Added for publication: *Please note that this paper considered a "reasonable worse case" scenario. These results should not be interpreted as a forecast of what is most likely to happen, but rather indicative outputs to inform planning at the time. RWCs are considered for planning to ensure that we are able to respond to a range of scenarios. These modelling outputs are subject to uncertainty given the evidence available at the time, and dependent on the assumptions made.*

MRC Centre for Global Infectious Disease Analysis, Imperial College London **02/03/2020**

Summary indicative effects of non-pharmaceutical interventions (NPIs) to reduce COVID-19 transmission and mortality

Table 1. Relative impact of NPI combinations on cases, deaths and hospital bed demand

	Stopping mass gatherings	Closure of schools and universities, for 13 weeks	Home isolation of symptomatic cases, for 13 weeks, when enacted early	Voluntary household quarantine, for 13 weeks, when enacted early	Social distancing of those over 65 years of age, for 13 weeks (17 weeks for last 3 rows)	Reduction of total cases	Reduction of total deaths	Reduction of peak cases	Reduction of peak deaths	Reduction in peak critical care bed demand	Reduction in peak general ward hospital bed demand	Delay in peak cases (weeks)
Interventions activated	✓					5%	2%	14%	19%	19%	17%	0
		✓				6%	2%	21%	14%	14%	16%	1
			✓			7%	11%	22%	27%	27%	27%	2
				✓		8%	12%	22%	28%	28%	29%	1
		✓	✓	✓		10%	9%	54%	50%	50%	50%	6
					✓	6%	30%	9%	34%	34%	26%	0
			✓		✓	13%	37%	28%	51%	51%	45%	2
			✓	✓	✓	14%	37%	45%	60%	60%	57%	3
		✓	✓		✓	18%	37%	59%	68%	70%	65%	7
		✓	✓	✓	✓	16%	35%	59%	67%	67%	64%	7
	✓	✓	✓	✓	✓	18%	37%	64%	71%	71%	69%	7
Assumptions	Includes shutting, in order of significance, bars/pubs, restaurants, cinemas, night clubs, sporting fixtures, places of worship and theatre. These represent about 12m contact hours of activity per day, or 5.3% of all hours outside home, school or work. Assuming a 3-fold higher risk of transmission than other activities, preventing them might reduce transmission outside household, school or work contacts by 16%.	Schools assumed to completely close, 25% of universities remain open. Household contact rates for student families increased by 50% during closure. Contacts outside the household increase by 25% during closure.	65% of symptomatic cases withdraw to the home for 7 days, reducing non household contacts by 75%. Household contacts unchanged.	Following the identification of a symptomatic case in the household, all other household members withdraw to the home for 14 days. Household contacts double during quarantine, all contact outside the household are reduced by 75%. 50% of households are assumed to comply with the policy.	75% compliance with policy. Those who do comply reduce contacts in schools or workplaces by 50%, increase household contact rates by 25%, but reduce all other contacts by 75%. This policy implies cessation of all activities outside the household (including social contact between different households) bar the essentials. Policy would need to include rigorous infection control in care/nursing homes.							

Notes: All results are for policies adopted for the SAGE/SPI-M approved reasonable worst-case scenario of R_0=2.4, IFR=1%, and associated rates of hospitalisation and critical care. Bed demand modelling has been cross-checked with NHS Executive.

All results shown are indicative and dependent on the assumptions made. about policy impacts on transmission. *Precise predictions are not possible with current data*.

Yellow-shaded rows show the the least intense policies policies giving maximum reduction in total deaths. Green and mauve shaded rows show options giving maximum reduction in bed demand. Mauve row shows most intense policy option. These options increase the duration of social distancing of those over 65 by an additional 30 days to cover a period of a slight rebound in transmission after cessation of other controls.

The definition of mass gatherings used here includes restaurants and bars – which far outweigh sporting fixtures, places of worship, cinema and theatre in terms of person-hours of contact time outside the context of households/schools/workplaces. Leaving bars and restaurants open but closing the other venues listed might only reduce transmission outside the household/school/workplace by ~5%, giving <1/4 of the impacts shown in the top row of this table.

