. Interventions should be implemented based on a city's own situation.	(S. Lin et al., 2020)
SIR model	Based off the results, authors suggest the window of opportunity for starting an intervention (e.g. social distancing, containment) is the week following the turning point in number of cases per day. Results show that starting an intervention after the peak prevalence of infections has no	(Wittkowski, 2020)*

	effect and starting right at the peak prevalence shortens the duration of the epidemic but herd immunity is decreased. Starting at the peak incidence will "flatten" the curve and maximizes the number of deaths prevented, but also reduces herd immunity. Whereas starting before the peak incidence also "flattens" the curve, but can cause a rebound unless the intervention is continued for many more months.	
Mathematical model	Social distancing delays the occurrence of infections and distributes the number of cases across a longer time span. By decreasing the demographic density through social distancing by 50% in NYC, the peak maximum number of infections will be delayed by 25 days and the number of new infections per day will decrease from 23,000 to 9,000. After the implementation of interventions, the growth rate in NYC dropped from $\mu_o = 0.926$/day to $\mu = 0.308$/day. Italy maintained their growth rate for 20 days and South Korea reduced theirs to 0 over a span of two weeks.	(Alvarez, Gonzalez-Gonzalez, & Trujillo-de Santiago, 2020)*
SEIR model	With no intervention measures in Australia and R=2.4, 81% of the population would be infected by the end of the epidemic, 35,000 people would require critical care, 105,000 would require hospitalization, and the peak would be in July. In the scenario where all infected individuals reduce their contacts by 1/3, R0 would be 1.6 and 57% of the population would be infected at the end of the epidemic, 15,000 would require critical care, 42,000 would require hospital beds, and the peak would shift to Nov. Another scenario where R0=0.8 due to a reduction in contacts by 2/3 shows that herd immunity will not be achieved and as soon as intervention measures are lifted, a second epidemic will emerge. In the last two scenarios, the number of infections would decrease modestly and herd immunity would not be achieved. Therefore, several intermittent periods of strong interventions would be required.	(McBryde, Meehan, & Trauer, 2020)*
Analysis	Using the results from a survey of contact patterns and compliance with physical distance measures from a sample of adults in the UK after a "lockdown" was implemented, authors evaluate whether these measure were effective by estimating their impact on R0. Survey results indicate a 73% reduction in the average daily number of contacts (physical and non-physical) per participant from 10.2 to 2.9. Based on all types of contacts, this would be sufficient to reduce R0 from 2.6 to 0.62 (95% CI: 0.37-0.89) after the lockdown. For physical contacts only, R0 would be reduced to 0.37 (95% CI: 0.22-0.53).	(Jarvis et al., 2020)*
SIR model	With exponential growth and no intervention measures, the number of affected individuals in India may increase to 500,000 by Apr 30. The effects of the countrywide lockdown on Mar 24 were simulated using the same patterns that were seen in Hubei. The peak is estimated to arrive on Apr 8, with ~1,500 patients a day. In addition, the effects of social distancing reductions of 30%, 50%, and 70% were estimated. Even with a 70% reduction in cases from social distancing efforts, 30,000 cases are estimated by Apr 20.	(Ranjan, 2020)*

SIR model	It is predicted that removing social distancing completely ("unlock") at any time in 2020 will result in catastrophe, overloading the healthcare system. Authors suggest a partial unlock of social distancing measures in the USA so case load can be managed to not exceed critical resources while allowing herd immunity to be reached. This strategy involves allowing individuals to not partake in social distancing 3 or 5 days a week. One of the scenarios shown involves a 3 day a week partial unlock strategy beginning on Apr 9 with a full unlock 5 weeks later. Critical resource usage (ventilators) increase toward the 70-80% range and drop dramatically in time for the full unlock.	(Shuler, 2020)*
SEIQR model	This model explores the effects of city lockdown, social distancing, and quarantine measures in Bangladesh. In the absence of intervention measures, R0 is estimated to be 5.93. A 50% reduction in contacts through social distancing is not effective and will only reduce R0 to 3.13. Whereas, a reduction of 90% will control the epidemic bringing R0 to 0.623. Quarantine and city lockdown results can be found in their sections.	(Chowdhury et al., 2020)*
SCHOOL AND WORK CLOSURES/TELEWORK		
Epidemiological data	This article analyzes the effects of healthcare absenteeism to care for children due to school closures on COVID-19 mortality rates. Specifically, authors look at the lost healthcare workforce (healthcare capacity) vs. cases prevented to establish whether there is enough healthcare capacity to deal with cases with the school closures in place. It is unclear if school closures justify the potential loss of healthcare workers with regards to reducing cumulative mortality.	(Bayham & Fenichel, 2020)
CDIM model	In Beijing, it is estimated that R0 would rebound to 0.8 after the city resumed work. By post-poning the return to work could reduce the infected number in Beijing by 77.3%.	(Xiao et al., 2020)
Not specified	With a 50% telework proportion, R0 will decrease by 10% in most countries. China, Poland, and Hong Kong would see slightly higher decreases, and there would almost no change for Peru with telework. The impact of school closures is country specific. There would be a 20% decrease in R0 in countries such as Italy, Luxembourg, and France and a 10% decrease for Belgium and Vietnam.	(Willem et al., 2020)
Deterministic compartmental model	The effect of school closure on the COVID-19 epidemic, 3 months of school closures with varying infectiousness of subclinical cases, at either 0, 0.25, 0.5 or 0.75 times the infectiousness of clinical cases was simulated in Italy, UK, and Zimbabwe. When compared to influenza-like infections, the delay and decrease of the peak due to school closures was smaller. This was especially the case in Zimbabwe, which had the highest proportion of children. Authors conclude school closures are less effective than for influenza-like infections where children play a more substantial role in transmission.	(Davies et al., 2020)
SEIR model	This model investigates the potential effect of opening schools on two age groups, children (19 years old or younger) and adults (>19 years old) in Korea. Assuming the transmission rate between children increases 10-fold after schools open on Mar 2, 60 new cases in children are expected	(Kim, Kim, Peck, & Jung, 2020)*

	between Mar 2-9 and 100 between Mar 9-23. Extending the school closure two weeks (Mar 23) could reduce the magnitude of cases and speed up the end of epidemic.	
SCHOOL and EVENT CLOSURES		
SIR model	This SIR model demonstrates the positive effect of the two recent governmental interventions in Germany, which included banning large gatherings on Mar 8 and closing schools and shops on Mar 15. Evidence for two changing points due to these interventions were seen as the effective spreading rated decreased by more than a factor of 2, from 0.29 to 0.13. A median delay of D=9.5 days from these change points are estimated to see a reflection in decreased case numbers. Therefore, the contact ban implemented on Mar 22 is expected to show effect through a decrease in novel case numbers approximately two weeks later.	(Dehning et al., 2020)*
SIR model	The R0 in Japan was estimated at 2.86 (95% CI: 2.73-2.97). The protection level was estimated as 0.4 (95% CI: 0.2-0.7) from the cancellation of sports and entertainment events (VEC) and school closures (SC), which significantly reduced the number of infected cases. Alone, SC can reduce the number of symptomatic patients by 5 million (7%) and VEC by six million (8%). Performed simultaneously, SC and VEC can reduce the total number of cases by 18%.	(Kurita, Sugishita, Sugawara, & Ohkusa, 2020)
Mathematical model	Control measures such as city shut downs (school/event closures) are effective. By the end of the epidemic, Germany will have 500,000 to 5 million infected. The epidemic will end in June without control measures, and will be delayed a month or two if they are implemented. Authors conclude there is an optimal time when an intervention should start. If it takes place too early, the epidemic can be stronger than one that starts later. A delayed shut down is almost as effective as an extended shut down as it will also reduce the peak number of sick individuals.	(Donsimoni, Glawion, Plachter, & Waelde, 2020)*
PUBLIC/LARGE GATHERINGS		
SEIMO model	Increasing the transmission parameter of a public health gathering of 10,000 people by 5% would increase 4,243 infected people eventually. This demonstrates the importance of canceling large events during an outbreak.	(T. Qiu & Xiao, 2020)
SIR model	With no control measures, the number of infections will spread rapidly in Japan. By reducing the time spent in crowded zones to less than 2 hours, the infection spread in Japan will gradually be contained.	(Karako, Song, Chen, & Tang, 2020)
SIS model	Based on realistic heterogeneous social networks, reducing the number and size of large gatherings can stop an outbreak. They estimate a cut-off size of 23 persons for gatherings.	(St-Onge, Thibeault, Allard, Dube, & Hebert-Dufresne, 2020)
WEARING MASKS, HAND WASHING, and SOCIAL DISTANCING		
SEIR meta-population model	To analyze the efficacy of self-protection measures such as wearing masks, washing hands, or avoiding crowed places, this model reduced the effectivity of the transmission by a certain fraction to determine the final	(Aleta & Moreno, 2020)

	size of the epidemic. A reduction of 60% or more is required to contain the disease and isolation is more effective than traffic restrictions or self-protection measures.	
Transmission model	If awareness is spread in the population quickly, prevention measures (wearing masks, hand washing, or social distancing) can significantly reduce the attack rate, decrease the number of cases, and delay the peak of the epidemic. If the efficacy of these measures is greater than 50%, a large epidemic can be avoided. If awareness is spread slowly, these measures will only delay the peak number of cases, but will not alter the magnitude of the outbreak or the attack rate.	(Teslya et al., 2020)
Analysis	A UK community cohort study estimated the association between respiratory hygiene and relative risk of coronavirus infection. When compared to low handwashing, moderate-frequency handwashing was associated with a significantly reduced risk of contracting coronavirus (age-adjusted IRR= 0.65, 95% CI: 0.45-0.95, p=0.03). There was no significant effect for higher intensity handwashing (age-adjusted IRR = 0.84, 95% CI: 0.56-1.25) p=0.39).	(Beale et al., 2020)
Analysis	Linear regression was used to analyze the association between COVID-19 cases and the national promotion of face masks in public, controlling for the age of the epidemic and testing intensity. China, Czechia, Hong Kong, Japan, Singapore, South Korea, Thailand, and Malaysia advocated wearing face masks in public. The results of a multivariate analysis show face mask use in public was negatively associated with the number of COVID-19 cases/inhabitant (coef. -326, 95% CI -601- -51, P=0.021). In addition, testing intensity was positively associated with COVID-19 cases (coef. 0.07, 95% CI 54 0.05-0.08, P<0.001).	(Kenyon, 2020)*
COMBINED INTERVENTIONS		
Forecasting methods	By delaying public health interventions (social distancing, community mitigation measures, quarantine) by one month, the number of global cases would increase from 211,000 to 3,929,641 and the end time would change from Jun 25-Aug 22. Using a case fatality rate of 34%, this delay would result in the number of deaths increasing from 7,174 to 133,608.	(Hu, Ge, Li, Jin, & Xiong, 2020)
Analysis	Two telephone surveys were conducted on Jan 20-23 and Feb 11-14 in Hong Kong. Results indicate that 74.5% and 97.5% of the general adult population wore facemasks when out in public, and 61.3% and 90.2% avoided crowed places, respectively. Authors did not report on the efficacy of these interventions for COVID-19, but they report influenza transmission declined substantially. There was a 44% (95% CI: 34-53%) reduction in transmissibility in the community (Rt from 1.28 [95% CI: 1.26-1.30] to 0.72 [95% CI: 0.70-0.74]), and a 33% (95% CI: 24-43%) reduction in transmissibility based on pediatric hospitalization rates.	(Cowling et al., 2020)
Microsimulation model	Multiple interventions need to be combined to have a substantial impact on transmission. Population-wide social distancing applied to the population (US and UK) as a whole would have the largest impact. By combining this with other interventions such as isolation of cases and school closures, there is the chance to suppress transmission (R0<1) and	(Ferguson et al., 2020)

	reduce the incidence of cases. To avoid a rebound in transmission these policies must remain in place for up to 18 months until there is a vaccine.	
Agent-based influenza epidemic simulation model	Using different R0 values in Singapore, the effect of four intervention scenarios were compared to baseline: 1) isolation measures for infected individuals and quarantining of family members; 2) quarantine plus school closure; 3) quarantine plus workplace distancing; 4) and quarantine, school closure, and workplace distancing (the combined intervention). The combined intervention was the most effective when R0=1.5, 2.0, and 2.5, reducing the median number of infections by 99.3% (IQR 92.6-99.9%), 93.0% (81.5-99.7%), and 78.2% (59.0-94.4%), respectively.	(Koo et al., 2020)
SIR model	In Wuhan and Shanghai, daily contact were reduced 7-9 fold during the COVID-19 outbreak and most interactions were contained within the household. This model demonstrates that social distancing alone is sufficient to bring R0 below 1 and control the outbreak. School closures will reduce peak incidence by half and delay the epidemic, but they are unable to interrupt transmission on their own.	(Juanjuan Zhang et al., 2020)
SEIR model	This model tests the effectiveness of five levels of control strategies in New Zealand. With no control measures R0=2.5. R0 will be reduced to 2.3, 2, 1.75, 1.2, and 0.75 by 1) closing schools and universities, 2) case isolation, 3) case isolation and quarantine, 4) case isolation, quarantine, and population-wide social distancing, 5) all of the above. However, when these controls are lifted after 400 days, an outbreak occurs with a similar peak size as for an uncontrolled epidemic demonstrating these strategies can delay but not prevent the epidemic. Another strategy shows that alternating periods of strong/weak control for ~750 days could prevent hospital capacity from being exceeded as long as R0 remains close to 1 during the periods of strong control.	(James et al., 2020)

VACCINATION AND HERD IMMUNITY

Nine studies evaluated the effectiveness of vaccination and establishing herd immunity through natural infection on containing SARS-CoV-2, Table 5.

Table 5: Nine publications evaluating vaccination and establishing herd immunity through natural infection to control SARS-CoV-2

Type of Model or Analysis	Main Outcomes	Reference
VACCINATION		
Mathematical model	Two alternate strategies were contrasted by modeling the proportion of the population that needs to be protected from infection by one-time vaccination (assuming 100% effectiveness) or by testing with isolation and treatment of individuals within six, 24, or 48 hours of symptom onset. Results indicate that either 90% of symptomatic patients would have to be tested and isolated for treatment or over 80% of the at-risk population would require vaccination coverage to end the epidemic in six months. In a population of ~10 million, far	(Chowell, Dhillon, & Srikrishna, 2020)

	fewer people would need to be reached with testing and isolation for treatment upon symptom onset in comparison to vaccination to achieve herd immunity.	
SIRI model	This model investigated how a hypothetical vaccine could affect a coronavirus epidemic taking into account behavioral changes of individuals in response to the available information on the status of the disease in a closed community. Results indicate the cumulative incidence may be significantly reduced when the information coverage is high enough and/or the information delay is short	(Buonomo, 2020)
Analysis	Using a combination of reports of both confirmed cases and deaths and growth curves in 52 countries, authors compare the results of countries that mandate Bacillus Calmette-Guérin (BCG) vaccination versus those that do not. Linear mixed models revealed that the presence of mandated BCG policies was associated with a significant flattening of the exponential increase in both confirmed cases and deaths during the first 30-day period of country-wide outbreaks.	(Berg, Yu, Salvador, Melani, & Kitayama, 2020)*
ESTABLISHING HERD IMMUNITY by NATURAL INFECTION		
Mathematical model	This simple simulation model looks at the scenario where containment is no longer possible. The next best scenario is to control the spread by allowing some infections to occur. This can be achieved by allowing infections to occur in low-risk groups so they acquire immunity through natural infection, which will ultimately lead to herd immunity and an overall reduction in mortality.	(Handel, Miller, Ge, & Fung, 2020)
Mathematical model	In the absence of control measures in France and R0=2.5, ~89% of the population would be infected, whereas the threshold required to achieve herd immunity is only 60%. However if control measures are too strong, the number of infected people remains below the threshold required for herd immunity, which leaves the population vulnerable to a return of the epidemic once preventative measures are lifted. A new outbreak of COVID-19 will not occur if ~2/3 people are infected, reaching the threshold for herd immunity.	(Alizon et al., 2020)
Mathematical model	Using the effective reproduction number, authors estimate of the minimum "critical" level of population immunity (Pcrit) required to halt the spread of infection is 0.67, or two-thirds of the population. This can be acquired through vaccination or natural immunity (after recovery from COVID-19).	(Kwok, Lai, Wei, Wong, & Tang, 2020)
SIR model	For a population to reach herd immunity, a mitigation strategy will need to allow R0 to be high enough. However, the margin of R0 for which successful mitigation into an overcritical but not ICU capacity-threatening epidemic can be achieved is extremely narrow. This SIR microsimulation for Germany and Poland conclude that this strategy will not be successful. Authors recommend combining social distancing and contact related countermeasures with an extensive testing strategy until a vaccine becomes available.	(Bock et al., 2020)
Analysis	A phased lift of control strategy is proposed to achieve herd immunity at the population level. This requires successive parts of the	(de Vlas & Coffeng, 2020)*

	country to release all interventions so the epidemic can rage locally, while strict control in the remaining parts wait for their turn. Simulations on this strategy predict on average individuals will experience 432 days (~14 months) of intensive control and at the end, 56% of the population will have immunity.	
SIR model	Authors use a model to propose an intervention strategy that involves identifying and deploying recovered individuals who have protective antibodies to SARS-CoV-2 in the community to develop "shield immunity". The intent is amplify the proportion of interactions with recovered individuals to help sustain safe interactions necessary for the functioning of essential goods and services. This strategy reduces the epidemic peak and reduces its duration. For example, for a population with 10,000 people and R0=2.33, the final number of deaths will be reduced from 71000 at baseline to either 58000 or 20000 depending on intermediate or enhanced shielding, respectively. In addition, shielding can work synergistically with social distancing.	(Weitz et al., 2020)*

MANAGEMENT OF MEDICAL WASTE

A novel multi-objective multi-period mixed integer program was modeled for the reverse logistics network design of the management of medical waste and healthcare hazards during an epidemic. This model was validated using a real-world case study based on the COVID-19 outbreak in Wuhan, China. Results indicate the rapidly increased medical waste due to COVID-19 needs to be collected and treated in a safe and timely manner to minimize the spread of SARS-CoV-2. Installing temporary incinerators may be an effective short-term solution to manage medical wasted and healthcare hazards during the COVID-19 outbreak in Wuhan (Yu, Sun, Solvang, & Zhao, 2020).

