Assessment of tiered restrictions and a second lockdown on COVID-19 deaths and hospitalisations in England: a modelling study

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Abstract

Background

A second wave of COVID-19 cases in Autumn 2020 led to localised, tiered “Alert Level” restrictions and subsequently a second national lockdown in England. We examine the impact of these tiered restrictions and options for lockdowns in terms of stringency, timing and length.

Methods

We fit an age-structured mathematical model of SARS-CoV-2 transmission to seven months of hospital, antibody, virology and death data across seven NHS England regions to project epidemiological dynamics under various scenarios forward to 31 March 2021. We analyse mobility and social contact data from March–October 2020 to estimate the effect of tiered restrictions in England, and of lockdowns of similar stringency to those implemented in Northern Ireland and Wales in October 2020, applied to England.

Findings

From 1 October 2020 to 31 March 2021, a COVID-19 epidemic without tiered restrictions or a lockdown is projected to result in 195,000 (95% credible interval: 192,000–199,000) hospital admissions and 31,800 (30,200–32,500) deaths, with a peak ICU occupancy of 3,030 (2,960–3,130) beds. The introduction of tiered restrictions on 14 October 2020 is projected to reduce the burden to 168,000 (164,000–171,000) hospital admissions and 26,500 (25,400–27,500) deaths with a peak ICU occupancy of 2,460 (2,400–2,530) beds. A four-week Wales-type lockdown with schools open, starting on 5 November 2020—similar to lockdown measures announced in England—is projected to further reduce the burden to 116,000 (114,000–118,000) hospital admissions and 18,200 (17,700–18,700) deaths, with a peak ICU occupancy of 1,770 (1,710–1,840) beds. Closing schools as well would likely further reduce deaths to 15,100 (14,700 - 15,400), but would make very little difference to peak ICU demand (1,740 (1,680 - 1,810)). We find that a lockdown of greater than 4 weeks reduces deaths but does not substantially reduce pressure on hospital services, and that an earlier lockdown reduces deaths and hospitalisations in the short term but leads to a faster resurgence in cases after January 2021.

Interpretation

Lockdown measures consistently outperform less stringent restrictions in reducing cumulative deaths. Amongst the scenarios modelled, the policy adopted in England appears to be a reasonable compromise—given the current epidemiological situation—as it reduces pressure on the health service to a similar extent to longer or more stringent lockdowns, is well-timed to suppress deaths over the winter period and keeps schools open.

Research in Context

Evidence before this study

Numerous studies have modelled the relative effect on SARS-CoV-2 transmission of non-pharmaceutical interventions. We searched PubMed, BioRxiv, and MedRxiv for English-language articles with the search terms ("COVID-19" OR "SARS-CoV-2" OR "coronavirus") AND ("lockdown") AND ("model"). This search returned a total of 676 results, of which 23 were modelling studies that were fitted to data and examined a second round of physical distancing restrictions, such as lockdowns or tiered restrictions. Most of the relevant studies used a model to assess the impact of lockdowns, often on a national scale and occasionally regionally. The two most similar studies considered tiered responses in China and "circuit breakers" in the UK. However, typically the length and/or stringency of the lockdown considered was not varied.

Added value of this study

This study builds upon the existing literature in a number of ways. First, mobility measures and contact survey data are used to estimate behavioural responses following the introduction of tiered restrictions in England and the "firebreak" and "circuit breaker" lockdowns in Wales and Northern Ireland, respectively. Second, the model is fitted to multiple data sources to reconstruct the dynamics of the SARS-CoV-2 outbreak in England from February until October 2020. Finally, policies for managing a second wave of COVID-19 cases are contrasted. Comparisons are made between a baseline scenario (i.e. a counterfactual scenario with no tiered restrictions and no lockdown), implementation of tiered restrictions only, and implementation of different-stringency lockdowns in England, with and without schools open. The effect on cumulative deaths, pressure on health services and time spent under restrictions is explored in relation to the type of intervention implemented and the duration and timing of lockdown interventions. Regional responses to different types, timings and durations of interventions are also explored.

Implications of all the available evidence

Without the additional public health interventions adopted, the second wave is projected to be about as severe as the first wave. The tiered restrictions introduced in October 2020 (in particular Tier 3) were likely to have had some effect in slowing transmission, but the addition of a temporary lockdown provides the strongest effect in reducing deaths and health service burden. Earlier lockdowns save lives in the short-term but because substantial susceptibility remains in the population they may result in larger resurgences later in time, requiring the introduction of further non pharmaceutical interventions.

Introduction

The UK saw a first wave of COVID-19 cases in spring 2020. Following the imposition of a national lockdown on the 23rd March 2020, with residents required to stay at home except for accessing medical care, daily exercise, shopping for essentials and essential work travel, COVID-19 cases, hospitalisations and deaths subsided. A resurgence of COVID-19 cases began in the late summer after most restrictions were lifted. By the end of October, large-scale population-based studies in England suggested there were about 50-100,000 new infections occurring every day[1,2]. This resulted in pressure on health services, with a total of 8,822 confirmed COVID-19 cases in English hospitals on 30 October 2020[3] – about half of that observed during the previous peak in April 2020 – and increasing numbers of deaths. Evidence of substantial geographical heterogeneity began to emerge across England, with a national infection survey suggesting that in late October around 1 in 45 people were infected in the North West, compared to 1 in 200 in the South East[2].