Table 2. Absolute impact of NPI combinations on deaths and bed demand

	Stopping mass gatherings	Closure of schools and universities, for 13 weeks	Home isolation of symptomatic cases, for 13 weeks, when enacted early	Voluntary household quarantine, for 13 weeks, when enacted early	Social distancing of those over 65 years of age, for 13 weeks (17 weeks for last 3 rows)	Total deaths	Deaths in peak week	Critical care bed requirements in peak week	General ward hospital bed demand in peak week
Interventions activated						**488,000**	**98,300**	**101,000**	**890,000**
	✓					443,000	80,000	82,300	735,000
		✓				477,000	84,400	86,800	749,000
			✓			435,000	72,200	74,200	655,000
				✓		427,000	70,400	72,400	632,000
		✓	✓	✓		443,000	49,400	50,800	442,000
					✓	343,000	64,600	66,500	658,000
			✓		✓	305,000	48,000	49,400	490,000
			✓	✓	✓	306,000	38,900	40,000	386,000
		✓	✓		✓	306,000	31,200	29,900	311,000
		✓	✓	✓	✓	315,000	32,400	33,300	318,000
	✓	✓	✓	✓	✓	305,000	28,000	28,800	276,000
Assumptions	Includes shutting, in order of significance, bars/pubs, restaurants, cinemas, night clubs, sporting fixtures, places of worship and theatre. These represent about 12m contact hours of activity per day, or 5.3% of all hours outside home, school or work. Assuming a 3-fold higher risk of transmission than other activities, preventing them might reduce transmission outside household, school or work contacts by 16%.	Schools assumed to completely close, 25% of universities remain open. Household contact rates for student families increased by 50% during closure. Contacts outside the household increase by 25% during closure.	65% of symptomatic cases withdraw to the home for 7 days, reducing non household contacts by 75%. Household contacts unchanged.	Following the identification of a symptomatic case in the household, all other household members withdraw to the home for 14 days. Household contacts double during quarantine, all contact outside the household are reduced by 75%. 50% of households are assumed to comply with the policy.	75% compliance with policy. Those who do comply reduce contacts in schools or workplaces by 50%, increase household contact rates by 25%, but reduce all other contacts by 75%. This policy implies cessation of all activities outside the household (including social contact between different households) bar the essentials. Policy would need to include rigorous infection control in care/nursing homes.				

Notes: All results are for policies adopted for the SAGE/SPI-M approved reasonable worst-case scenario of R_0=2.4, IFR=1%, and associated rates of hospitalisation and critical care. Bed demand modelling has been cross-checked with NHS Executive.

All results shown are indicative and dependent on the assumptions made. about policy impacts on transmission. *Precise predictions are not possible with current data*.

Red shaded row is RWC epidemic without interventions. Yellow-shaded rows show the the least intense policies policies giving maximum reduction in total deaths. Green and mauve shaded rows show options giving maximum reduction in bed demand. Mauve row shows most intense policy option. These options increase the duration of social distancing of those over 65 by an additional 30 days to cover a period of a slight rebound in transmission after cessation of other controls.

Figure 1 shows the temporal profile of the reasonable worst-case scenario, while Figure 2 stratifies cases and deaths by age. Figure 3 shows the impact of the different strategies in the table above on cases and deaths.

Figure 1. Incidence of infections, symptomatic cases and deaths over time (top), and hospital bed requirements (bottom) for the reasonable worst-case scenario with no interventions. Results for England shown. Week zero is the week of maximum case incidence.