PUBLIC AWARENESS

Three publications estimated the effects of public awareness measures on the epidemic, Table 6.

TABLE 6: THREE PUBLICATIONS EVALUATING THE EFFICACY OF PUBLIC AWARENESS MEASURES ON COVID-19

Type of Analysis or Model	Main Outcomes	Reference
Cross-sectional study	During the outbreak China has issued strict regulations on wet markets including closing live poultry markets and bans on wild animal transactions. When comparing between before and during the outbreak, the proportion of individuals visiting wet markets declined from 23.3% to 3.1% in Wuhan ($p<0.001$) and 20.4% to 4.4% in Shanghai ($p<0.001$). Similarly, the proportion of individuals consuming wild animal products declined from 10.2% to 0.6% in Wuhan ($p<0.001$) and from 5.2% to 0.8% in Shanghai ($p<0.001$). As shown by changes in behavior, the public has responded quickly to the outbreak. However,	(Z. Hou et al., 2020)

	it is unclear from this study if the behavior changes are due to an increase in public education and awareness or from the containment measures implemented by the government.	
SIR model	There was a significant negative correlation between information diffusion and the spread of SARS-CoV-2 in China. Authors conclude the spread of epidemic information and self-protection information have significantly reduced the further spread of the disease.	(Shanlang et al., 2020)*
Analysis	Provinces in China that reported the life tracks of confirmed cases to the public had lower increases in daily confirmed cases. When compared with paired provinces with similar population densities, Tianjin, Jilin, Gansu, Shanxi, Hainan, and Guizhou had significant differences in the number of new confirmed cases and had lower mean rank (P<0.05). Authors believe life tracks of confirmed cases is effective as it allows the public to see the location of cases close to them so they can avoid those places, and also makes them more "alert" and hopefully more cautious.	(Jie Zhang et al., 2020)*

GENERAL OR COMBINED

Eighty-six publications estimated the effects of general or combined control measures on the number of COVID-19 cases and R0, Table 7. These publications either did not specify what public health intervention was used in the analysis, or they combined all or some of the public health interventions being used.

TABLE 7: EIGHTY-SIX PUBLICATIONS EVALUATING THE EFFICACY OF CONTROL MEASURES ON COVID-19

Type of Analysis or Model	Main Outcomes	Reference
CHINA		
SIR model	This model estimated the burden on the healthcare system in China given different percentages of public health intervention achievement, assuming a 50% diagnosis rate. If a public health intervention efficacy of 70% could be reached, the number of COVID-19 cases in China would drop dramatically from the predicted 36,809 cases to 11,056 as of Feb 7.	(Ming, Huang, & Zhang, 2020)
SEIR model	The implementation of control measures in China has decreased R0 gradually from 3.6 to 0.67 in Wuhan, 3.4 to 0.83 in Hubei (excluding Wuhan), and 3.33 to 0.63 in China (except Hubei). By early April, they predict the epidemic will end with 42,073, 21,342, and 13,384 infected cases in Wuhan, Hubei (except Wuhan), and China (except Hubei).	(B. Zhang, Zhou, & Zhou, 2020)
Epidemiological data	Following the launch of Level 1 Response to Public Health Emergencies (including public awareness, increased surveillance, isolation, restriction of gatherings etc.), R0 decreased from 3.5 to 1.93 in Hefei and 1.48 in Shenzhen (p<0.001) by February 11. However, when researchers analyzed the relationship between R0 and population inflow from the epidemic focus, there were different patterns of disease spread	(Ding et al., 2020)

	between the two cities. This suggests that that future control measures should consider population flow.	
Epidemiological data	Data from a retrospective cohort study recruiting all patients diagnosed with COVID-19 from a single-center (Shanghai Public Health Center) was used to evaluate the impact of control and prevention measures on SARS-CoV-2. During this time, Shanghai has issued a number of strict control measures such as the shutdown of all large entertainment venues, reducing passenger flow, and strong social propaganda on the importance of hand washing and wearing facemasks. The results suggest the transmission rate within Shanghai had decreased more than 95% than previously speculated due to the implemented prevention measures.	(H. Lu et al., 2020)
SEIR model	It was estimated that R0 declined with both time and the implementation of various intervention strategies (e.g. travel restrictions, quarantine) from 5.75 to 1.69 in Wuhan and 6.22 to 1.67 in China (excluding Wuhan) from Jan 19-Feb 16. This model indicates the peak of new asymptomatic cases per day, new symptomatic infections of COVID-19 in patients, and COVID-19 inpatients in Wuhan occurred on Feb 6, 3, and 14 respectively. In addition, the number of confirmed cases would decrease in Wuhan to less than 10 on Mar 27 and Mar 19 in China (excluding Wuhan).	(Pan et al., 2020)
Time-series model	The relative reproductive number (R_t) declined from the range of 4-5 towards 1, from Jan 21–Feb 2 in Wuhan, while there was an initial growth followed by a decline in a shorter period in Hubei and other provinces. The ratio of transmission rates decreased dramatically from Jan 23–27, which is likely due to public health interventions implemented by the government effective on Jan 23.	(H. Lin, Liu, Gao, Nie, & Fan, 2020)
Mathematical model	The importance of timing public health interventions was demonstrated. If government imposed public restrictions were implemented one week earlier there would be a final size of ~5,750 cases with a turning point at day 34. If these restrictions were implemented a week later, cases would increased to 1,234,000 with a turning point at day 47.	(Z. Liu, Magal, Sedyi, & Webb, 2020)
Discrete stochastic model	When prediction and control strategies were strengthened on Jan 23 in China, R0 started to decline in Shaanxi province to less than 1 around Jan 27th and almost 0 recently.	(S. Tang et al., 2020)
Epidemiological data	Provinces in mainland China surrounding Hubei initiated level-1 response to the public health emergency between Jan 23-25th. After 11 days of initiation, this analysis found that an early response to the outbreak significantly reduced the newly confirmed case rate. Provinces who responded 1 day earlier could reduce cases by 2.2% (497.4 new cases per 10,000 population per square kilometer).	(Q. Zhang, Deng, & Zhang, 2020)

Log-incidence over time model	Authors believe the prevention and control measures in Hangzhou may have been effective as the peak number of daily new cases simulated by the model occurred about a week after implementation.	(Diao, Zhang, Chen, & Hu, 2020)
SIR model	This model explored how to time short-one-time interventions in response to COVID-19. If an intervention cannot be sustained long term, implementing it early will only delay the epidemic curve, not alter its shape. It is most effective to implement the intervention to start closer to the peak of an epidemic when the number of infections is reasonably large. In addition, interventions that target sub-populations based on the infections levels of the group are more effective than synchronized interventions that begin when the first population reaches a threshold.	(Di Lauro, Kiss, & Miller, 2020)
SEIR model	Authors simulated the spread dynamics of the COVID-19 outbreak and impact of different control measures in China. These control measures were associated with slower increase of the infected population and the decline of R0. For twelve consecutive days (Feb 18-29), the daily number of new recovered cases exceeded new confirmed cases, indicating the public health control measures were effective.	(Y. Fang, Nie, & Penny, 2020)
SEIR model	In Beijing, the predicted peak number of cases is around 466 on Feb 29. When different levels of intervention (strict, mild, or weak) are imposed, results indicate that transmission dynamics will change and the peak number of cases will change in proportion between 56-159%.	(Hong et al., 2020)
SEIR model	There were a total of 114,325 COVID cases in mainland China as of Feb 29 and these were highly correlated with reported incidence ($p<0.001$, $R2=0.86$). In the absence of non-pharmaceutical interventions (NPI), there would be an estimated 67-fold increase (IQR: 44-94) in cases. Implementing these NPIs one week earlier could have reduced cases by 66%. The early detection and isolation of cases would substantially prevent more cases than contact reduction and social distancing across the country (5-fold vs 2.6-fold). However, in the long term, without contact reduction, the epidemic would increase exponentially. It is ideal to integrate NPIS to achieve the greatest effect on outbreak containment.	(Lai et al., 2020)
SEIR model	After the implementation of non-pharmaceutical interventions (NPIs) in Wuhan, the effective reproductive number dropped from 3.86 (95% CI: 3.74-3.97) to 0.32 (95% CI: 0.28-0.37). Up until Feb 18, these NPIs were estimated to prevent 94.5% of COVID-19 infections.	(C. Wang et al., 2020)
Epidemiological data	Under government control measures, the number of new COVID-19 patients in Jingmen, China gradually decreased and disappeared after 20 days.	(Gao et al., 2020)
SEIR model	The control measures in Wenzhou city resulted in a steady decrease of R0 after Jan 29, 2020. The median interval between onset and diagnosis was shortened from 7 to 3 days.	(H. Huang et al., 2020)

SEIAR model	With no prevention measures, the total number of infected patients in Changsha, China would reach 2.27 million on the 79th day after the outbreak and end in 240 days. With moderate prevention measures, the number of infected patients would reach 1.60 million on the 28th day after the outbreak and end in 110 days. With full prevention measures, the number would reach 234 on the 23rd day after the outbreak and end in about 60 days.	(Zha et al., 2020)
SEIR model	With no control measures in China, there would be 600,000 cases as of Apr 1. A comparison to the 80,651 cases as of Mar 6 lead authors to believe the control measures in mainland China have been effective. The situation in South Korea is simulated by importing some of the interventions adopted in China and conclude that South Korea must adopt more stringent measures to halt further infections.	(B. Tang, F. Xia, N. L. Bragazzi, et al., 2020)
Stochastic compartmental model	This model captures the unique transmission dynamics of COVID-19 and the effects of interventions implemented in mainland China. Results indicate the containment of the epidemic should occur around late Feb to early Mar. Since the implementation of control measures, the time dependent controlled reproduction numbers have been significantly reduced from 2-3, where they were at the beginning of the epidemic.	(Yuan Zhang et al., 2020)
SEIR model	In China, cities that pre-emptively implemented a Level 1 response (any combination of control measures including banning of public gatherings, closing entertainment venues, suspending intra-city transport, or prohibiting inter-city travel) before discovering any COVID-19 cases reported 33.3% (95% CI: 11.1-44.4%) fewer cases during the first week of an outbreak (13.0 cases, 95% CI: 7.1-18.8) compared with cities that started control efforts later (20.6 cases, 95% CI: 14.5-26.8). The most effective interventions were suspending intra-city public transport, closing entertainment venues, and banning public gatherings.	(Tian, Liu, et al., 2020a)
Phylodynamic analysis	Control efforts in China reduced epidemic growth rates and contributed to the eventual control of the epidemic in Weifang, China. The estimated R0 of 1.99 (95% HPD: 1.48-3.14) in Weifang is lower than other areas and corresponds to the period of time where they were implementing public health interventions such as contact tracing, public health messaging, isolation, optimizing triaging of suspected cases, travel restrictions, extending school closures, and establishing "fever clinics" for consultation.	(Volz et al., 2020)
CDIM model	In Shanghai, R0 decreased from 2.5 to 0.55 (95% CI: 0.48-0.59) after the first-level response measures were implemented.	(Xiao et al., 2020)
Network-driven epidemic dynamics model	By reducing transmissibility by 25% via community-level interventions the epidemic progression could be delayed by up to 34 days and peak magnitude reduced by 39%.	(P. Liu et al., 2020)

SEIR model	These simulations demonstrate the peak value and the number of cumulative cases are substantially decreased when individual behavior interventions (e.g. quarantine) or governmental interventions (e.g. travel restrictions) are imposed. However when these measures are combined, the reduction becomes even more substantial.	(Q. Lin et al., 2020)
Bayesian estimation model	The time-dependent reproduction number (R(t)) shows a downward trend from Jan 27-Feb 10 in Wuhan, Hubei province, outside Hubei, and China. Authors speculate this is due to prevention and control efforts.	(S. Zhang, Diao, Duan, Lin, & Chen, 2020)
SEIR model	The non-pharmaceutical interventions implemented in mainland China excluding Hubei have successfully reduced transmission intensity and prevented the epidemic growth in a short time frame. The effective daily reproduction ratio (Re(t)) dropped from 3.34 on Jan 20 to 0.89 on Jan 31. To block the continuous spread of the virus and end the epidemic, the contact rate should be kept below 30% of the normal level until the end of April.	(Wan, Cui, & Yang, 2020)
SIR model	Without any control measures, the total infections in mainland China would be 72,172 by Mar 12 with a peak by Feb 21. If control efforts are expanded, the total number of infections would be 54,348 and the peak would advance to Feb 14. If person-to-person contacts are increased with work and school resuming, this would increase cases to 149,774 and post-pone the peak to Feb 26.	(X. Zhu et al., 2020)
Mathematical model	This framework incorporates the effectiveness of government control measures to forecast the whole process of a new unknown infectious disease in its early-outbreak. This was then applied to analyze and evaluate the COVID-19 outbreak using publicly available data in China beyond Hubei. After the shutdown of most parts of Hubei and other parts of the province on Jan 23, the rapid spread of the epidemic was controlled in these areas as shown by a significant downward trend in Kt (intensity of the spread of the epidemic) after Jan 27. There was an increase in daily confirmed cases after people returned to work on Feb 3, but Kt continued to decline again after Feb 11.	(Wang, Zhang, Lu, & Wang, 2020)
Analysis	The intervention measures put in place by the Wenzhou government were successful in reducing or preventing the transmission of the virus as shown through dramatic declines in the number of cases on Jan 31, Feb 4, and Feb 6 after their implementation. The COVID-19 Wenzhou Community-Based Isolation Strategy (COVID-WCIS) included restricting the movement of people (traffic and travel control), reducing close contact between individuals (suspending school and construction projects, closing entertainment venues), centralizing treatment at designated health care institutions, and disseminating prevention and control measures through multiple channels.	(J. Huang et al., 2020)
Analysis	The effective reproduction number (Rt) was estimated to assess the impact of prevention and control measures in China. In the early stages of the outbreak (before Dec 31), Rt waved between 2.7-4.0. After some initial measures such as case finding, contact tracing, and	(L. Zhao et al., 2020)

