The effect of social distance measures on deaths and peak demand for hospital services in England
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LSHTM Modelling Team
Nick Davies, Adam Kucharski, Rosalind Eggo, John Edmunds

Aim: to assess the impact of social distance measures against COVID-19 on the numbers of deaths and demand for hospital services in England.

Methods: We used a stochastic age-structured transmission dynamic model of COVID-19, fitted to the growth phase of the epidemic in Wuhan and adapted to the English population using local contact patterns and local demographics. The impact of the epidemic on inpatient and critical care beds as well as the number of deaths were calculated using agreed "reasonable worst case" severity indicators and lengths of hospital stay. We modelled a number of mitigation measures, which we assumed to be implemented 6-weeks before the median peak incidence and continue until 6 weeks after the peak incidence. We use both optimistic and pessimistic assumptions about the impact of the different measures on contact patterns. Only the optimistic results are shown in this brief report. The measures were: school closure (reduction of POLYMOD "school" contacts to zero); social distancing (reduction of POLYMOD "Work" and "Other" contacts by 50%); cocooning of the Elderly (POLYMOD "work" and "other" contacts are reduced by 75%); home isolation of cases (decreases infectiousness of clinical cases by 35%); a hybrid of School Closure and Social Distancing; the Full package of all four measures.

Results:
The unmitigated epidemic is expected to result in 570,000 deaths (150,000-1,200,000) in England and result in a peak demand of 990,000 non-ICU beds (320,000-1,500,000) and 130,000 ICU beds (43,000-200,000) at peak. Closure of schools is estimated to be the least effective of these policies, reducing peak demand for both ICU and non-ICU beds by about 22% and deaths by 11%. Cocooning of the elderly, general social distances, and case isolatation are all estimated to reduce deaths by about 25%, though social distancing reduces peak demand on hospital services more than the other strategies. The combination of school closure and social distancing is estimated to reduce the peak demand for hospital beds by about 75% and deaths by 32%. The combination of all four interventions reduces demand for hospital beds by about 75% and reduces deaths by about half (table).

	Peak non-ICU beds occupied (thousands)	**Peak ICU beds occupied (thousands)**	**Total deaths (thousands)**
Baseline	990 (320-1500)	130 (43-200)	570 (150-1200)
1- Schools	780 (220-1300)	100 (28-170)	510 (120-1200)
2- Social distance	510 (140-960)	65 (18-120)	410 (96-980)
3- Elderly	770 (250-1200)	91 (30-150)	420 (120-900)
4- Hybrid school + social	260 (49-620)	33 (6.2-79)	390 (69-1000)
5- Home isolation of cases	640 (190-1200)	82 (24-150)	440 (100-1100)
6- Full package	260 (45-520)	33 (5.9-67)	290 (56-900)

Table. Estimated England impact. We assumed the England epidemic impact over time was the same as in Birmingham, but scaled up according to population (i.e. by factor 56m/1.1m).

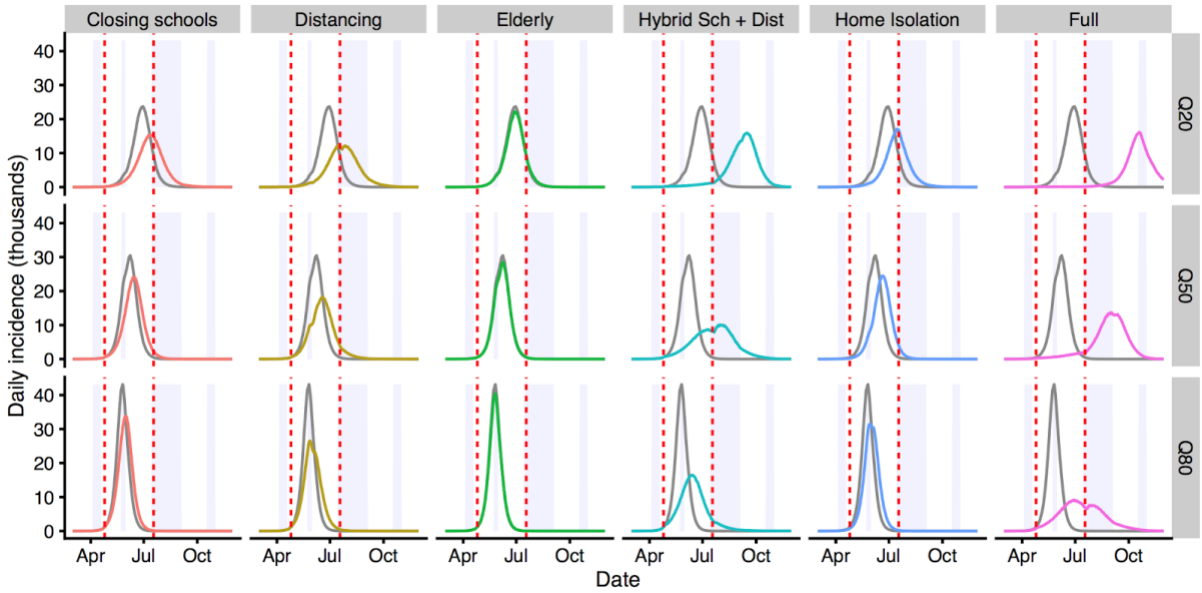

Figure. Intervention scenarios for Birmingham. The red dashed lines mark the intervention time period. Shaded areas are periods of school holidays. Grey is no intervention, and coloured line is the intervention. The upper row shows the lower 20% quantile, the middle the median simulation, and the lower the 80% quantile. This gives some understanding of the uncertainty in the estimates. In a given row, the grey lines are the same and are included so direct comparison is possible.

Discussion: Social distancing measures can have a significant impact on reducing peak demand and deaths. However, their impact is not necessarily additive. For instance the hybrid of social distance and school closures has a similar impact on peak reduction as the combination of all four interventions, as the hybrid strategy results in a longer period of school closure due to the interaction with the school terms and the Full programme results in a large rebound when restrictions are lifted (see figure). This also illustrates that these interventions need to be timed near the peak for maximum effect. Shorter durations of social distancing are less effective and more variable in their impact as their timing is less likely to be optimal (results not shown here). These findings heavily rely on assumptions and are subject to considerable uncertainty.