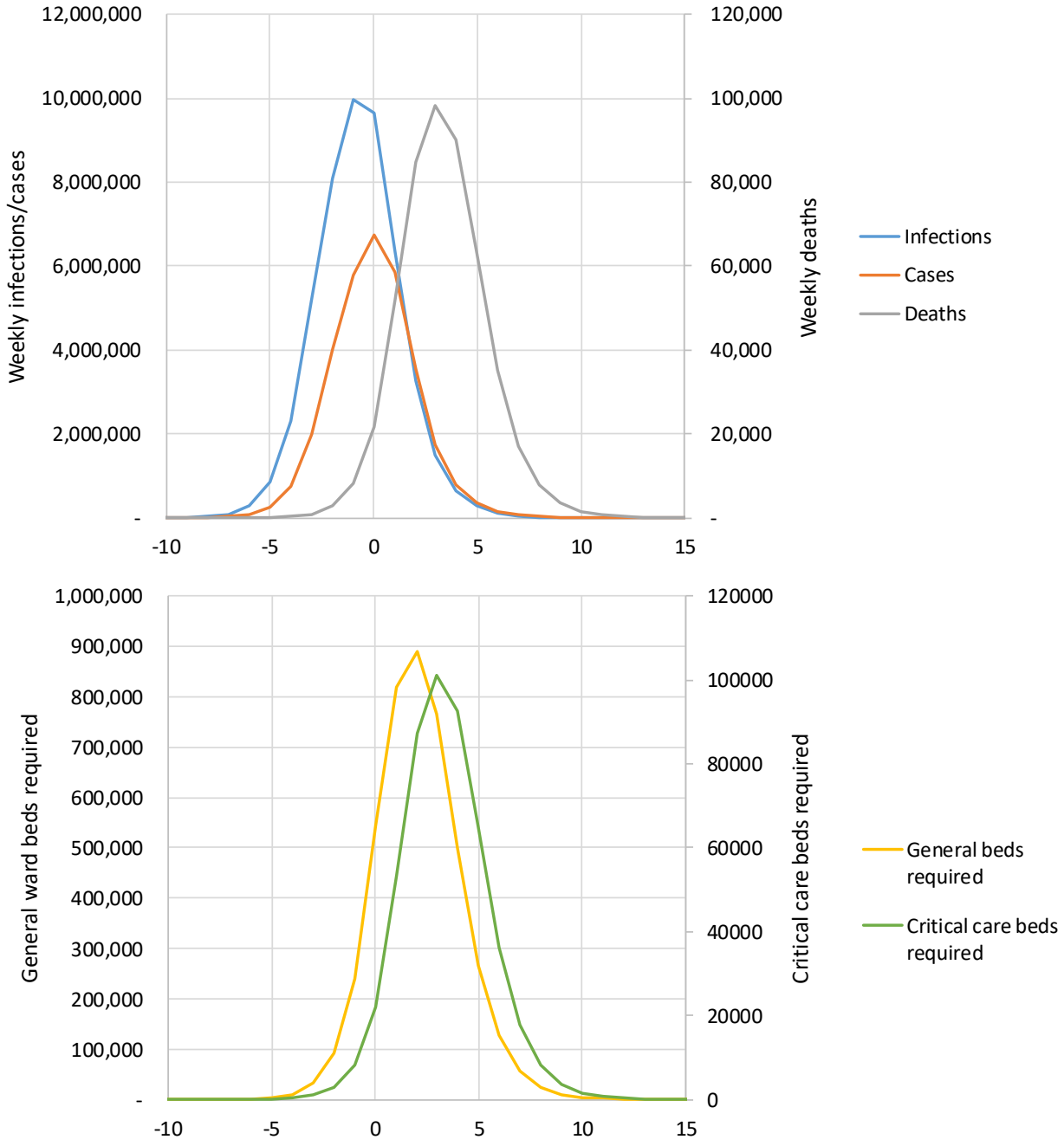

Figure 2. Incidence of symptomatic cases (top) and deaths (bottom) over time stratified by age group for the reasonable worst-case scenario with no interventions. Results for England shown. Week zero is the week of maximum case incidence.