	investigations of infective sources in the epicenter reduced Rt to around 3. However, it wasn't until Jan 23 when vigorous interventions were implemented (lock down of Wuhan, extending Spring Festival, and post-poning school) that Rt was consistently decreased to below 1 in two weeks.	
Markov model	Due to the impact of containment and intervention strategies in different regions, the estimated case fatality rates for COVID-19 differ for Hubei compared to the rest of China at 6% and 0.95% respectively.	(Y. Liu, 2020)
Analysis	Interventions to contain the COVID-19 outbreak in China has led to air quality improvements that brought health benefits which outnumbered the deaths due to the disease. Specifically, NO_2 dropped by 22.8 μg/m3 and 12.9 μg/m3 34 in Wuhan and China, respectively. PM2.5 dropped by 1.4 μg/m3 in Wuhan and decreased by 18.9 μg/m3 35 across 367 other cities. The improved air quality during the quarantine period avoided 8,911 (95% CI: 6,950-10,866) NO2 related deaths (65% of which were from cardiovascular diseases), and 3,214 (95% CI: 2,340-4,087) PM2.5 related deaths (73% of which were form cardiovascular diseases). Numbers should be interpreted with caution due to the potential overlap between NO2 and PM2.5 related mortality and disrupted healthcare treatment during the outbreak.	(K. Chen, Wang, Huang, Kinney, & Paul, 2020)
SEIRD model	Under the forty different public health intervention policies implemented in China, R0 was reduced from 3.38 to under 0.5. The growth curve of new cases, the virus infection curve, and the daily transmission replication curve also significantly decreased. The peak of infection occurred on Jan 29, and the outbreak has been controlled since that day.	(Wenbao et al., 2020)
SIR model	Wuhan implemented strict quarantine measures after Feb 7, including locking down residential buildings and compounds, strict self-quarantine for families, door-to-door inspection for suspected cases, quarantining suspected cases and close contacts in newly established spaces. Without these measures, the peak would have occurred on Feb 27 with 120,000 cases. A combination of a 10% reduction in the transmission rate and a 90% increase in the diagnosis rate by implemented these strict measures can effectively force the newly diagnosed cases to decline, and significantly shorten the duration of the epidemic. In addition, a second outbreak is very likely in Wuhan after people return to work even with travel restrictions still in place.	(Roda, Varughese, Han, & Li, 2020)
Analysis	A comprehensive analysis demonstrates the unprecedented public health intervention measures taken by the Chinese government effectively controlled the COVID-19 outbreak in Wuhan and Hubei province. These measures include shutting down Wuhan transportation, extending the legal holiday, mass isolation, strict enforcement of quarantine, and canceling all public gatherings.	(S. Cheng, Zhao, Kaminga, Zhang, & Xu, 2020)
Mathematical model	The effectiveness of the non-pharmaceutical interventions implemented in China on the containment of the epidemic were confirmed by performing GEMF stochastic simulations. Without these	(Q. Yang et al., 2020)

	aggressive control measures, the epidemic in Hubei province would have become persistent. The actual trajectory of what happened in Hubei can only be reconstructed in a simulation by decreasing the infection rate through protective measures and social distancing.	
Mathematical model	This model demonstrates the transmission rates in Wuhan, Hubei (excluding Wuhan), and the rest of China (excluding Hubei) all began to decline exponentially around the same rate after the large-scale control measures were implemented on Jan 23. The declines were more rapid outside of Wuhan after Feb 12. South Korea, Italy, and Iran also show declining transmission rates exponentially over time.	(F. Zhang, Zhang, Cao, Zhang, & Hui, 2020)
Compartmental dynamic model	In Wuhan, keeping the quarantine intervention measures until Apr 25 would ensure a smooth decline of the epidemics regardless of the combinations of public contact rates and facial mask usage. Different variations of facial mask usage and increasing public contact rate were analyzed, to see what is necessary to avoid a second major outbreak. For example, to lift the quarantine date early (Mar 21), facial mask usage would need to be sustained at a high rate (>85%) if public contacts were to recover to 100% of pre-quarantine level.	(L. Zhang et al., 2020)
Analysis	This risk assessment concludes that under mild and strict protective conditions, the probably of a COVID-19 resurgence in China in the coming week (Mar 13-19) after people return to work ranges from 0.6-6.8% and 0.2-2.4%, respectively. The probably is zero in some areas such as Zhejiang, Jiangsu, and Shenzhen due to the absence of new cases in the past 14 days.	(K. Zhao, Long, Wang, Zeng, & Fu, 2020)
Mathematical model	Cities that implemented a Level 1 response (a combination of control measures) before discovering any COVID-19 cases, reported 33.3% (95% CI: 11.1-44.4%) fewer cases during the first week of their outbreaks compared with cities that started their control efforts later (P<0.01). Without the travel ban or Level 1 response, there would have been 744,00 (+/- 156,000) cases outside Wuhan by Feb 19. Alone, the Wuhan travel ban would have decreased this to 202,000 (+/- 10,000) cases and alone, the Level 1 response would have decreased this to 199,000 (+/- 8,500) cases. Together, these interventions limited the number of infections to 29,839 (+/- 1,400) cases.	(Tian, Liu, et al., 2020b)*
SICRD model	With no intervention measures, the cumulative numbers of infected cases were 11.2M (95% CI: 11-11.4M), 6.18M (95% CI: 5.87-6.40M), 27.1M (95% CI: 26.4-278M), and 21.1M (95% CI: 20.7-21.6M) in Wuhan, Huanggang, Chongqing, and Shanghai, respectively. The strict intervention measures that were implemented for 8 weeks resulted in a decrease of these cases to 89,600 (95% CI: 44,200-289,800), 19,300 (95% CI: 12,500-31,300), 2,390 (95% CI: 1,970-3,250), and 2,080 (95% CI: 1,710-2,830), respectively. If these intervention measures were implemented 10 days earlier (Jan 13 instead of Jan 23), the estimated number of cases would be reduced from 280,000 to 65,200 (95% CI: 42,000-77,500). The duration of these measures should be maintained for 2 months (Jan 23-Mar 22) to avoid a resurgent epidemic.	(Jiang Zhang et al., 2020)*

Mathematical model	By using a time-varying reproduction numbers method, the heterogeneity and effectiveness of control measures of 25 cities in China was investigated. There was a downward trend in R0 values overall, but there were significant differences in trends among cities. By Feb 10, R0 had dropped to <1 in 21/25 of these cities (exceptions: Wuhan, Tianmen, Ezhou and Enshi). The turning point of COVID-19 control in most cities is estimated to have occurred around Feb 7.	(Q. Cheng, Liu, Cheng, & Huang, 2020)*
SEIR model	The evolution of the epidemic in China is predicted under the governments strict control measures. The predicted number of infected individuals in Wuhan, Hubei (except Wuhan), Guangdong province, and mainland China (except Hubei) are 56519, 21093, 1377, and 13641, respectively. The epidemic will end by May 5 in Wuhan, April 13 in Hubei (except Wuhan), May 15 in Guangdong province, and Mar 27 in mainland China (except Hubei). In addition, the maximum accumulated hospitalized patients will be 38888, 14849, 1029, and 9057 in Wuhan, Hubei (except Wuhan), Guangdong province, and mainland China (except Hubei), respectively.	(Shang, Yang, Chen, & Shang, 2020)*
EUROPE		
SIR model	Based on results of their model in Berlin, authors confirm lockdowns are effective and suggest that a complete lockdown no later than once 10% of hospital capacities available for COVID-19 are in use is necessary. The removal of infections through school, childcare, workplace, and leisure closures will not be enough to sufficiently slow down the infection dynamics. However, removing infections in the public transport system reduces the infection speed and the height of the peak by ~20%.	(Muller, Balmer, Neumann, & Nagel, 2020)
SEIR model	This model aimed to evaluate the consistency of containment rules and identify possible SARS-CoV-2 local mutations in Italy. Results are unclear.	(Rovetta & Bhagavathula, 2020)
Analysis	Nested doubling times were calculated over a period of 5-6 days to measure the effectiveness of prevention and control measures (telecommuting, closing schools, travel restrictions, and social distancing) in Nordic countries. The trend is positive, an increase in doubling times is evident in all Nordic countries demonstrating slower growth. In Denmark, the doubling time changed from 2 to 10 days during the course of a few weeks.	(Stangeland, 2020)
SIR-X model	This model estimates the implementation of strong control measures will reduce R0 from 6.2 to 1.36 and the peak number of cases in Belgium will occur around Apr 12.	(Smeets, Watte, & Ramon, 2020)
SEAIHR model	If no intervention measures are implemented, there will be a peak of 40,000 cases on Apr 6 in Portugal. If the government implements strict intervention measures and the population mildly adheres to self-protecting measures, they will reach a maximum of 700 cases (this is unlikely, as of Mar 18 there are 642 cases). If the government implements some intervention measures and the population mildly adheres to self-protecting measures, they will reach a maximum of	(Teles, 2020)

	7000 cases by Apr 20. Therefore, the peak number lies between 700-7000 cases and will be reached between Apr 9-20.	
eSIR model	Under the current intervention measures in Italy (as of Mar 8), the total number of infected cases is estimated to be 30,085 (95% CI: 7,920-81,869) and the endpoint would be Apr 25 (95% CI: Mar 30-Aug 7). If the interventions were implemented earlier (Mar 5), the mean number of cases would be 10,636 (95% CI: 2,357-23,326) and the endpoint would be Mar 16 (95% CI: Mar 9-Apr 22). If the interventions were implanted later (Mar 15), the mean number of cases would be 44,993 (95% CI: 16,676-96,759) and the endpoint would be Apr 27 (95% CI: Apr 1-Jul 7).	(W. Jia et al., 2020)
Mathematical model	To reflect the lockdown of Italy, a 90% reduction in the effective transmission rates starting on Mar 8 were used to forecast the epidemic. If these strict control measures continue to hold, the outbreak in Lombardy, Italy will fade out by the end of May.	(Russo et al., 2020)
Epidemiological data	Two weeks after the lockdown in Italy on Mar 8 reduced the initial growth rate of 0.22 to 0.1. The doubling time was reduced from 3.5 to almost 7 days. In Canada, the growth rate has increased from 0.13 to 0.25 between Mar 1-13 and Mar 13-22, which corresponds to a doubling time of 2.7 days. With no public health interventions, 15,000 cases are projected in Canada by Mar 31. If immediate public health interventions are imposed in Canada similar to Italy to reduce the growth rate to 0.1, the projected cases can be reduced to 4,000.	(Scarabel, Pellis, Bragazzi, & Wu, 2020)
SIR model	This model analyzes the uncertainty resulting from the complex interactions between disease, policy, and public response in the UK. For example, if compliance to public health interventions declines on a time-scale of two months, the median fatalities nearly doubles to 91,000 but the overall stress on hospitals does not increase much. Authors speculate this is because new policy measures are rapidly put into place once a secondary outbreak starts. However, the frequency at which policy measures are reviewed an implemented can have dramatic impacts on outcomes. For example, in cases where policy response is slow, herd immunity can be unintentionally achieved.	(Rossberg & Knell, 2020)*
SEIR model	This model analyzes the impact of quitting the confinement measures implemented in France which are scheduled to end on Apr 15. Whether returning to business as usual happens fast or slow, the major peak of the epidemic will appear in spring. This peak will arrive sooner and its magnitude will be higher in the case of returning to business as usual fast. Even if individuals reduce their contact with others to 1/3 of what they did before the epidemic, it is not enough to prevent another major outbreak in Nov. However, if individuals can return to business as usual slowly and achieve a higher reduction in contact rates compared to before the epidemic, this second peak can be avoided.	(Augeraud-Veron, 2020)*
Richards growth model	This model is used to describe the fatality curves for four different countries (China, Italy, Spain, Iran, and Germany) and different stages of the outbreak. Authors use the example of Italy to demonstrate that	(Vasconcelos et al., 2020)*

	the efficiency of intervention strategies decay quickly as the adoption time is delayed. There is a narrow window of opportunity to implement intervention measures.	
Stochastic age-structured transmission model	In the absence of control measures, 24M (95% CI: 16-30M) clinical cases and 370K deaths (95% CI: 250-470K) in the UK are predicted up to Dec 2021. Social distancing, school closures, shielding of the elderly, and self-isolation of symptomatic individuals for a total of 12 weeks all result in a decrease of the total number of cases by 70-75% and delay the peak of the epidemic by 3-8 weeks. In terms of a reducing cases, social distancing is most effective reducing the predicted cases to 17M (95% CI: 10-23M). However, shielding the elderly was predicted to have the greatest impact on the number of deaths reducing the prediction to 220K (95% CI: 130-330K). When implemented alone, none of these interventions were able to decrease the healthcare need to below available capacity. Combining these interventions would have the most positive effect. In addition, when only a short intervention is deployed, it is advantageous to deploy the intervention later (after the peak) to minimize the total health burden. Stopping spectator sports would have little effect on the number of cases, and a general reduction in leisure contacts through closure of bars, restaurants, cinemas etc would have a larger impact. By adding one additional contact per weekday through schoolchildren being cared for by others (grandparents, childcare) as a result of school closures would almost entirely eliminate the benefit of closing schools. An intensive 12 week lockdown would delay the peak of the epidemic by ~8 weeks and to reduce the total number of deaths by half.	(Davies et al., 2020)*
SEIR model	The effects of containment measures involving school, café, and restaurant closures (Mar 14) and strict social distancing (Mar 18) in Belgium, was demonstrated by a decrease of R0 from 3.38 (95% CI: 2.90-3.85) to 2.0 (95% CI: 1.81-2.19). A clear decrease in R0 in Spain is shown after the nationwide measures enforced on Mar 15, but they are not drastic enough to reverse the trend of the epidemic yet.	(De Brouwer et al., 2020)*
Hybrid multi-scale model	In the absence of any mitigation measures, 98.4% of the population of Italy will be infected with a CFR of 6.5%. Restricting population movement through a partial lockdown will be effective in reducing the number of infections and deaths. In panic situations, social distancing measures aiming to maintain a distance of 1.5m will not be effective to prevent infection transmission in crowds.	(Bouchnita & Jebrane, 2020)*
INDIA		
SEIR model	Without government intervention measures, the spread of COVID-19 might infect 124 (95% CI: 116-132) persons per million in India. With minimal, medium, and high mitigation action plans, it may infect 115 (95% CI: 108-123), 66 (95% CI: 62-70), or 21 (95% CI: 20 - 22) persons per million, respectively. Under the current scenario in India, R0 is predicted to be 0.94 and is projected to reduce to 0.688 under a high action mitigation plan.	(Channapathi & Thatikonda, 2002)*

