Effects of isolation and shielding

Jordan Klein, MPH *(Princeton University)*

7/10/2020

Fraction Dead

Summary Statistics

Isolation_capacity	Shielding_strategy	n	mean	sd
Isolation cap 0	No shielding	500	0.100	0.033
Isolation cap 0	Shield 10 conts/wk	500	0.098	0.032
Isolation cap 0	Shield 2 conts/wk	500	0.100	0.033
Isolation cap 10	No shielding	500	0.059	0.053
Isolation cap 10	Shield 10 conts/wk	500	0.059	0.052
Isolation cap 10	Shield 2 conts/wk	500	0.062	0.052
Isolation cap 25	No shielding	500	0.050	0.051
Isolation cap 25	Shield 10 conts/wk	500	0.048	0.049
Isolation cap 25	Shield 2 conts/wk	500	0.050	0.050

Effect of isolation capacity under each shielding strategy (pairwise t-tests)

Shielding_strategy	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
No shielding	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
No shielding	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
No shielding	Isolation cap 10	Isolation cap 25	500	500	0.0031	**	0.0092	**
Shield 10 conts/wk	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
Shield 10 conts/wk	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
Shield 10 conts/wk	Isolation cap 10	Isolation cap 25	500	500	0.0002	***	0.0006	***
Shield 2 conts/wk	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
Shield 2 conts/wk	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
Shield 2 conts/wk	Isolation cap 10	Isolation cap 25	500	500	0.0001	***	0.0004	***

Effect of shielding strategy in each isolation capacity scenario (pairwise t-tests)

Isolation_capacity	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
Isolation cap 0	No shielding	Shield 10 conts/wk	500	500	0.344	ns	1	ns
Isolation cap 0	No shielding	Shield 2 conts/wk	500	500	0.980	ns	1	ns
Isolation cap 0	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.356	ns	1	ns
Isolation cap 10	No shielding	Shield 10 conts/wk	500	500	0.957	ns	1	ns
Isolation cap 10	No shielding	Shield 2 conts/wk	500	500	0.429	ns	1	ns
Isolation cap 10	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.398	ns	1	ns
Isolation cap 25	No shielding	Shield 10 conts/wk	500	500	0.495	ns	1	ns
Isolation cap 25	No shielding	Shield 2 conts/wk	500	500	0.956	ns	1	ns
Isolation cap 25	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.461	ns	1	ns

Time to Peak Number of Infections

Summary Statistics

Isolation_capacity	Shielding_strategy	n	mean	sd
Isolation cap 0	No shielding	500	63.72	13.97
Isolation cap 0	Shield 10 conts/wk	500	95.03	24.84
Isolation cap 0	Shield 2 conts/wk	500	103.99	27.16
Isolation cap 10	No shielding	500	114.86	89.18
Isolation cap 10	Shield 10 conts/wk	500	131.28	85.15
Isolation cap 10	Shield 2 conts/wk	500	136.53	83.53
Isolation cap 25	No shielding	500	126.54	91.70
Isolation cap 25	Shield 10 conts/wk	500	141.15	86.63
Isolation cap 25	Shield 2 conts/wk	500	147.04	86.05

Effect of isolation capacity under each shielding strategy (pairwise t-tests)

Shielding_strategy	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
No shielding	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
No shielding	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
No shielding	Isolation cap 10	Isolation cap 25	500	500	0.0130	*	0.0390	*
Shield 10 conts/wk	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
Shield 10 conts/wk	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
Shield 10 conts/wk	Isolation cap 10	Isolation cap 25	500	500	0.0294	*	0.0882	ns
Shield 2 conts/wk	Isolation cap 0	Isolation cap 10	500	500	0.0000	****	0.0000	****
Shield 2 conts/wk	Isolation cap 0	Isolation cap 25	500	500	0.0000	****	0.0000	****
Shield 2 conts/wk	Isolation cap 10	Isolation cap 25	500	500	0.0194	*	0.0581	ns