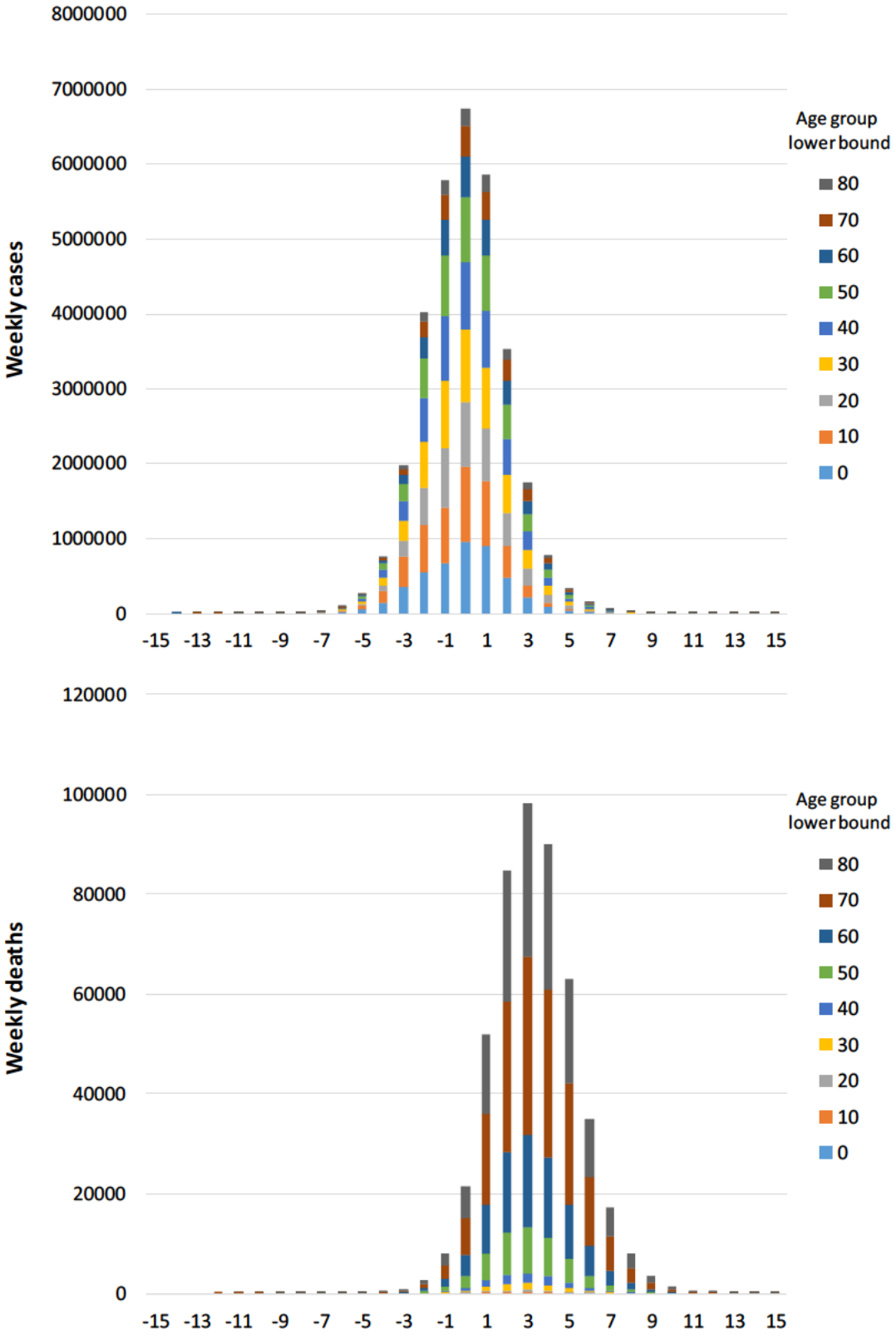

Figure 3. Incidence of symptomatic cases (top) and deaths (bottom) over for the no-intervention scenario and the last 5 intervention scenarios shown in the table. Results for England shown. Week zero is the week of maximum case incidence. MG=closure of mass gatherings, PC=closure of schools and universities, CI=case isolation in the home, HQ=voluntary home quarantine, SDO=social distancing of those aged 65+.