SEIR model	In the absence of intervention measures, the peak of the outbreak will be 120 days from Feb 29 with 2.58M infections and 283,100 deaths in Tamil Nadu India. If the government takes strong precautionary measures, the number of infections reaches a peak around 220 days and infections are reduced to 1.32M and 166,181 deaths.	(Ayubali & Satheesh, 2020)*
IRAN		
SEIR model	In Iran, this model predicts ~493,000 current infected cases (90% CI: 271K-810K) as of Mar 20. After analyzing different seasonal effects and intervention measures (reduction of contact rate), the most optimistic scenario estimates 1.6 million Iranians (90% CI: 0.9M-2.6M) are likely to get infected, and 58,000 of these cases will die (90% CI: 32K-97K). Without seasonal effects or intervention measures, the death toll may exceed 103,000 cases (90% CI: 56K-172K).	(Ghaffarzadegan & Rahmandad, 2020)
Mathematical model	Over 40,000 cases in Tehran would be seen by mid-June if no control measures are put in place. By implementing control measures, the spread of COVID-19 would peak in April with a downward trend dropping off by the end of May (70 days). If no further control measures are implemented, the spread of COVID-19 would continue gradually reaching 21,000 by mid-June.	(Moghadami et al., 2020)
USA		
SEIR model	This model investigated reductions of contact rates (isolation, quarantine, telecommuting, and school closures) and travel restrictions (reducing commuting and travel among countries) in the USA. Simulations conclude reductions of contact rate more substantially slow the spread and increase of confirmed cases compared to travel restrictions. With no intervention measures the peak incidence would be on May 21 with 470,000 new infections. A 25% reduction in contacts would result in peak incidence on Jun 30 with 270,000 new infections and a 50% reduction would flatten the curve. By reducing cross-country mobility by 95%, the peak incidence would be on May 21 with 300,000 new infections.	(Pei & Shaman, 2020)
SEIR model	In Chicago, USA, strong mitigation measures such as lockdown or shelter in place order implemented by Apr 1 can avert prevent overflow of ICU capacity. In this scenario, the total number of deaths is estimated at 1,151 by Sept 1. By delaying mitigation measure until Apr 20, the available capacity will be exceeded by a factor of 10, and the total number of deaths is estimated as 7445.	(Maslov & Goldenfeld, 2020)
Linear fixed effects model	Authors investigate the evolution of the case growth trajectory with major public intervention policies in 16 countries. Unchecked exponential growth is seem in countries without active intervention measures (Australia, and the USA). Other countries with extreme intervention measures show large decreases in the infection rate over time, indicating the process of bringing the epidemic under control. Further simulations show that if the USA had 100% of South Korea's or Italy's efficacy of public intervention measures, there would be a 139,600 or 1.2 million cases, respectively. With 50% of South Korea's	(K. Lin, Joye, Giang, & Richardson, 2020)*

	efficacy in the USA, the peak will be around Apr 3, whereas if they had 75-100% of Italy's efficacy the peak will be mid-Apr.	
SEIAR model	Policies such as social distancing, quarantine, and increasing testing capacity will significantly reduce the total number of infections. The effects of these measures are most visible in NY, NJ, MI, and IL. Most states will see an exponential reduction of infections by Apr 29 with increased testing capacity and reporting.	(S. Chen et al., 2020)*
OTHER or COMBINED COUNTRIES		
SEIHR model	Full article in Korean. The initial R0 in Korea was 0.555 but increased a few days later to between 3.47-3.54. Decreasing the transmission rate by 90-99% will result in a decrease in the number of patients infected and the size of the outbreak peak.	(Choi & Ki, 2020)
Mathematical models	The impact of three scenarios of travel ban in Australia were explored. Without a travel ban, this model estimates the epidemic will continue for more than a year resulting in 2000 cases and 400 deaths in Australia. With a full travel ban, this model estimates 57 cases in Australia by Mar 6. Results estimate the travel ban implemented on Feb 1 reduced the number of cases and deaths in Australia by ~87%.	(Costantino, Heslop, & MacIntyre, 2020)
Epidemiological data	Gaussian distribution was used to analyze the effect of control measures in China, Italy, Korea, and Iran. If prevention and control efforts were started 5 days earlier in China, there would be 28,000 infected people instead of 69,000 (0.42 times the number of infected people). If they were started 5 days later, the number of infected people would be as high as 156,000 (2.26 times). In Korea and Iran, R0 was 4.2 and 4.0 and decreased to 0.1 and 0.2 after the implementation of control measures. The control efforts implemented in Italy on Mar 8, 2020 are expected to reduce the predicted number of cases from 200,000 to 84,000 by the end of Mar.	(L. Li et al., 2020)
Analysis	This analysis looked at the top 35 countries (not Canada) and 26 states of the USA affected by the epidemic as of end-March and the following benchmarks: Moderation, Control, and Containment (growth < 10%, 1%, and 0.1% respectively). It took countries approximately 3 weeks to "Act" (implement interventions). Asian countries acted quicker than European countries, and smaller countries acted quicker than larger ones. On average, countries take about three weeks to moderate, four weeks to control, and over 6 weeks to contain the spread of the disease, after aggressive intervention. Lockdowns and social distancing will need to last for months to be effective.	(Tellis, Sood, & Sood, 2020)
Mathematical model	If the epidemic is left unmanaged, it is estimated 3% of the population will die within 3 months. The death rate decreases very strongly with increasing intensity of the lockdown, and a "complete shutdown" would reduce the epidemic to 25 days and the death toll to 0.003% of the population. A lockdown strategy with intermittent periods of normal social contact could be effective if 2/3 of the time was in lock down and 1/3 of time for social interactions. An adaptive strategy	(Westerhoff & Kolodkin, 2020)

	would be the most effective where it starts off intensive and then adapts to the severity of the epidemic. The earlier the lockdown is implemented, the more effective it will be. If the strategy is applied 15 days later, the number of deaths at the end of the year will be come 20 times higher.	
Analysis & SIR model	Data on anti-contagion policies across localities in China, South Korea, Iran, Italy, France, and the USA analyzed with econometric methods, estimated that in the absence of any policy actions early infections exhibit exponential growth rates of roughly 45% per day. The combined effect of all policies (quarantine and lockdowns, travel restrictions, social distancing, and emergency declarations), have slowed the average daily growth rate of infections 0.166 per day (±0.015,p< 0.001) in China, 0.276 (±0.066,p < 0.001) in South Korea, 0.158 (±0.071,p < 0.05) in Italy, 0.292 (±0.037,p < 0.001) in Iran, 0.132 (±0.053,p < 0.05) in France and 0.044 (±0.059, p = 0.45) in the USA. The policies in the USA have been implemented too recently to have any substantial. All policies individually likely contribute to slowing the growth rate of infections, except two policies, social distancing in France and Italy, where point estimates are slightly positive, small in magnitude, and not statistically different from zero. To date, current policies have already prevented or delayed ~80 million infections.	(Hsiang et al., 2020)
SEICR model	Without improving the implementation of active interventions, Japan and the USA will see ~6.55% and 18.2% of their population eventually infected. A four-fold or ten-fold elevation in control efforts would bring these numbers down to 1.54% or 0.23% in Japan and 9.32% or 2.7% in the USA, respectively.	(Zhan, Tse, Lai, Chen, & Mo, 2020)
SEIR model	This model predicts the epidemic progression and its peak in Italy, South Korea, and Iran. If strict control measures remain in place, the epidemic will be under control by the end of April and will end in June 2020.	(Zhan, Tse, Lai, Hao, & Su, 2020)
Mathematical model	This model takes government intervention and public response into account to make projections of the outbreak in China, South Korea, Iran, Italy, France, USA, and Germany. The reduction coefficient of daily cases increase rate (Rc) varies according to the effectiveness of government intervention, the awareness and response of the public, and the efficiency of the healthcare system. When Rc increases, the cumulative number of cases decreases over time.	(J. Lu, 2020)
SEIR model	The results indicate under strict control measures, the number of active cases will reach their peak in 16-32 days (early-mid Apr) in Italy, Iran, South Korea, Germany, France, USA, Spain, and Japan. Under these strict control measures, the epidemic peak would decrease significantly and the peak would arrive sooner. However, these measures would need to be maintained for several months until a vaccine becomes available. The number of cases at peak value in Italy, Iran, South Korea, Germany, France, USA, Spain, and Japan are 71950, 36240, 10420, 85750, 36980, 41850, 61420, and 1560, respectively.	(Xiang Zhou et al., 2020)*

SEIR model	Strict control measures at the beginning of an epidemic will create low infectious numbers which can then be managed by mitigation measures over longer periods of time. The stronger the control measures in the beginning, the faster it will achieve the low infectious numbers that are conducive to subsequent management. The ideal situation involves measures that will bring R<1 at the beginning of the epidemic, followed by mitigation measures that maintain R0 around 1. Ultimately making this epidemic manageable on the healthcare system.	(Hochberg, 2020)*
Analysis	COVID-19 growth curves were used to monitor the impact of control measures on the spread of the disease in 123 countries as of Mar 25. Denmark, Estonia and Qatar are in the deceleration stage (number of new cases reduces daily) and China and South Korea are in the stationary stage (stagnation of the prevalence with sporadic new cases occurring each day). Approximately 1 week after the implementation of control measures that drastically reduced human movement, a decline in growth acceleration was observed. In these five countries, deceleration of growth was achieved within 2 weeks. The prevalence of COVID-19 plateaued within 6 weeks for China and South Korea.	(Utsunomiya et al., 2020)*
SIRU model	With no intervention measures implemented in Brazil, the predicted number of infected individuals of 121,482 with a peak around day 47. Reducing the transmission rate by 50% through strict isolation and sanitary measures will result in a decrease of infected individuals to 96,306 with a peak around day 45. The most effective intervention involves a combination of public health measures such as mass-testing and strict isolation/sanitary measures which will reduce the number of cases to 86,777 with a peak around day 46.	(Cotta, Naveira-Cotta, & magal, 2020)*
SEAIRD model	This model strives to find the best control measures to substantially minimize the cumulative number of deaths until a vaccine can be deployed. The optimal control strategy involves a rapid increase in intense intervention measures over the first quarter of the time period to an intermediate value, followed by a steady decrease. Other strategies with constant or cycling allocations of the same amount of resources to control the outbreak will be less effective.	(Djidjou-Demasse, Michalakis, Choisy, Sofonea, & Alizon, 2020)*
Mathematical model	Data from the COVID-19 epidemics in China, Japan, and South Korea were used to build a mathematical model which was then used to produce scenarios for thirteen other countries. The epidemic curve and discussions on impact of control measures are provided for the following countries: Norway, Sweden, Austria, Denmark, Belgium, Switzerland, Germany, France, Spain, UK, Italy, and Iran.	(Mangiarotti et al., 2020)*
SEMCR model	This model analyzes the effectiveness of mitigation, suppression, and hybrid interventions for controlling COVID-19 outbreaks in London and Wuhan. Results indicate that although suppression efforts taken in Wuhan and London have significantly reduced the total number of individuals exposed and infectious, this intervention has to be consistently maintained for up to 12 months to eliminate the risk of a second wave. A hybrid intervention is suggested as the effectiveness of	(P. Yang et al., 2020)*

	taking only one of these interventions (either suppression or mitigation) is likely to be limited.	
Analysis	In this study, R0 was calculated from the incidence of different countries over a 20-day period using the serial interval for SARS-CoV-2. The global outbreak (outside of China) has grown exponentially with an R0 of 1.98 (95% CI: 1.83-2.13). Due to various mitigation measures, China and South Korea have controlled the spread of SARS-CoV-2. Specifically, these measures in South Korea reduced R0 from 3.41 (95% CI: 3.10-3.70) to 0.73 (95% CI: 0.47-1.0). The R0 for Italy is significantly higher than the global average sitting at 2.72 (95% CI: 2.23-3.20), p=0.0003.	(Bifani & Ooi, 2020)*
Mathematical model	On the basis of power law scaling, authors report on the gradual spread in cumulative total number of infected people in China, Denmark, Germany, France, Brazil, India, and the USA. There is an initial rapid growth stage of infection over time followed by a reduction due to the government interventions. Post-intervention reductions can be seen in China, Denmark, Germany, and Brazil. The USA, India, and France have yet to reach this stage.	(Bhattacharya, Islam, & De, 2020)*
SIR model	Authors use network science and a model to demonstrate how a network of interactions can be used to predict the spread of a virus and how mitigation strategies can work. Results indicate that targeting hubs in a network has the potential to slow down the rate of infection and essentially "flatten the curve". Removing edges from hubs instead of from random locations in a network is a more successful strategy, therefore limiting the number of interactions that each individual in a network can have will reduce the number of infections at a time.	(Herrmann & Schwartz, 2020)*
SEIR model	This SEIR model demonstrates that a combination of testing, treatment if necessary, social protection (handwashing, facemasks), and self-isolation after testing positive (TTI) is effective in controlling the COVID-19 pandemic. Assuming an R0 of 2.4, 65% effective social protection will bring R below 1. This can also be achieved with a combination of 20% effective social protection and 75% of the symptomatic population self-isolating after testing positive (TTI) within 12 hours of symptom on set. In addition, a combination of 20% effective social protection and TTI of 1/4 symptomatic individuals can cut the peak daily incidence in half and substantially "flatten the curve".	(Chowell, Chowell, Roosa, Dhillon, & Srikrishna, 2020)*

REVIEWS

Three publications review the literature on the efficacy of public health interventions, Table 7.

TABLE 7: THREE REVIEWS EVALUATING THE EFFICACY OF CONTROL MEASURES

Type of Review[1]	Public Health Intervention	Reference
Rapid	Quarantine	(Nussbaumer-Streit et al., 2020)

Systematic	School closure and other social school social distancing practices	(Viner et al., 2020)
Rapid systematic	Public facemask use	(Brainard, Jones, Lake, Hooper, & Hunter, 2020)*

[1] As specified by the author

References

Acuna-Zegarra, M. A., Comas-Garcia, A., Hernandez-Vargas, E., Santana-Cibrian, M., & Velasco-Hernandez, J. X. (2020). The SARS-CoV-2 epidemic outbreak: a review of plausible scenarios of containment and mitigation for Mexico. *medRxiv*, 2020.2003.2028.20046276. doi: 10.1101/2020.03.28.20046276

Adekunle, A. I., Meehan, M., Rojaz Alvarez, D., Trauer, J., & McBryde, E. (2020). Delaying the COVID-19 epidemic in Australia: Evaluating the effectiveness of international travel bans. *medRxiv*, 2020.2003.2022.20041244. doi: 10.1101/2020.03.22.20041244

Adiga, A., Venkatramanan, S., Peddireddy, A., Telionis, A., Dickerman, A., Wilson, A., . . . Barrett, C. (2020). Evaluating the impact of international airline suspensions on COVID-19 direct importation risk. *medRxiv*, 2020.2002.2020.20025882. doi: 10.1101/2020.02.20.20025882

Ai, S., Zhu, G., Tian, F., Li, H., Gao, Y., Wu, Y., . . . Lin, H. (2020). Population movement, city closure and spatial transmission of the 2019-nCoV infection in China. *medRxiv*, 2020.2002.2004.20020339. doi: 10.1101/2020.02.04.20020339

Aleta, A., Hu, Q., Ye, J., Ji, P., & Moreno, Y. (2020). A data-driven assessment of early travel restrictions related to the spreading of the novel COVID-19 within mainland China. *medRxiv*, 2020.2003.2005.20031740. doi: 10.1101/2020.03.05.20031740

Aleta, A., & Moreno, Y. (2020). Evaluation of the incidence of COVID-19 and of the efficacy of contention measures in Spain: a data-driven approach. *medRxiv*, 2020.2003.2001.20029801. doi: 10.1101/2020.03.01.20029801

Alizon, S., Bénéteau, T., Choisy, M., Danesh, G., Djidjou-Demasse, R., Elie, B., . . . Sofonea, M. T. (2020). Herd immunity & epidemic final size: University of Montpellier.

Alvarez, M. M., Gonzalez-Gonzalez, E., & Trujillo-de Santiago, G. (2020). Modeling COVID-19 epidemics in an Excel spreadsheet: Democratizing the access to first-hand accurate predictions of epidemic outbreaks. *medRxiv*, 2020.2003.2023.20041590. doi: 10.1101/2020.03.23.20041590

Anzai, A., Kobayashi, T., Linton, N. M., Kinoshita, R., Hayashi, K., Suzuki, A., . . . Nishiura, H. (2020). Assessing the impact of reduced travel on exportation dynamics of novel coronavirus infection (COVID-19). *medRxiv*, 2020.2002.2014.20022897. doi: 10.1101/2020.02.14.20022897

Augeraud-Veron, E. (2020). How to quit confinement? French scenarios face to COVID-19. *medRxiv*, 2020.2004.2002.20051342. doi: 10.1101/2020.04.02.20051342

Ayubali, A. A., & Satheesh, S. R. (2020). On predicting the novel COVID-19 human infections by using Infectious Disease modelling method in the Indian State of Tamil Nadu during 2020. *medRxiv*, 2020.2004.2005.20054593. doi: 10.1101/2020.04.05.20054593

Baerwolff, G. K. F. (2020). A Contribution to the Mathematical Modeling of the Corona/COVID-19 Pandemic. *medRxiv*, 2020.2004.2001.20050229. doi: 10.1101/2020.04.01.20050229

Balilla, J. (2020). Assessment of COVID-19 Mass Testing: The Case of South Korea. *SSRN- Lancet prepublication*.