Effect of shielding strategy in each isolation capacity scenario (pairwise t-tests)

Isolation_capacity	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
Isolation cap 0	No shielding	Shield 10 conts/wk	500	500	0.0000	****	0.0000	****
Isolation cap 0	No shielding	Shield 2 conts/wk	500	500	0.0000	****	0.0000	****
Isolation cap 0	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.0000	****	0.0000	****
Isolation cap 10	No shielding	Shield 10 conts/wk	500	500	0.0026	**	0.0077	**
Isolation cap 10	No shielding	Shield 2 conts/wk	500	500	0.0001	****	0.0002	***
Isolation cap 10	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.3350	ns	1.0000	ns
Isolation cap 25	No shielding	Shield 10 conts/wk	500	500	0.0089	**	0.0266	*
Isolation cap 25	No shielding	Shield 2 conts/wk	500	500	0.0002	***	0.0007	***
Isolation cap 25	Shield 10 conts/wk	Shield 2 conts/wk	500	500	0.2910	ns	0.8740	ns

Case Fatality Ratio

Summary Statistics

Model	variable	n	mean	sd
Experiment A, null, isocap0, FateD	CFR	500	0.120	0.047
Experiment A, shield 10 conts/week, isocap0, FateD	CFR	500	0.119	0.047
Experiment A, shield 2 conts/week, isocap0, FateD	CFR	500	0.120	0.047
Experiment B, null, isocap10, FateD	CFR	500	0.113	0.045
Experiment B, null, isocap25, FateD	CFR	500	0.112	0.045
Experiment B, shield 10 conts/week, isocap10, FateD	CFR	500	0.105	0.045
Experiment B, shield 10 conts/week, isocap25, FateD	CFR	500	0.100	0.044
Experiment B, shield 2 conts/week, isocap10, FateD	CFR	500	0.105	0.046
Experiment B, shield 2 conts/week, isocap25, FateD	CFR	500	0.100	0.045

Effect of isolation capacity under each shielding strategy (pairwise t-tests)

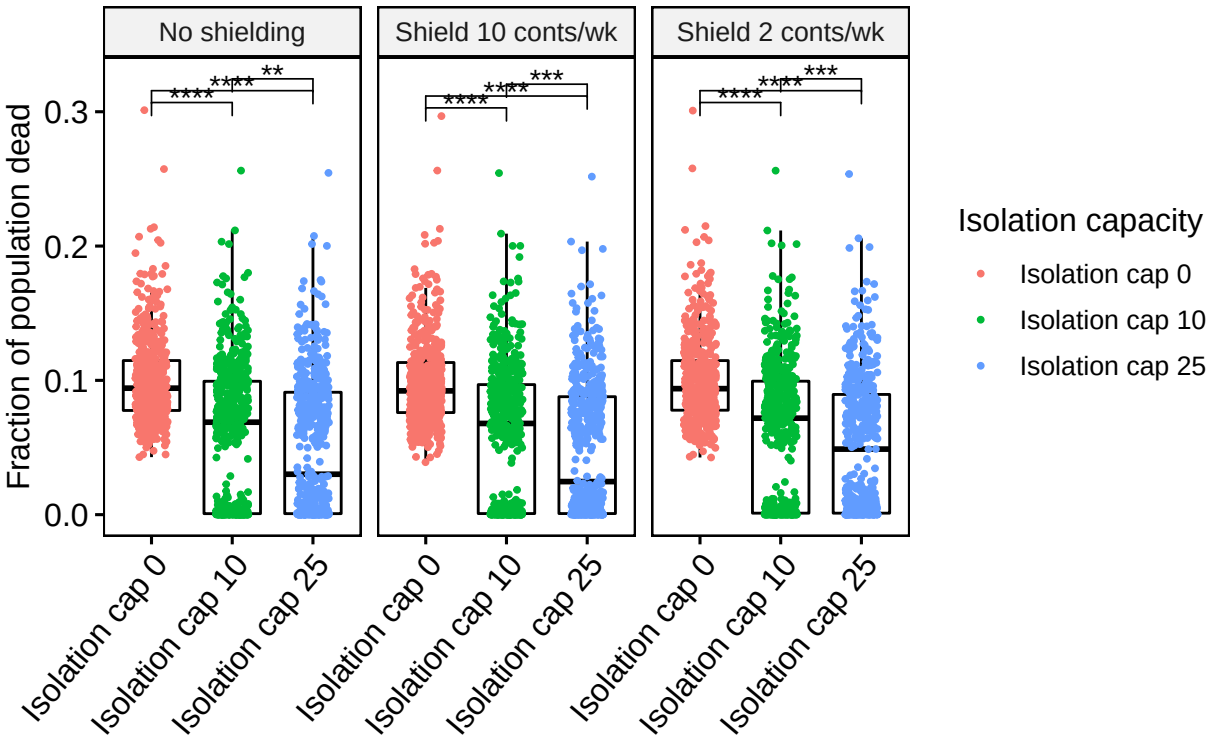
Structure	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
null	isocap0	isocap10	500	500	0.0174	*	0.0521	ns
null	isocap0	isocap25	500	500	0.0035	**	0.0105	*
null	isocap10	isocap25	500	500	0.5870	ns	1.0000	ns
shield 10 conts/week	isocap0	isocap10	500	500	0.0000	****	0.0000	****
shield 10 conts/week	isocap0	isocap25	500	500	0.0000	****	0.0000	****
shield 10 conts/week	isocap10	isocap25	500	500	0.1190	ns	0.3570	ns
shield 2 conts/week	isocap0	isocap10	500	500	0.0000	****	0.0000	****
shield 2 conts/week	isocap0	isocap25	500	500	0.0000	****	0.0000	****
shield 2 conts/week	isocap10	isocap25	500	500	0.0712	ns	0.2140	ns

Effect of shielding strategy in each isolation capacity scenario (pairwise t-tests)

Isolation_cap	group1	group2	n1	n2	p	p.signif	p.adj	p.adj.signif
isocap0	null	shield 10 conts/week	500	500	0.6520	ns	1.0000	ns
isocap0	null	shield 2 conts/week	500	500	0.9980	ns	1.0000	ns
isocap0	shield 10 conts/week	shield 2 conts/week	500	500	0.6500	ns	1.0000	ns
isocap10	null	shield 10 conts/week	500	500	0.0021	**	0.0064	**
isocap10	null	shield 2 conts/week	500	500	0.0054	**	0.0162	*
isocap10	shield 10 conts/week	shield 2 conts/week	500	500	0.7720	ns	1.0000	ns
isocap25	null	shield 10 conts/week	500	500	0.0000	****	0.0001	***
isocap25	null	shield 2 conts/week	500	500	0.0000	****	0.0001	***
isocap25	shield 10 conts/week	shield 2 conts/week	500	500	0.9730	ns	1.0000	ns

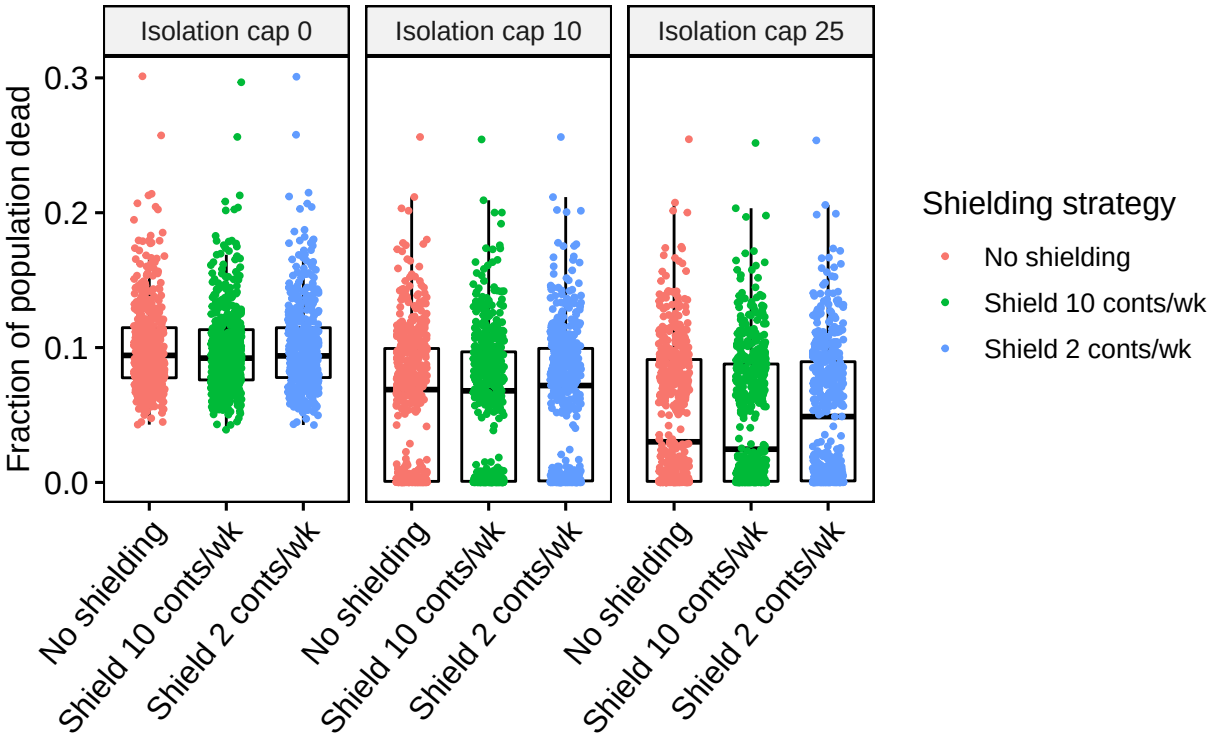
Effect of isolation capacity on deaths from an outbreak

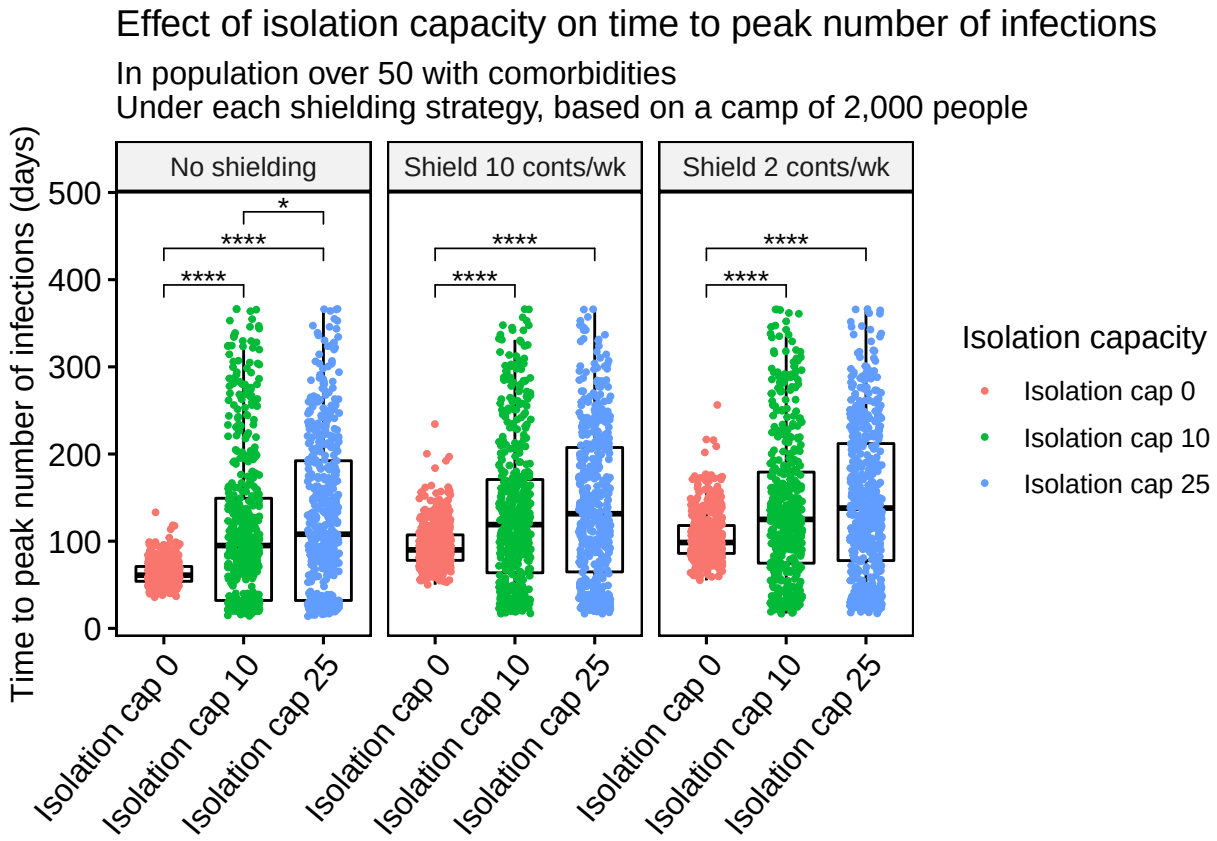
Under each shielding strategy, based on a camp of 2,000 people