Bayham, J., & Fenichel, E. P. (2020). The Impact of School Closure for COVID-19 on the US Healthcare Workforce and the Net Mortality Effects. *medRxiv*, 2020.2003.2009.20033415. doi: 10.1101/2020.03.09.20033415

Beale, S., Johnson, A. M., Zambon, M., Hayward, A. C., Fragaszy, E. B., & Group, F. W. (2020). Hand and Respiratory Hygiene Practices and the Risk and Transmission of Human Coronavirus Infections in a UK Community Cohort. *SSRN- Lancet prepublication*.

Bendtsen Cano, O., Cano Morales, S., & Bendtsen, C. (2020). COVID-19 Modelling: the Effects of Social Distancing. *medRxiv*, 2020.2003.2029.20046870. doi: 10.1101/2020.03.29.20046870

Berg, M. K., Yu, Q., Salvador, C. E., Melani, I., & Kitayama, S. (2020). Mandated Bacillus Calmette-Guérin (BCG) vaccination predicts flattened curves for the spread of COVID-19. *medRxiv*, 2020.2004.2005.20054163. doi: 10.1101/2020.04.05.20054163

Bhattacharya, S., Islam, M. M., & De, A. (2020). Search for trends of Covid-19 infection in India, China, Denmark, Brazil, France. Germany and the USA on the basis of power law scaling. *medRxiv*, 2020.2004.2003.20052878. doi: 10.1101/2020.04.03.20052878

Bifani, A. M., & Ooi, E. E. (2020). Estimating the R 0 of SARS-CoV-2 in Different Health Systems: An Update on Transmissibility at the Country Level. *SSRN- Lancet prepublication*.

Bock, W., Adamik, B., Bawiec, M., Bezborodov, V., Bodych, M., Burgard, J. P., . . . Szymanski, P. (2020). Mitigation and herd immunity strategy for COVID-19 is likely to fail. *medRxiv*, 2020.2003.2025.20043109. doi: 10.1101/2020.03.25.20043109

Boldog, P., Tekeli, T., Vizi, Z., Dénes, A., Bartha, F. A., & Röst, G. (2020). Risk Assessment of Novel Coronavirus COVID-19 Outbreaks Outside China. *Journal of Clinical Medicine, 9*(2), 571.

Bouchnita, A., & Jebrane, A. (2020). A hybrid multi-scale model of COVID-19 transmission dynamics to assess the potential of non-pharmaceutical interventions. *medRxiv*, 2020.2004.2005.20054460. doi: 10.1101/2020.04.05.20054460

Brainard, J. S., Jones, N., Lake, I., Hooper, L., & Hunter, P. (2020). Facemasks and similar barriers to prevent respiratory illness such as COVID-19: A rapid systematic review. *medRxiv*, 2020.2004.2001.20049528. doi: 10.1101/2020.04.01.20049528

Buonomo, B. (2020). Effects of information-dependent vaccination behavior on coronavirus outbreak: insights from a SIRI model. *Research Square*. doi: 10.21203/rs.3.rs-17081/v1

Burns, A., & Gutfraind, A. (2020). Symptom-Based Isolation Policies: Evidence from a Mathematical Model of Outbreaks of Influenza and COVID-19. *medRxiv*, 2020.2003.2026.20044750. doi: 10.1101/2020.03.26.20044750

Channapathi, T., & Thatikonda, S. (2002). Stochastic Transmission Dynamic Model for Evaluating Effectiveness of Control Measures of COVID-19. *SSRN- Lancet prepublication*.

Chen, B., Shi, M., Ni, X., Ruan, L., Jiang, H., Yao, H., . . . Ge, T. (2020). Visual Data Analysis and Simulation Prediction for COVID-19: Cornell University.

Chen, K., Wang, M., Huang, C., Kinney, P. L., & Paul, A. T. (2020). Air Pollution Reduction and Mortality Benefit during the COVID-19 Outbreak in China. *medRxiv*, 2020.2003.2023.20039842. doi: 10.1101/2020.03.23.20039842

Chen, S., Li, Q., Gao, S., Kang, Y., & Shi, X. (2020). Mitigating COVID-19 outbreak via high testing capacity and strong transmission-intervention in the United States. *medRxiv*, 2020.2004.2003.20052720. doi: 10.1101/2020.04.03.20052720

Cheng, Q., Liu, Z., Cheng, G., & Huang, J. (2020). Heterogeneity and effectiveness analysis of COVID-19 prevention and control in major cities in China through time-varying reproduction numbers estimation *Research Square*.

Cheng, S., Zhao, Y., Kaminga, A. C., Zhang, P., & Xu, H. (2020). China's fight against COVID-19: What we have done and what we should do next? *medRxiv*, 2020.2003.2028.20046086. doi: 10.1101/2020.03.28.20046086

Chinazzi, M., Davis, J. T., Ajelli, M., Gioannini, C., Litvinova, M., Merler, S., . . . Vespignani, A. (2020). The effect of travel restrictions on the spread of the 2019 novel coronavirus (2019-nCoV) outbreak. *medRxiv*, 2020.2002.2009.20021261. doi: 10.1101/2020.02.09.20021261

Choi, S. C., & Ki, M. (2020). Estimating the reproductive number and the outbreak size of Novel Coronavirus disease (COVID-19) using mathematical model in Republic of Korea. *Epidemiol Health, 0*(0), e2020011-2020010. doi: 10.4178/epih.e2020011

Chong, K. C., Cheng, W., Zhao, S., Ling, F., Mohammad, K., Wang, M., . . . Chen, E. (2020). Transmissibility of coronavirus disease 2019 (COVID-19) in Chinese cities with different transmission dynamics of imported cases. *medRxiv*, 2020.2003.2015.20036541. doi: 10.1101/2020.03.15.20036541

Chowdhury, A., Kabir, K. M. A., & Tanimoto, J. (2020). How quarantine and social distancing policy can suppress the outbreak of novel coronavirus in developing or under poverty level countries : a mathematical and statistical analysis. *Research Square*. doi: 10.21203/rs.3.rs-20294/v1

Chowell, G., Chowell, D., Roosa, K., Dhillon, R., & Srikrishna, D. (2020). Sustainable social distancing through facemask use and testing during the Covid-19 pandemic. *medRxiv*, 2020.2004.2001.20049981. doi: 10.1101/2020.04.01.20049981

Chowell, G., Dhillon, R., & Srikrishna, D. (2020). Getting to zero quickly in the 2019-nCov epidemic with vaccines or rapid testing. *medRxiv*, 2020.2002.2003.20020271. doi: 10.1101/2020.02.03.20020271

Clifford, S. J., Klepac, P., Van Zandvoort, K., Quilty, B. J., Eggo, R. M., & Flasche, S. (2020). Interventions targeting air travellers early in the pandemic may delay local outbreaks of SARS-CoV-2. *medRxiv*, 2020.2002.2012.20022426. doi: 10.1101/2020.02.12.20022426

Costantino, V., Heslop, D. J., & MacIntyre, C. R. (2020). The effectiveness of full and partial travel bans against COVID-19 spread in Australia for travellers from China. *medRxiv*, 2020.2003.2009.20032045. doi: 10.1101/2020.03.09.20032045

Cotta, R. M., Naveira-Cotta, C. P., & magal, p. (2020). Modelling the COVID-19 epidemics in Brasil: Parametric identification and public health measures influence. *medRxiv*, 2020.2003.2031.20049130. doi: 10.1101/2020.03.31.20049130

Cowling, B. J., Ali, S. T., Ng, T. W. Y., Tsang, T. K., Li, J. C. M., Fong, M. W., . . . Leung, G. M. (2020). Impact assessment of non-pharmaceutical interventions against COVID-19 and influenza in Hong Kong: an observational study. *medRxiv*, 2020.2003.2012.20034660. doi: 10.1101/2020.03.12.20034660

Dandekar, R., & Barbastathis, G. (2020). Quantifying the effect of quarantine control in Covid-19 infectious spread using machine learning. *medRxiv*, 2020.2004.2003.20052084. doi: 10.1101/2020.04.03.20052084

Davies, N. G., Klepac, P., Liu, Y., Prem, K., Jit, M., & Eggo, R. M. (2020). Age-dependent effects in the transmission and control of COVID-19 epidemics. *medRxiv*, 2020.2003.2024.20043018. doi: 10.1101/2020.03.24.20043018

De Brouwer, E., Raimondi, D., & Moreau, Y. (2020). Modeling the COVID-19 outbreaks and the effectiveness of the containment measures adopted across countries. *medRxiv*, 2020.2004.2002.20046375. doi: 10.1101/2020.04.02.20046375

de Vlas, S. J., & Coffeng, L. E. (2020). A phased lift of control: a practical strategy to achieve herd immunity against Covid-19 at the country level. *medRxiv*, 2020.2003.2029.20046011. doi: 10.1101/2020.03.29.20046011

Dehning, J., Zierenberg, J., Spitzner, F. P., Wibral, M., Neto, J. P., Wilczek, M., & Priesemann, V. (2020). Inferring COVID-19 spreading rates and potential change points for case number forecasts. *medRxiv*, 2020.2004.2002.20050922. doi: 10.1101/2020.04.02.20050922

Di Lauro, F., Kiss, I. Z., & Miller, J. (2020). The timing of one-shot interventions for epidemic control. *medRxiv*, 2020.2003.2002.20030007. doi: 10.1101/2020.03.02.20030007

Diao, M., Zhang, S., Chen, D., & Hu, W. (2020). The novel coronavirus (COVID-19) infection in Hangzhou: An experience to share. *Infection Control & Hospital Epidemiology*, 1-5. doi: 10.1017/ice.2020.62

Ding, Y., Luo, S., Zheng, X., Ling, P., Yue, T., Liu, Z., & Weng, J. (2020). Association of Population Migration and Coronavirus Disease 2019 Epidemic Control. *medRxiv*, 2020.2002.2018.20024661. doi: 10.1101/2020.02.18.20024661

Djidjou-Demasse, R., Michalakis, Y., Choisy, M., Sofonea, M. T., & Alizon, S. (2020). Optimal COVID-19 epidemic control until vaccine deployment. *medRxiv*, 2020.2004.2002.20049189. doi: 10.1101/2020.04.02.20049189

Donsimoni, J. R., Glawion, R., Plachter, B., & Waelde, K. (2020). Projecting the Spread of COVID19 for Germany. *medRxiv*, 2020.2003.2026.20044214. doi: 10.1101/2020.03.26.20044214

Drake, J. M. (2020). Time to containment of COVID-19 in China: Georgia University.

Drake, J. M., & Rohani, P. (2020). Scenario analysis for the transmission of COVID-19 in Georgia: Georgia University.

Einian, M., & Tabarraei, H. R. (2020). Modeling of COVID-19 Pandemic and Scenarios for Containment. *medRxiv*, 2020.2003.2027.20045849. doi: 10.1101/2020.03.27.20045849

Fang, H., Wang, L., & Yang, Z. (2020). Human Mobility Restrictions and the Spread of the Novel Coronavirus (2019-nCoV) in China. *SSRN- Lancet prepublication*.

Fang, Y., Nie, Y., & Penny, M. (2020). Transmission dynamics of the COVID-19 outbreak and effectiveness of government interventions: A data-driven analysis. *Journal of Medical Virology*. doi: 10.1002/jmv.25750

Ferguson, N. M., Laydon, D., Nedjati-Gilani, G., Imai, N., Ainslie, K., Baguelin, M., . . . Ghani, A. C. (2020). Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand: Imperial College of London.

Ferretti, L., Wymant, C., Kendall, M., Zhao, L., Nurtay, A., Bonsall, D. G., & Fraser, C. (2020). Quantifying dynamics of SARS-CoV-2 transmission suggests that epidemic control and avoidance is feasible through instantaneous digital contact tracing. *medRxiv*, 2020.2003.2008.20032946. doi: 10.1101/2020.03.08.20032946

Ganhdi, K. R. R., Murthy, K. V. R., Prasada Rao, S. S., & Casella, F. (2020). Non-Pharmaceutical Interventions (NPIs) to reduce COVID-19 mortality. *SSRN- Lancet prepublication*.

Gao, Q., Hu, Y., Dai, Z., Xiao, F., Wang, J., & Wu, J. (2020). The Epidemiological Characteristics of 2019 Novel Coronavirus Diseases (COVID-19) in Jingmen, China. *SSRN- Lancet prepublication*.

Ge, Y., McKay, B. K., Sun, S., Zhang, F., & Handel, A. (2020). Assessing the impact of a symptom-based mass screening and testing intervention during a novel infectious disease outbreak: The case of COVID-19. *medRxiv*, 2020.2002.2020.20025973. doi: 10.1101/2020.02.20.20025973

Ghaffarzadegan, N., & Rahmandad, H. (2020). Simulation-based Estimation of the Spread of COVID-19 in Iran. *medRxiv*, 2020.2003.2022.20040956. doi: 10.1101/2020.03.22.20040956

Gostic, K., Gomez, A. C. R., Mummah, R. O., Kucharski, A. J., & Lloyd-Smith, J. O. (2020). Estimated effectiveness of traveller screening to prevent international spread of 2019 novel coronavirus (2019-nCoV). *medRxiv*, 2020.2001.2028.20019224. doi: 10.1101/2020.01.28.20019224

Gross, B., Zheng, Z., Liu, S., Chen, X., Sela, A., Li, J., . . . Havlin, S. (2020). Spatio-temporal propagation of COVID-19 pandemics. *medRxiv*, 2020.2003.2023.20041517. doi: 10.1101/2020.03.23.20041517

Handel, A., Miller, J., Ge, Y., & Fung, I. C.-H. (2020). If containment is not possible, how do we minimize mortality for COVID-19 and other emerging infectious disease outbreaks? *medRxiv*, 2020.2003.2013.20034892. doi: 10.1101/2020.03.13.20034892

Hellewell, J., Abbott, S., Gimma, A., Bosse, N. I., Jarvis, C. I., Russell, T. W., . . . Eggo, R. M. (2020). Feasibility of controlling COVID-19 outbreaks by isolation of cases and contacts. *The Lancet Global Health*. doi: 10.1016/S2214-109X(20)30074-7

Hernandez, M., Milechin, L. E., Davis, S. K., DeLaura, R., Claypool, K. T., & Swiston, A. (2020). The Impact of Host-Based Early Warning on Disease Outbreaks. *medRxiv*, 2020.2003.2006.20029793. doi: 10.1101/2020.03.06.20029793

Herrmann, H. A., & Schwartz, J.-M. (2020). Using network science to propose strategies for effectively dealing with pandemics: The COVID-19 example. *medRxiv*, 2020.2004.2002.20050468. doi: 10.1101/2020.04.02.20050468

Hochberg, M. E. (2020). Importance of suppression and mitigation measures in managing COVID-19 outbreaks. *medRxiv*, 2020.2003.2031.20048835. doi: 10.1101/2020.03.31.20048835

Hoehl, S., Berger, A., Kortenbusch, M., Cinatl, J., Bojkova, D., Rabenau, H., . . . Ciesek, S. (2020). Evidence of SARS-CoV-2 Infection in Returning Travelers from Wuhan, China. *New England Journal of Medicine*. doi: 10.1056/NEJMc2001899

Hong, N., He, J., Ma, Y., Jiang, H., Han, L., Su, L., . . . Long, Y. (2020). Evaluating the secondary transmission pattern and epidemic prediction of the COVID-19 in metropolitan areas of China. *medRxiv*, 2020.2003.2006.20032177. doi: 10.1101/2020.03.06.20032177

Hossain, M. P., Junus, A., Zhu, X., Jia, P., Wen, T.-H., Pfeiffer, D., & Yuan, H.-Y. (2020). The effects of border control and quarantine measures on global spread of COVID-19. *SSRN- Lancet prepublication*.