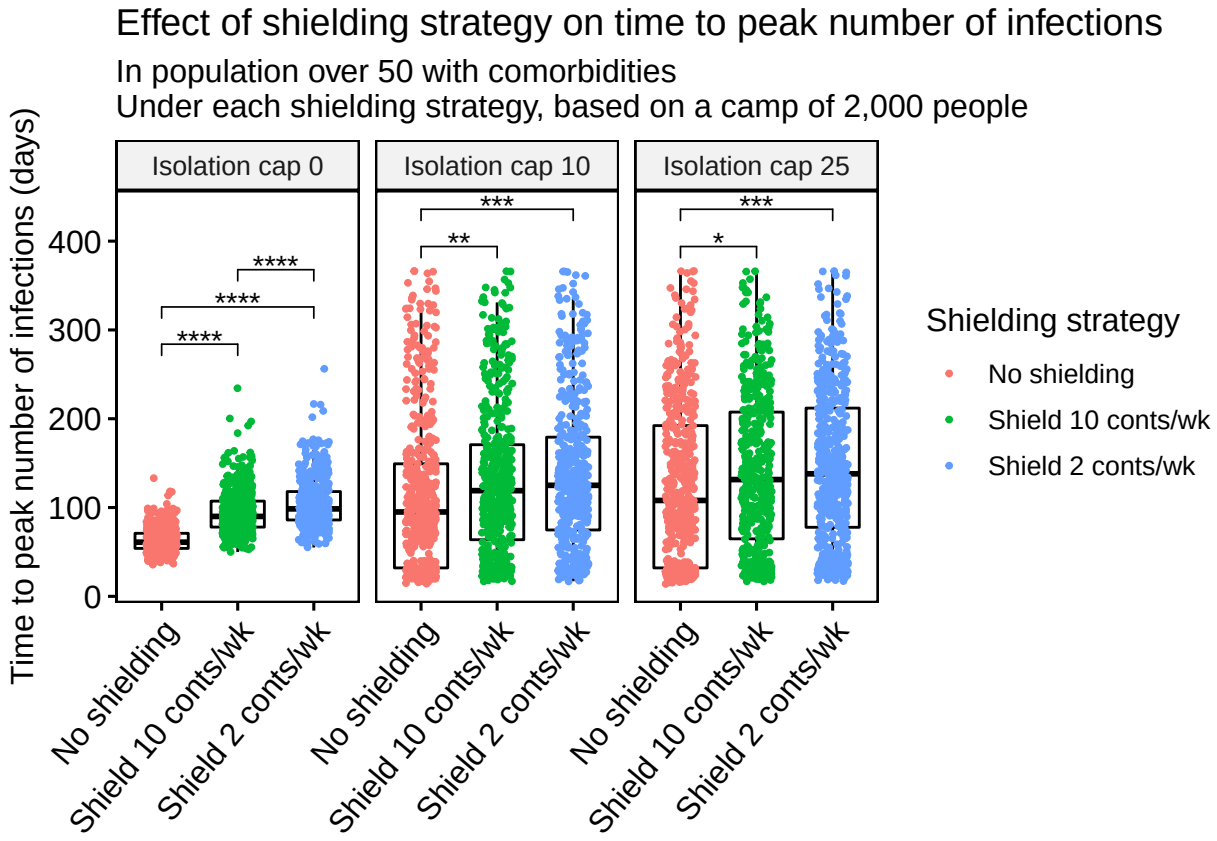


Effect of shielding strategy on deaths from an outbreak

Under each isolation capacity scenario, based on a camp of 2,000 people




Effect of isolation capacity on time to peak number of infections
In population over 50 with comorbidities
Under each shielding strategy, based on a camp of 2,000 people
No shielding
Shield 10 conts/wk
Shield 2 conts/wk
Time to peak number of infections (days)
0
100
200
300
400
500
****
****
*
****
****
****
****
Isolation cap 0
Isolation cap 10
Isolation cap 25
Isolation capacity
Isolation cap 0
Isolation cap 10
Isolation cap 25


Effect of shielding strategy on time to peak number of infections
In population over 50 with comorbidities
Under each shielding strategy, based on a camp of 2,000 people
Isolation cap 0
Isolation cap 10
Isolation cap 25
Time to peak number of infections (days)
0
100
200
300
400
****
****
****
***
**
***
*
No shielding
Shield 10 conts/wk
Shield 2 conts/wk
Shielding strategy
No shielding
Shield 10 conts/wk
Shield 2 conts/wk

Analysis/recommendations

We find that isolation of symptomatic cases is an effective intervention for preventing deaths. The fraction of a camp's population that dies in our models is statistically significantly reduced each time the level of isolation capacity is increased; from 0 to 10 beds per camp of 2,000, and from 10 to 25 beds per camp of 2,000, regardless of the shielding strategy that is implemented. We also find that isolating symptomatic cases should slow down outbreaks. Case isolation significantly delays the date at which infections peak, most importantly in more vulnerable populations such as older individuals and those with comorbidities; any, even a small ammount of case isolation has this delaying effect.