Hou, J., Hong, J., Ji, B., Dong, B., Chen, Y., Ward, M. P., . . . Zhang, Z. (2020). Changing transmission dynamics of COVID-19 in China: a nationwide population-based piecewise mathematical modelling study. *medRxiv*, 2020.2003.2027.20045757. doi: 10.1101/2020.03.27.20045757

Hou, Z., Lin, L., Lu, L., Du, F., Qian, M., Liang, Y., . . . Yu, H. (2020). Public Exposure to Live Animals, Behavioural Change, and Support in Containment Measures in response to COVID-19 Outbreak: a population-based cross sectional survey in China. *medRxiv*, 2020.2002.2021.20026146. doi: 10.1101/2020.02.21.20026146

Hsiang, S., Allen, D., Bell, K., Bolliger, I., Annan-Phan, S., Chong, T., . . . Wu, T. (2020). The Effect of Large-Scale Anti-Contagion Policies on the Coronavirus (COVID-19) Pandemic. *medRxiv*, 2020.2003.2022.20040642. doi: 10.1101/2020.03.22.20040642

Hu, Z., Ge, Q., Li, S., Jin, L., & Xiong, M. (2020). Evaluating the effect of public health intervention on the global-wide spread trajectory of Covid-19. *medRxiv*, 2020.2003.2011.20033639. doi: 10.1101/2020.03.11.20033639

Huang, H., Wang, Y., Zhenfeng, W., Zhenzhen, L., Qu, S., Ma, S., & Liu, X. (2020). Epidemic features and control of 2019 novel coronavirus pneumonia in Wenzhou, China. *SSRN- Lancet prepublication*.

Huang, J., Yu, J., Ning, R., Jin, Y., McAlinden, C., Sun, F., . . . Wu, W. (2020). COVID-19 Wenzhou Community Based Isolation Strategy for Controlling the Novel Coronavirus Pneumonia Epidemic. *SSRN- Lancet prepublication*.

James, A., Hendy, S. C., Plank, M. J., & Steyn, N. (2020). Suppression and Mitigation Strategies for Control of COVID-19 in New Zealand. *medRxiv*, 2020.2003.2026.20044677. doi: 10.1101/2020.03.26.20044677

Jamieson-Lane, A. D., & Cytrnbaum, E. (2020). The Effectiveness of Targeted Quarantine for Minimising Impact of COVID-19. *medRxiv*, 2020.2004.2001.20049692. doi: 10.1101/2020.04.01.20049692

Jarvis, C. I., Van Zandvoort, K., Gimma, A., Prem, K., Klepac, P., Rubin, G. J., & Edmunds, W. J. (2020). Quantifying the impact of physical distance measures on the transmission of COVID-19 in the UK. *medRxiv*, 2020.2003.2031.20049023. doi: 10.1101/2020.03.31.20049023

Jenny, P., Jenny, D. F., Gorji, H., Arnoldini, M., & Hardt, W.-D. (2020). Dynamic Modeling to Identify Mitigation Strategies for Covid-19 Pandemic. *medRxiv*, 2020.2003.2027.20045237. doi: 10.1101/2020.03.27.20045237

Jia, J. S., Lu, X., Yuan, Y., Xu, G., Jia, J., & Christakis, N. A. (2020). Population Outflow from Wuhan Determines the Spread and Distribution of the COVID-19 Epidemic in China. *Research Square*. doi: 10.21203/rs.3.rs-17315/v1

Jia, W., Han, K., Song, Y., Cao, W., Wang, S., Yang, S., . . . He, Y. (2020). Extended SIR prediction of the epidemics trend of COVID-19 in Italy and compared with Hunan, China. *medRxiv*, 2020.2003.2018.20038570. doi: 10.1101/2020.03.18.20038570

Jin, G., Yu, J., Han, L., & Duan, S. (2020). The impact of traffic isolation in Wuhan on the spread of 2019-nCov. *medRxiv*, 2020.2002.2004.20020438. doi: 10.1101/2020.02.04.20020438

Karako, K., Song, P., Chen, Y., & Tang, W. (2020). Analysis of COVID-19 infection spread in Japan based on stochastic transition model. *Biosci Trends, advpub*. doi: 10.5582/bst.2020.01482

Keeling, M. J., Hollingsworth, T. D., & Read, J. M. (2020). The Efficacy of Contact Tracing for the Containment of the 2019 Novel Coronavirus (COVID-19). *medRxiv*, 2020.2002.2014.20023036. doi: 10.1101/2020.02.14.20023036

Kenyon, C. (2020). Widespread use of face masks in public may slow the spread of SARS CoV-2: an ecological study. *medRxiv*, 2020.2003.2031.20048652. doi: 10.1101/2020.03.31.20048652

Kim, S., Kim, Y.-J., Peck, K. R., & Jung, E. (2020). School Opening Delay Effect on Transmission Dynamics of Coronavirus Disease 2019 in Korea: Based on Mathematical Modeling and Simulation Study. *Journal of Korean medical science, 35*(13), e143. doi: 10.3346/jkms.2020.35.e143

Kissler, S., Tedijanto, C., Lipstich, M., & Yonatan, G. (2020). Social distancing strategies for curbing the COVID-19 epidemic: Harvard University.

Klausner, Z., Fattal, E., Hirsch, E., & Shapira, S. C. (2020). A single holiday was the turning point of the COVID-19 policy of Israel. *medRxiv*, 2020.2003.2026.20044412. doi: 10.1101/2020.03.26.20044412

Klein, D., Hagedorn, B., Kerr, C., Hu, H., Bedford, T., & Famulare, M. (2020). Working paper – model-based estimates of COVID-19 burden in King and Snohomish counties through April 7, 2020: Institute for Disease Modeling.

Kochanczyk, M., Grabowski, F., & Lipniacki, T. (2020). Dynamics of COVID-19 pandemic at constant and time-dependent contact rates. *medRxiv*, 2020.2003.2013.20035485. doi: 10.1101/2020.03.13.20035485

Koo, J. R., Cook, A. R., Park, M., Sun, Y., Sun, H., Lim, J. T., . . . Dickens, B. L. (2020). Interventions to mitigate early spread of SARS-CoV-2 in Singapore: a modelling study. *The Lancet Infectious Diseases*. doi: 10.1016/S1473-3099(20)30162-6

Kraemer, M. U. G., Yang, C.-H., Gutierrez, B., Wu, C.-H., Klein, B., Pigott, D. M., . . . Scarpino, S. V. (2020). The effect of human mobility and control measures on the COVID-19 epidemic in China. *medRxiv*, 2020.2003.2002.20026708. doi: 10.1101/2020.03.02.20026708

Kretzschmar, M. E., Rozhnova, G., & van Boven, M. E. (2020). Effectiveness of isolation and contact tracing for containment and slowing down a COVID-19 epidemic: a modelling study. *medRxiv*, 2020.2003.2010.20033738. doi: 10.1101/2020.03.10.20033738

Ku, C.-C., Ng, T.-C., & Lin, H.-H. (2020). Epidemiological benchmarks of the COVID-19 outbreak control in China after Wuhan's lockdown: a modelling study with an empirical approach. *SSRN- Lancet prepublication*. doi: 10.2139/ssrn.3544127

Kurita, J., Sugishita, Y., Sugawara, T., & Ohkusa, Y. (2020). Estimation of protection for COVID-19 in children from epidemiological information and estimate effect of policy in Japan. *medRxiv*, 2020.2003.2027.20045252. doi: 10.1101/2020.03.27.20045252

Kwok, K. O., Lai, F., Wei, W. I., Wong, S. Y. S., & Tang, J. (2020). Herd immunity – estimating the level required to halt the COVID-19 epidemics in affected countries. *Journal of Infection*. doi: 10.1016/j.jinf.2020.03.027

Lai, S., Ruktanonchai, N. W., Zhou, L., Prosper, O., Luo, W., Floyd, J. R., . . . Tatem, A. J. (2020). Effect of non-pharmaceutical interventions for containing the COVID-19 outbreak: an observational and modelling study. *medRxiv*, 2020.2003.2003.20029843. doi: 10.1101/2020.03.03.20029843

Lau, H., Khosrawipour, V., Kocbach, P., Mikolajczyk, A., Schubert, J., Bania, J., & Khosrawipour, T. (2020). The positive impact of lockdown in Wuhan on containing the COVID-19 outbreak in China. *Journal of Travel Medicine*. doi: 10.1093/jtm/taaa037

Li, D., Liu, Q., Liu, Z., Gao, Z., Zhu, J., Yang, J., & Wang, Q. (2020). Estimating the Efficacy of Traffic Blockage and Quarantine for the Epidemic Caused by 2019-nCoV (COVID-19). *medRxiv*, 2020.2002.2014.20022913. doi: 10.1101/2020.02.14.20022913

Li, D., Lv, J., Botwin, G., Braun, J., Cao, W., Li, L., & McGovern, D. P. B. (2020). Estimating the scale of COVID-19 Epidemic in the United States: Simulations Based on Air Traffic directly from Wuhan, China. *medRxiv*, 2020.2003.2006.20031880. doi: 10.1101/2020.03.06.20031880

Li, J., Wang, Y., Gilmour, S., Wang, M., Yoneoka, D., Wang, Y., . . . Hao, Y. (2020). Estimation of the epidemic properties of the 2019 novel coronavirus: A mathematical modeling study. *medRxiv*, 2020.2002.2018.20024315. doi: 10.1101/2020.02.18.20024315

Li, L., Yang, Z., Dang, Z., Meng, C., Huang, J., Meng, H., . . . Shao, Y. (2020). Propagation analysis and prediction of the COVID-19. *Infectious Disease Modelling, 5*, 282-292. doi: https://doi.org/10.1016/j.idm.2020.03.002

Li, X., Zhao, X., & Sun, Y. (2020). The lockdown of Hubei Province causing different transmission dynamics of the novel coronavirus (2019-nCoV) in Wuhan and Beijing. *medRxiv*, 2020.2002.2009.20021477. doi: 10.1101/2020.02.09.20021477

Liang, J., & Yuan, H.-Y. (2020). The impacts of diagnostic capability and prevention measures on transmission dynamics of COVID-19 in Wuhan. *medRxiv*, 2020.2003.2031.20049387. doi: 10.1101/2020.03.31.20049387

Lin, H., Liu, W., Gao, H., Nie, J., & Fan, Q. (2020). Trends in Transmissibility of 2019 Novel Coronavirus-infected Pneumonia in Wuhan and 29 Provinces in China. *medRxiv*, 2020.2002.2021.20026468. doi: 10.1101/2020.02.21.20026468

Lin, K., Joye, C., Giang, N., & Richardson, A. (2020). Global Empirical Forecasts of COVID-19 Trajectories Under Limited Information on the Efficacy of Intervention Strategies. *SSRN- Lancet prepublication*.

Lin, Q., Zhao, S., Gao, D., Lou, Y., Yang, S., Musa, S. S., . . . He, D. (2020). A conceptual model for the coronavirus disease 2019 (COVID-19) outbreak in Wuhan, China with individual reaction and governmental action. *International Journal of Infectious Diseases, 93*, 211-216. doi: 10.1016/j.ijid.2020.02.058

Lin, S., Huang, J., He, Z., & Zhan, D. (2020). Which Measures are Effective in Containing COVID-19? Empirical Research Based on Prevention and Control Cases in China. *medRxiv*, 2020.2003.2028.20046110. doi: 10.1101/2020.03.28.20046110

Liu, H., Bai, X., Shen, H., Pang, X., Liang, Z., & Liu, Y. (2020). Synchronized travel restrictions across cities can be effective in COVID-19 control. *medRxiv*, 2020.2004.2002.20050781. doi: 10.1101/2020.04.02.20050781

Liu, P., Beeler, P., & Chakrabarty, R. K. (2020). COVID-19 Progression Timeline and Effectiveness of Response-to-Spread Interventions across the United States. *medRxiv*, 2020.2003.2017.20037770. doi: 10.1101/2020.03.17.20037770

Liu, X., Hewings, G. J. D., Wang, S., Qin, M., Xiang, X., Zheng, S., & Li, X. (2020). Modeling the situation of COVID-19 and effects of different containment strategies in China with dynamic differential equations and parameters estimation. *medRxiv*, 2020.2003.2009.20033498. doi: 10.1101/2020.03.09.20033498

Liu, Y. (2020). Estimating the Case Fatality Rate for the COVID-19 virus: A Markov Model Application. *SSRN-Lancet prepublication*.

Liu, Z., Magal, P., Sedyi, O., & Webb, G. (2020). Predicting the Cumulative Number of Cases for the COVID-19 Epidemic in China From Early Data. *Preprints*. doi: 10.20944/preprints202002.0365.v1

Liu, Z., Magal, P., Seydi, O., & Webb, G. (2020). Understanding Unreported Cases in the COVID-19 Epidemic Outbreak in Wuhan, China, and the Importance of Major Public Health Interventions. *Biology, 9*(3). doi: 10.3390/biology9030050

Lopez, L. R., & Rodo, X. (2020). A modified SEIR model to predict the COVID-19 outbreak in Spain: simulating control scenarios and multi-scale epidemics. *medRxiv*, 2020.2003.2027.20045005. doi: 10.1101/2020.03.27.20045005

Lu, H., Ai, J., Shen, Y., Li, Y., Li, T., Zhou, X., . . . Zhang, W. (2020). A descriptive study of the impact of diseases control and prevention on the epidemics dynamics and clinical features of SARS-CoV-2 outbreak in Shanghai, lessons learned for metropolis epidemics prevention. *medRxiv*, 2020.2002.2019.20025031. doi: 10.1101/2020.02.19.20025031

Lu, J. (2020). A New, Simple Projection Model for COVID-19 Pandemic. *medRxiv*, 2020.2003.2021.20039867. doi: 10.1101/2020.03.21.20039867

Malmberg, H., & Britton, T. (2020). Inflow restrictions can prevent epidemics when contact tracing efforts are effective but have limited capacity. *medRxiv*, 2020.2004.2001.20050401. doi: 10.1101/2020.04.01.20050401

Mandal, S., Bhatnagar, T., Arinaminpathy, N., Agarwal, A., Chowdhury, A., Murhekar, M., . . . Sarkar, S. (2020). Prudent public health intervention strategies to control the coronavirus disease 2019 transmission in India: A mathematical model-based approach. LID - 10.4103/ijmr.IJMR_504_20 [doi]. (0971-5916 (Print)).

Mangiarotti, S., Peyre, M., Zhang, Y., Huc, M., Roger, F., & Kerr, Y. (2020). Chaos theory applied to the outbreak of Covid-19: an ancillary approach to decision-making in pandemic context. *medRxiv*, 2020.2004.2002.20051441. doi: 10.1101/2020.04.02.20051441

Maslov, S., & Goldenfeld, N. (2020). Window of Opportunity for Mitigation to Prevent Overflow of ICU capacity in Chicago by COVID-19. *medRxiv*, 2020.2003.2020.20040048. doi: 10.1101/2020.03.20.20040048

Matrajt, L., & Leung, T. (2020). Evaluating the effectiveness of social distancing interventions against COVID-19. *medRxiv*, 2020.2003.2027.20044891. doi: 10.1101/2020.03.27.20044891

McBryde, E. S., Meehan, M. T., & Trauer, J. M. (2020). Flattening the curve is not enough, we need to squash it. An explainer using a simple model. *medRxiv*, 2020.2003.2030.20048009. doi: 10.1101/2020.03.30.20048009

Ming, W.-k., Huang, J., & Zhang, C. J. P. (2020). Breaking down of the healthcare system: Mathematical modelling for controlling the novel coronavirus (2019-nCoV) outbreak in Wuhan, China. *bioRxiv*, 2020.2001.2027.922443. doi: 10.1101/2020.01.27.922443

Mizumoto, K., Kagaya, K., & Chowell, G. (2020). Early epidemiological assessment of the transmission potential and virulence of coronavirus disease 2019 (COVID-19) in Wuhan City: China, January-February, 2020. *medRxiv*, 2020.2002.2012.20022434. doi: 10.1101/2020.02.12.20022434

Moghadami, M., Moghadami, M., Hassanzadeh, M., wa, k., Hedayati, A., & Malekolkalami, M. (2020). Modeling the Corona Virus Outbreak in IRAN. *medRxiv*, 2020.2003.2024.20041095. doi: 10.1101/2020.03.24.20041095

Muller, S. A., Balmer, M., Neumann, A., & Nagel, K. (2020). Mobility traces and spreading of COVID-19. *medRxiv*, 2020.2003.2027.20045302. doi: 10.1101/2020.03.27.20045302

Neufeld, Z., & Khataee, H. (2020). Targeted adaptive isolation strategy for Covid-19 pandemic. *medRxiv*, 2020.2003.2023.20041897. doi: 10.1101/2020.03.23.20041897

Ng, Y., Li, Z., Chua, Y., Chaw, W., Zhao, Z., Er, B., . . . Lee, V. (2020). Evaluation of the Effectiveness of Surveillance and Containment Measures for the First 100 Patients with COVID-19 in Singapore — January 2–February 29, 2020. *MMWR Morb Mortal Wkly Rep, 69*, 307-311. doi: http://dx.doi.org/10.15585/mmwr.mm6911e1external icon

Niehus, R., De Salazar, P. M., Taylor, A., & Lipsitch, M. (2020). Quantifying bias of COVID-19 prevalence and severity estimates in Wuhan, China that depend on reported cases in international travelers. *medRxiv*, 2020.2002.2013.20022707. doi: 10.1101/2020.02.13.20022707

Nishiura, H. (2020). Backcalculating the Incidence of Infection with COVID-19 on the Diamond Princess. *Journal of Clinical Medicine, 9*(3). doi: 10.3390/jcm9030657

Nishiura, H., Oshitani, H., Kobayashi, T., Saito, T., Sunagawa, T., Matsui, T., . . . Suzuki, M. (2020). Closed environments facilitate secondary transmission of coronavirus disease 2019 (COVID-19). *medRxiv*, 2020.2002.2028.20029272. doi: 10.1101/2020.02.28.20029272

Nussbaumer-Streit, B., Chapman, A., Dorescu, A. L., Mayr, V., Persad, E., Klerings, I., & Gartlehner, G. (2020). The Effectiveness of Quarantine to Control the Coronavirus Disease 2019: A Rapid Review. *SSRN- Lancet prepublication*.

Odendaal, W. G. (2020). A Method to Model Outbreaks of New Infectious Diseases with Pandemic Potential such as COVID-19. *medRxiv*, 2020.2003.2011.20034512. doi: 10.1101/2020.03.11.20034512

Pais, R. J., & Taveira, N. (2020). Predicting the evolution and control of COVID-19 pandemic in Portugal. *medRxiv*, 2020.2003.2028.20046250. doi: 10.1101/2020.03.28.20046250

Pan, J., Yao, Y., Liu, Z., Li, M., Wang, Y., Dong, W., . . . Wang, W. (2020). Effectiveness of intervention strategies for Coronavirus Disease 2019 and an estimation of its peak time. *medRxiv*, 2020.2002.2019.20025387. doi: 10.1101/2020.02.19.20025387

Park, S. W., Sun, K., Viboud, C., Grenfell, B. T., & Dushoff, J. (2020). Potential roles of social distancing in mitigating the spread of coronavirus disease 2019 (COVID-19) in South Korea. *medRxiv*, 2020.2003.2027.20045815. doi: 10.1101/2020.03.27.20045815

Peak, C. M., Kahn, R., Grad, Y. H., Childs, L. M., Li, R., Lipsitch, M., & Buckee, C. O. (2020). Modeling the Comparative Impact of Individual Quarantine vs. Active Monitoring of Contacts for the Mitigation of COVID-19. *medRxiv*, 2020.2003.2005.20031088. doi: 10.1101/2020.03.05.20031088

Pei, S., & Shaman, J. (2020). Initial Simulation of SARS-CoV2 Spread and Intervention Effects in the Continental US. *medRxiv*, 2020.2003.2021.20040303. doi: 10.1101/2020.03.21.20040303

Peng, T., Liu, X., Ni, H., Cui, Z., & Du, L. (2020). Wuhan City Lockdown and Nationwide Intensive Community Screening Are Effective in Controlling COVID-19 Epidemic: Analysis Based on a Modified SIR Model. *SSRN- Lancet prepublication*.

Pepe, E., Bajardi, P., Gauvin, L., Privitera, F., Lake, B., Cattuto, C., & Tizzoni, M. (2020). COVID-19 outbreak response: a first assessment of mobility changes in Italy following national lockdown. *medRxiv*, 2020.2003.2022.20039933. doi: 10.1101/2020.03.22.20039933

Pike, W. T., & Saini, V. (2020). An international comparison of the second derivative of COVID-19 deaths after implementation of social distancing measures. *medRxiv*, 2020.2003.2025.20041475. doi: 10.1101/2020.03.25.20041475

Pinotti, F., Di Domenico, L., Ortega, E., Mancastroppa, M., Pullano, G., Valdano, E., . . . Colizza, V. (2020). Lessons learnt from 288 COVID-19 international cases: importations over time, effect of interventions, underdetection of imported cases. *medRxiv*, 2020.2002.2024.20027326. doi: 10.1101/2020.02.24.20027326

Prasad, J., & Mohapatra, T. (2020). Minimizing the Effect of COVID-19 Pandemic Through an Adaptive Staggered Approach to Lock-Downs. *SSRN- Lancet prepublication*.

Prem, K., Liu, Y., Russell, T. W., Kucharski, A. J., Eggo, R. M., Davies, N., . . . Klepac, P. (2020). The effect of control strategies to reduce social mixing on outcomes of the COVID-19 epidemic in Wuhan, China: a modelling study. *The Lancet Public Health*. doi: 10.1016/S2468-2667(20)30073-6

Qiu, T., & Xiao, H. (2020). Revealing the influence of national public health policies for the outbreak of the SARS-CoV-2 epidemic in Wuhan, China through status dynamic modeling. *medRxiv*, 2020.2003.2010.20032995. doi: 10.1101/2020.03.10.20032995

Qiu, Y., Chen, X., & Shi, W. (2020). Impacts of social and economic factors on the transmission of coronavirus disease (COVID-19) in China. *medRxiv*, 2020.2003.2013.20035238. doi: 10.1101/2020.03.13.20035238

Quilty, B., Clifford, S., Flasche, S., & Eggo, R. M. (2020). Effectiveness of airport screening at detecting travellers infected with 2019-nCoV. *medRxiv*, 2020.2001.2031.20019265. doi: 10.1101/2020.01.31.20019265

Ranjan, R. (2020). Predictions for COVID-19 outbreak in India using Epidemiological models. *medRxiv*, 2020.2004.2002.20051466. doi: 10.1101/2020.04.02.20051466

Read, J. M., Bridgen, J. R., Cummings, D. A., Ho, A., & Jewell, C. P. (2020). Novel coronavirus 2019-nCoV: early estimation of epidemiological parameters and epidemic predictions. *medRxiv*, 2020.2001.2023.20018549. doi: 10.1101/2020.01.23.20018549

Rocklöv, J., Sjödin, H., & Wilder-Smith, A. (2020). COVID-19 outbreak on the Diamond Princess cruise ship: estimating the epidemic potential and effectiveness of public health countermeasures. *Journal of Travel Medicine*. doi: 10.1093/jtm/taaa030

Roda, W. C., Varughese, M. B., Han, D., & Li, M. Y. (2020). Why is it difficult to accurately predict the COVID-19 epidemic? *Infectious Disease Modelling, 5*, 271-281. doi: https://doi.org/10.1016/j.idm.2020.03.001

Rogers, C., Haueter, A., Kiker, J., Harris, C., Villanueva, D., Franco, R., & Record, R. (2020). Observational Study of Drive Through Mass Testing and Timely Detection of COVID-19 in Alabama. *SSRN- Lancet prepublication*.

Rossberg, A. G., & Knell, R. J. (2020). How will this continue? Modelling interactions between the COVID-19 pandemic and policy responses. *medRxiv*, 2020.2003.2030.20047597. doi: 10.1101/2020.03.30.20047597

Rovetta, A., & Bhagavathula, A. S. (2020). Modelling the epidemiological trend and behavior of COVID-19 in Italy. *medRxiv*, 2020.2003.2019.20038968. doi: 10.1101/2020.03.19.20038968

Russo, L., Anastassopoulou, C., Tsakris, A., Bifulco, G. N., Campana, E. F., Toraldo, G., & Siettos, C. (2020). Tracing DAY-ZERO and Forecasting the Fade out of the COVID-19 Outbreak in Lombardy, Italy: A Compartmental Modelling and Numerical Optimization Approach. *medRxiv*, 2020.2003.2017.20037689. doi: 10.1101/2020.03.17.20037689

Ryu, S., Ali, S. T., Lim, J.-s., & Chun, B. C. (2020). Estimate number of individuals infected with the 2019-novel coronavirus in South Korea due to the influx of international students from countries with virus risk: a simulation study. *medRxiv*, 2020.2002.2015.20023234. doi: 10.1101/2020.02.15.20023234

Sanche, S., Lin, Y. T., Xu, C., Romero-Severson, E., Hengartner, N., & Ke, R. (2020). The Novel Coronavirus, 2019-nCoV, is Highly Contagious and More Infectious Than Initially Estimated. *medRxiv*, 2020.2002.2007.20021154. doi: 10.1101/2020.02.07.20021154

Scarabel, F., Pellis, L., Bragazzi, N. L., & Wu, J. (2020). Canada Needs to Rapidly Escalate Public Health Interventions for Its COVID-19 Mitigation Strategies. *SSRN- Lancet prepublication*.

Shang, C., Yang, Y., Chen, G.-Y., & Shang, X.-D. (2020). A simple transmission dynamics model for predicting the evolution of COVID-19 under control measures in China. *Research Square*.

Shanlang, L., Chao, M., Ruofei, L., Junpei, H., Ruohan, X., & Aini, Y. (2020). Research on the Influence of Information Diffusion on the Transmission of the Novel Coronavirus (COVID-19). *medRxiv*, 2020.2003.2031.20048439. doi: 10.1101/2020.03.31.20048439

Shao, N., Pan, H., Li, X., Li, W., Wang, S., Xuan, Y., . . . Chen, W. (2020). CoVID-19 in Japan: What could happen in the future? *medRxiv*, 2020.2002.2021.20026070. doi: 10.1101/2020.02.21.20026070

Shao, P. (2020). Impact of city and residential unit lockdowns on prevention and control of COVID-19. *medRxiv*, 2020.2003.2013.20035253. doi: 10.1101/2020.03.13.20035253

Shao, P., & Shan, Y. (2020). Beware of asymptomatic transmission: Study on 2019-nCoV prevention and control measures based on extended SEIR model. *bioRxiv*, 2020.2001.2028.923169. doi: 10.1101/2020.01.28.923169

Shayak, B., Sharma, M. M., Rand, R. H., Singh, A. K., & Misra, A. (2020). Transmission Dynamics of COVID-19 and Impact on Public Health Policy. *medRxiv*, 2020.2003.2029.20047035. doi: 10.1101/2020.03.29.20047035

Shen, M., Peng, Z., Guo, Y., Xiao, Y., & Zhang, L. (2020). Lockdown may partially halt the spread of 2019 novel coronavirus in Hubei province, China. *medRxiv*, 2020.2002.2011.20022236. doi: 10.1101/2020.02.11.20022236

Shi, Z., & Fang, Y. (2020). Temporal relationship between outbound traffic from Wuhan and the 2019 coronavirus disease (COVID-19) incidence in China. *medRxiv*, 2020.2003.2015.20034199. doi: 10.1101/2020.03.15.20034199

Shlomai, A., Leshno, A., Sklan, E. H., & Leshno, M. (2020). Global versus focused isolation during the SARS-CoV-2 pandemic-A cost-effectiveness analysis. *medRxiv*, 2020.2003.2030.20047860. doi: 10.1101/2020.03.30.20047860

Shuler, R. L. (2020). Partial unlock model for COVID-19 or similar pandemic averts medical and economic disaster. *medRxiv*, 2020.2003.2030.20048082. doi: 10.1101/2020.03.30.20048082

Smeets, B., Watte, R., & Ramon, H. (2020). Scaling analysis of COVID-19 spreading based on Belgian hospitalization data. *medRxiv*, 2020.2003.2029.20046730. doi: 10.1101/2020.03.29.20046730

Sookaromdee, P., & Wiwaniveitkit, V. (2020). Imported Novel Coronavirus Infections: Observation on Active and Passive Case Detection in Thailand. *Population Health Management*. doi: https://doi.org/10.1089/pop.2020.0014

St-Onge, G., Thibeault, V., Allard, A., Dube, L. J., & Hebert-Dufresne, L. (2020). School closures, event cancellations, and the mesoscopic localization of epidemics in networks with higher-order structure: Cornell University.

Stangeland, B. (2020). How to evaluate the success of the COVID-19 measures implemented by the Norwegian government by analyzing changes in doubling time. *medRxiv*, 2020.2003.2029.20045187. doi: 10.1101/2020.03.29.20045187

Sugishita, Y., Kurita, J., Sugawara, T., & Ohkusa, Y. (2020). Forecast of the COVID-19 outbreak, collapse of medical facilities, and lockdown effects in Tokyo, Japan. *medRxiv*, 2020.2004.2002.20051490. doi: 10.1101/2020.04.02.20051490

Tang, B., Xia, F., Bragazzi, N. L., Wang, X., He, S., Sun, X., . . . Wu, J. (2020). Lessons drawn from China and South Korea for managing COVID-19 epidemic: insights from a comparative modeling study. *medRxiv*, 2020.2003.2009.20033464. doi: 10.1101/2020.03.09.20033464

Tang, B., Xia, F., Tang, S., Bragazzi, N. L., Li, Q., Sun, X., . . . Wu, J. (2020). The evolution of quarantined and suspected cases determines the final trend of the 2019-nCov epidemics based on multi-source data analyses. . *SSRN- Lancet prepublication*. doi: https://ssrn.com/abstract=3537099

Tang, S., Tang, B., Bragazzi, N. L., Xia, F., Li, T., He, S., . . . Wu, J. (2020). Stochastic discrete epidemic modeling of COVID-19 transmission in the Province of Shaanxi incorporating public health intervention and case importation. *medRxiv*, 2020.2002.2025.20027615. doi: 10.1101/2020.02.25.20027615

Teles, P. (2020). PREDICTING THE EVOLUTION OF COVID-19 IN PORTUGAL USING AN ADAPTED SIR MODEL PREVIOUSLY USED IN SOUTH KOREA FOR THE MERS OUTBREAK. *medRxiv*, 2020.2003.2018.20038612. doi: 10.1101/2020.03.18.20038612

Tellis, G. J., Sood, A., & Sood, N. (2020). How Long Should Social Distancing Last? Predicting Time to Moderation, Control, and Containment of COVID-19. *SSRN- Lancet prepublication*.

Teslya, A., Pham, T. M., Godijk, N. E., Kretzschmar, M. E., Bootsma, M. C. J., & Rozhnova, G. (2020). Impact of self-imposed prevention measures and short-term government intervention on mitigating and delaying a COVID-19 epidemic. *medRxiv*, 2020.2003.2012.20034827. doi: 10.1101/2020.03.12.20034827

Thompson, R. N. (2020). Novel Coronavirus Outbreak in Wuhan, China, 2020: Intense Surveillance Is Vital for Preventing Sustained Transmission in New Locations. *Journal of Clinical Medicine, 9*(2), 498. doi: https://doi.org/10.3390/jcm9020498

Tian, H., Li, Y., Liu, Y., Kraemer, M. U. G., Chen, B., Cai, J., . . . Dye, C. (2020). Early evaluation of the Wuhan City travel restrictions in response to the 2019 novel coronavirus outbreak. *medRxiv*, 2020.2001.2030.20019844. doi: 10.1101/2020.01.30.20019844

Tian, H., Liu, Y., Li, Y., Wu, C.-H., Chen, B., Kraemer, M. U. G., . . . Dye, C. (2020a). The impact of transmission control measures during the first 50 days of the COVID-19 epidemic in China. *medRxiv*, 2020.2001.2030.20019844. doi: 10.1101/2020.01.30.20019844

Tian, H., Liu, Y., Li, Y., Wu, C.-H., Chen, B., Kraemer, M. U. G., . . . Dye, C. (2020b). An investigation of transmission control measures during the first 50 days of the COVID-19 epidemic in China. *Science*, eabb6105. doi: 10.1126/science.abb6105

Torneri, A., Libin, P. J. K., Vanderlocht, J., Vandamme, A.-M., Neyts, J., & Hens, N. (2020). A prospect on the use of antiviral drugs to control local outbreaks of COVID-19. *medRxiv*, 2020.2003.2019.20038182. doi: 10.1101/2020.03.19.20038182

Traini, M. C., Caponi, C., & De Socio, G. V. (2020). Modelling the epidemic 2019-nCoV event in Italy: a preliminary note. *medRxiv*, 2020.2003.2014.20034884. doi: 10.1101/2020.03.14.20034884

Tuite, A., Fisman, D. N., & Greer, A. L. (2020). Mathematical modeling of COVID-19 transmission and mitigation strategies in the population of Ontario, Canada. *medRxiv*, 2020.2003.2024.20042705. doi: 10.1101/2020.03.24.20042705

Utsunomiya, Y. T., Utsunomiya, A. T. H., Torrecilha, R. B. P., Paulan, S. C., Milanesi, M., & Garcia, J. F. (2020). Growth rate and acceleration analysis of the COVID-19 pandemic reveals the effect of public health measures in real time. *medRxiv*, 2020.2003.2030.20047688. doi: 10.1101/2020.03.30.20047688

Vasconcelos, G. L., Macêdo, A. M. S., Ospina, R., Almeida, F. A. G., Duarte-Filho, G. C., & Souza, I. C. L. (2020). Modelling fatality curves of COVID-19 and the effectiveness of intervention strategies. *medRxiv*, 2020.2004.2002.20051557. doi: 10.1101/2020.04.02.20051557

Viner, R., Russell, S., Croker, H., Packer, J., Ward, J., Stansfield, C., . . . Booy, R. (2020). School Closure and Management Practices During Coronavirus Outbreaks Including COVID-19: A Rapid Narrative Systematic Review. *SSRN- Lancet prepublication*.