Shielding also significantly slows down outbreaks, especially in vulnerable populations who are being shielded. While any shielding strategy has this delaying effect compared to no shielding, the more close contact between shielded and non-shielded individuals is restricted, the greater this delaying effect is, especially at very low levels of isolation capacity.

Neither of these interventions, isolation or shielding, have an effect on case fatality ratio (CFR) on their own. But, our most important finding is that when implemented together, they irrefutably have a significant effect on reducing the CFR we may expect from an outbreak. It appears that this works by shifting the overall burden of infections away from more vulnerable segments of the population with higher mortality risk from an infection onto less vulnerable segments of the population with lower mortality risk from an infection. This finding highlights the complimentary nature of these two interventions and the necessity of implementing them in tandem.

Based on these findings, with the three goals in mind of 1) Preventing deaths, 2) Reducing the overall case fatality rate, and 3) Buying additional time to improve capacity to manage an outbreak, we recommend the following:
1. Placing a significant focus on increasing isolation capacity as soon as possible, and promptly isolating any individuals with symptoms common to COVID-19 (fever, cough, loss of smell, etc) as soon as the capacity exists to do so.
2. Promplty moving vulnerable people (people aged over 50, people aged 13-50 with comorbidities, and limited numbers of their immediate family members) into shielded "green zones".
3. Using additional time obtained from these measures to further increase isolation capacity, and to improve screening for common COVID-19 symptoms.