Volz, E., Fu, H., Wang, H., Xi, X., Chen, W., Liu, D., . . . Nie, Q. (2020). Genomic epidemiology of a densely sampled COVID19 outbreak in China. *medRxiv*, 2020.2003.2009.20033365. doi: 10.1101/2020.03.09.20033365

Wan, H., Cui, J.-a., & Yang, G.-J. (2020). Risk estimation and prediction by modeling the transmission of the novel coronavirus (COVID-19) in mainland China excluding Hubei province. *medRxiv*, 2020.2003.2001.20029629. doi: 10.1101/2020.03.01.20029629

Wang, C., Liu, L., Hao, X., Guo, H., Wang, Q., Huang, J., . . . Wu, T. (2020). Evolving Epidemiology and Impact of Non-pharmaceutical Interventions on the Outbreak of Coronavirus Disease 2019 in Wuhan, China. *medRxiv*, 2020.2003.2003.20030593. doi: 10.1101/2020.03.03.20030593

Wang, F., Li, Y., Tang, D., Li, Q., Liu, G., He, Z., . . . Liu, Y. (2020). Trend of the Coronavirus Disease-2019 Epidemic in China After the Lockdown of Wuhan City on January 23, 2020. *SSRN- Lancet prepublication*.

Wang, H., Zhang, Y., Lu, S., & Wang, S. (2020). Tracking and forecasting milepost moments of the epidemic in the early-outbreak: framework and applications to the COVID-19. *medRxiv*, 2020.2003.2021.20040139. doi: 10.1101/2020.03.21.20040139

Wang, Q., Shi, N., Huang, J., Cui, T., Yang, L., Ai, J., . . . Jin, H. (2020). Effectiveness and cost-effectiveness of public health measures to control COVID-19: a modelling study. *medRxiv*, 2020.2003.2020.20039644. doi: 10.1101/2020.03.20.20039644

Wang, W., Chen, Y., Wang, Q., Cai, P., He, Y., Hu, S., . . . Wenxiang, W. (2020). The Transmission Dynamics of SARS-COV-2 in China: Modeling Study and the Impact of Public Health Interventions. *SSRN- Lancet prepublication*.

Weitz, J. S., Beckett, S. J., Coenen, A. R., Demory, D., Dominguez-Mirazo, M., Dushoff, J., . . . Zhao, C. (2020). Intervention Serology and Interaction Substitution: Modeling the Role of 'Shield Immunity' in Reducing COVID-19 Epidemic Spread. *medRxiv*, 2020.2004.2001.20049767. doi: 10.1101/2020.04.01.20049767

Wells, C. R., Sah, P., Moghadas, S. M., Pandey, A., Shoukat, A., Wang, Y., . . . Galvani, A. P. (2020). 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*, 202002616. doi: 10.1073/pnas.2002616117

Wenbao, W., Yiqin, C., Qi, W., Ping, C., Ye, H., Shanwen, H., . . . Wenxiang, W. (2020). Transmission dynamics of SARS-COV-2 in China: impact of public health interventions. *medRxiv*, 2020.2003.2024.20036285. doi: 10.1101/2020.03.24.20036285

Westerhoff, H. V., & Kolodkin, A. N. (2020). Advice from a systems-biology model of the Corona epidemics. *medRxiv*, 2020.2003.2029.20045039. doi: 10.1101/2020.03.29.20045039

Wilder, B., Charpignon, M., Killian, J. A., Ou, H.-C., Mate, A., Perrault, A., . . . Majumder, M. S. (2020). The Role of Age Distribution and Family Structure on COVID-19 Dynamics: A Preliminary Modeling Assessment for Hubei and Lombardy. *SSRN- Lancet prepublication*.

Willem, L., Hoang, T. V., Funk, S., Coletti, P., Beutels, P., & Hens, N. (2020). SOCRATES: An online tool leveraging a social contact data sharing initiative to assess mitigation strategies for COVID-19. *medRxiv*, 2020.2003.2003.20030627. doi: 10.1101/2020.03.03.20030627

Wittkowski, K. M. (2020). The first three months of the COVID-19 epidemic: Epidemiological evidence for two separate strains of SARS-CoV-2 viruses spreading and implications for prevention strategies. *medRxiv*, 2020.2003.2028.20036715. doi: 10.1101/2020.03.28.20036715

Xiao, W., Liu, Q., Huan, J., Sun, P., Wang, L., Zang, C., . . . Gao, L. (2020). A Cybernetics-based Dynamic Infection Model for Analyzing SARS-COV-2 Infection Stability and Predicting Uncontrollable Risks. *medRxiv*, 2020.2003.2013.20034082. doi: 10.1101/2020.03.13.20034082

Xie, Q., Wang, J., You, J., Zhu, S., Zhou, R., Tian, Z., . . . Wang, J. (2020). Effect of large-scale testing platform in prevention and control of the COVID-19 pandemic: an empirical study with a novel numerical model. *medRxiv*, 2020.2003.2015.20036624. doi: 10.1101/2020.03.15.20036624

Xiong, H., & Yan, H. (2020). Simulating the infected population and spread trend of 2019-nCov under different policy by EIR model. *medRxiv*, 2020.2002.2010.20021519. doi: 10.1101/2020.02.10.20021519

Xu, L., Yuan, J., Zhang, Y., Zhang, G., Lu, F., Su, J., & Qu, J. (2020). Highland of COVID-19 outside Hubei: epidemic characteristics, control and projections of Wenzhou, China. *medRxiv*, 2020.2002.2025.20024398. doi: 10.1101/2020.02.25.20024398

Yang, P., Qi, J., Zhang, S., Wang, X., Bi, G., Yang, Y., & Sheng, B. (2020). Feasibility Study of Mitigation and Suppression Intervention Strategies for Controlling COVID-19 Outbreaks in London and Wuhan. *medRxiv*, 2020.2004.2001.20043794. doi: 10.1101/2020.04.01.20043794

Yang, Q., Yi, C., Vajdi, A., Cohnstaedt, L. W., Wu, H., Guo, X., & Scoglio, C. M. (2020). Short-term forecasts and long-term mitigation evaluations for the COVID-19 epidemic in Hubei Province, China. *medRxiv*, 2020.2003.2027.20045625. doi: 10.1101/2020.03.27.20045625

Ying, S., Li, F., Geng, X., Li, Z., Du, X., Chen, H., . . . Shen, H. (2020). Spread and control of COVID-19 in China and their associations with population movement, public health emergency measures, and medical resources. *medRxiv*, 2020.2002.2024.20027623. doi: 10.1101/2020.02.24.20027623

Yu, H., Sun, X., Solvang, W. D., & Zhao, X. (2020). Reverse Logistics Network Design for Effective Management of Medical Waste in Epidemic Outbreak: Insights from the Coronavirus Disease 2019 (COVID-19) in Wuhan. *SSRN- Lancet prepublication*. doi: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3538063

Yuan, Z., & Yuan, C. (2020). A simple model to assess Wuhan lock-down effect and region efforts during COVID-19 epidemic in China Mainland. *medRxiv*, 2020.2002.2029.20029561. doi: 10.1101/2020.02.29.20029561

Zha, W., Zhou, N., Li, G., Li, W., Zhang, H., Zhang, S., . . . LV, Y. (2020). Assessment and forecasting the spread of SARS-CoV-2 outbreak in Changsha, China: Based on a SEIAR Dynamic Model. *Research Square*. doi: 10.21203/rs.3.rs-16659/v1

Zhan, C., Tse, C. K., Lai, Z., Chen, X., & Mo, M. (2020). General Model for COVID-19 Spreading with Consideration of Intercity Migration, Insufficient Testing and Active Intervention: Application to Study of Pandemic Progression in Japan and USA. *medRxiv*, 2020.2003.2025.20043380. doi: 10.1101/2020.03.25.20043380

Zhan, C., Tse, C. K., Lai, Z., Hao, T., & Su, J. (2020). Prediction of COVID-19 Spreading Profiles in South Korea, Italy and Iran by Data-Driven Coding. *medRxiv*, 2020.2003.2008.20032847. doi: 10.1101/2020.03.08.20032847

Zhang, B., Zhou, H., & Zhou, F. (2020). Study on SARS-COV-2 transmission and the effects of control measures in China. *medRxiv*, 2020.2002.2016.20023770. doi: 10.1101/2020.02.16.20023770

Zhang, C., Chen, C., Shen, W., Tang, F., Lei, H., Xie, Y., . . . Du, X. (2020). Impact of Population Movement on the Spread of 2019-nCoV in China. *SSRN- Lancet prepublication*.

Zhang, F., Zhang, J., Cao, M., Zhang, Y., & Hui, C. (2020). Exponential damping key to successful containment of COVID-19 outbreak. *medRxiv*, 2020.2003.2022.20041111. doi: 10.1101/2020.03.22.20041111

Zhang, H., Zhao, X., Yin, K., Yan, Y., Qian, W., Chen, B., & Fang, X. (2020). Dynamic Estimation of Epidemiological Parameters of COVID-19 Outbreak and Effects of Interventions on Its Spread. *medRxiv*, 2020.2004.2001.20050310. doi: 10.1101/2020.04.01.20050310

Zhang, J., Dong, L., Zhang, Y., Chen, X., Yao, G., & Han, Z. (2020). Predicting the Spread of the COVID-19 Across Cities in China with Population Migration and Policy Intervention. *SSRN- Lancet prepublication*.

Zhang, J., Litvinova, M., Liang, Y., Wang, Y., Wang, W., Zhao, S., . . . Yu, H. (2020). Age profile of susceptibility, mixing, and social distancing shape the dynamics of the novel coronavirus disease 2019 outbreak in China. *medRxiv*, 2020.2003.2019.20039107. doi: 10.1101/2020.03.19.20039107

Zhang, J., Wang, T., Wang, J., Chen, J., Yan, H., & Sun, L. (2020). Reporting the life tracks of confirmed cases can effective prevent and control the COVID-19 outbreak in China. *medRxiv*, 2020.2004.2001.20050450. doi: 10.1101/2020.04.01.20050450

Zhang, K. K., Xie, L., Lawless, L., Zhou, H., Gao, G., & Xue, C. (2020). Characterizing the transmission and identifying the control strategy for COVID-19 through epidemiological modeling. *medRxiv*, 2020.2002.2024.20026773. doi: 10.1101/2020.02.24.20026773

Zhang, L., Shen, M., Ma, X., Su, S., Gong, W., Wang, J., . . . Fairley, C. K. (2020). What is required to prevent a second major outbreak of the novel coronavirus SARS-CoV-2 upon lifting the metropolitan-wide quarantine of Wuhan city, China. *medRxiv*, 2020.2003.2024.20042374. doi: 10.1101/2020.03.24.20042374

Zhang, Q., Deng, H., & Zhang, C. (2020). The Value of Early Response by Surrounding Areas of Epidemic Center Hubei During COVID-2019 Outbreak in China: A Quasi-Experiment Analysis. *SSRN- Lancet prepublication*.

Zhang, S., Diao, M., Yu, W., Pei, L., Lin, Z., & Chen, D. (2020). Estimation of the reproductive number of novel coronavirus (COVID-19) and the probable outbreak size on the Diamond Princess cruise ship: A data-driven analysis. (1878-3511 (Electronic)).

Zhang, S., Diao, M. Y., Duan, L., Lin, Z., & Chen, D. (2020). The novel coronavirus (SARS-CoV-2) infections in China: prevention, control and challenges. *Intensive Care Medicine*. doi: 10.1007/s00134-020-05977-9

Zhang, Y., Jiang, B., Yuan, J., & Tao, Y. (2020). The impact of social distancing and epicenter lockdown on the COVID-19 epidemic in mainland China: A data-driven SEIQR model study. *medRxiv*, 2020.2003.2004.20031187. doi: 10.1101/2020.03.04.20031187

Zhang, Y., You, C., Cai, Z., Sun, J., Hu, W., & Zhou, X.-H. (2020). Prediction of the COVID-19 outbreak based on a realistic stochastic model. *medRxiv*, 2020.2003.2010.20033803. doi: 10.1101/2020.03.10.20033803

Zhao, K., Long, C., Wang, Y., Zeng, T., & Fu, X. (2020). Negligible risk of the COVID-19 resurgence caused by work resuming in China (outside Hubei): a statistical probability study. *Journal of Public Health*. doi: 10.1093/pubmed/fdaa046

Zhao, L., Liu, Y.-X., Wei, J.-T., Zhu, Y.-C., Qian, J., Ye, R.-Z., . . . Group, C. E. C. C. (2020). Transmission Dynamics of COVID-19 in Mainland China: Impact of Public Health Control Measures. *SSRN- Lancet prepublication*.

Zhao, P. J. (2020). A Social Network Model of the COVID-19 Pandemic. *medRxiv*, 2020.2003.2023.20041798. doi: 10.1101/2020.03.23.20041798

Zhao, Q., Chen, Y., & Small, D. S. (2020). Analysis of the epidemic growth of the early 2019-nCoV outbreak using internationally confirmed cases. *medRxiv*, 2020.2002.2006.20020941. doi: 10.1101/2020.02.06.20020941

Zhao, S., & Chen, H. (2020). Modeling the epidemic dynamics and control of COVID-19 outbreak in China. *Quantitative Biology*. doi: 10.1007/s40484-020-0199-0

Zhou, X., Hong, N., Ma, Y., He, J., Jiang, H., Liu, C., . . . Long, Y. (2020). Forecasting the Worldwide Spread of COVID-19 based on Logistic Model and SEIR Model. *medRxiv*, 2020.2003.2026.20044289. doi: 10.1101/2020.03.26.20044289

Zhou, X., Wu, Z., Yu, R., Cao, S., Fang, W., Jiang, Z., . . . Chen, D. (2020). Modelling-based evaluation of the effect of quarantine control by the Chinese government in the coronavirus disease 2019 outbreak. *medRxiv*, 2020.2003.2003.20030445. doi: 10.1101/2020.03.03.20030445

Zhu, H. (2020). Transmission Dynamics and Control Methodology of COVID-19: a Modeling Study. *medRxiv*, 2020.2003.2029.20047118. doi: 10.1101/2020.03.29.20047118

Zhu, X., Zhang, A., Xu, S., Jia, P., Tan, X., Tian, J., . . . Yu, J. (2020). Spatially Explicit Modeling of 2019-nCoV Epidemic Trend based on Mobile Phone Data in Mainland China. *medRxiv*, 2020.2002.2009.20021360. doi: 10.1101/2020.02.09.20021360

Prepared by Tricia Corrin, NML: patricia.corrin@canada.ca