On 12th October 2020, the UK government announced a programme of regionally-differentiated physical distancing measures using a three-tiered approach, known as “Alert Levels”[4]. By default, regions were placed into Tier 1, the least restrictive tier, but could be moved into Tier 2 or 3 if incidence increased. Regions in Tier 1 had a 10pm curfew for hospitality venues and restrictions on the number of individuals who could meet (“the rule of six”). Tier 2 imposed additional restrictions on individuals from different households mixing and advised residents to avoid making unnecessary journeys. Regions in Tier 3 had additional closures of hospitality and leisure venues such as pubs and restaurants. In the weeks following the announcement, the UK government placed several local authority districts—particularly in the north of England— into the highest restriction category, Tier 3. Despite these measures, incidence continued to rise in all regions of England[1,2]. Consequently, on 31 October 2020, a new four-week national lockdown for England was announced, beginning on 5 November 2020. These restrictions were broadly similar to the initial spring lockdown, but allowed schools and universities to remain open. It remains unclear how effective the tiered restrictions were in reducing transmission and what additional reduction in transmission may be accomplished by the second lockdown.

The other UK nations experienced similar resurgences in September and, in response to this, both Northern Ireland and Wales implemented time-limited lockdowns in mid-October. These differed in their stringency, with the “firebreak” measures in Wales being more comprehensive than the “circuit breaker” measures in Northern Ireland. Both lockdowns were timed to coincide with the school half-term vacation period. Here, we analyse mobility and contact survey data to estimate the impact of tiered restrictions and of the lockdowns in Northern Ireland and Wales. We combine this with a mathematical model fitted to multiple detailed data sources to estimate the impact of tiered restrictions and explore alternative scenarios regarding the timing, duration, and stringency of extended physical distancing measures on hospitalisations and deaths due to COVID-19.

Methods

Epidemiological model and fitting

We used a previously-published dynamic compartmental model of SARS-CoV-2 transmission[5,6] stratified into 5-year age bands, and fitted using Markov chain Monte Carlo (MCMC) methods to reported regional data on hospital admissions, hospital and intensive care unit (ICU) bed occupancy, seroprevalence, PCR positivity, and deaths within 28 days of a patient's first positive SARS-CoV-2 test, which is used as the primary measure of COVID-19 mortality in the United Kingdom[7]. Hospital admissions and occupancy data were provided by NHS England and deaths data were provided by Public Health England. These data sources are unpublished and not public, but are closely aligned with the UK Government COVID-19 Dashboard[3]. Seroprevalence data were obtained from the Office for National Statistics COVID-19 Infection Survey (ONS-CIS)[8], UK Biobank[9], and the REACT-2 study[10], and PCR positivity data were obtained from the REACT-1 study[1].

The age-specific probability of ICU admission given hospital admission was estimated using individual patient data from an ongoing study of COVID-19 patients in the United Kingdom, the CO-CIN study[11]. The relative age-specific infection fatality risk (IFR) was adopted from a global meta-analysis[12], and the relative age-specific infection hospitalisation risk (IHR) was adopted from a study of the COVID-19 epidemic in France[13]; given these relative age-specific rates, the overall IFR, IHR and probability of ICU admission given hospitalisation were inferred for each NHS England region during model fitting. We also fitted the average length of stay for COVID-19 patients in hospital and in ICU. The age-specific fatality risk among hospitalised patients decreased substantially over time in CO-CIN data[11], so we estimated this relative decrease during model fitting, assuming no further change in the IFR from September 2020 onwards. A full description of fitted and non-fitted parameters is provided in **Tables S1** and **S2**.

Transmission rates and mobility indices

Because some of the most reliable indicators of infection—hospitalisations and deaths—lag substantially behind transmission rates, it is challenging to estimate the impact of policy and behavioural changes on SARS-CoV-2 transmission in real time. We used anonymised mobility data collected from smartphone users by Google Community Mobility[14] in conjunction with fine-grained social contact survey data, CoMix[15], which has been collecting data on UK residents' daily interpersonal contacts since late March 2020. This allowed us to use indirect but rapidly-available mobility data to predict changes in transmission resulting from behavioural and policy changes over time. We used this approach both in fitting the model to policy changes over the first wave of the COVID-19 epidemic in England, and in estimating the impact of tiered restrictions in England and of the lockdown interventions in Northern Ireland and Wales (see Appendix for full details).

Intervention scenarios

We constructed a number of intervention scenarios. The lockdown in Northern Ireland was less stringent than in Wales. In Northern Ireland non-essential retail remained open and

household bubbles of up to 10 people from two households were allowed to mix, whereas in Wales non-essential retail was closed, residents were advised to stay at home and were prohibited from mixing with individuals from outside their households. We therefore constructed a Northern Ireland-type lockdown scenario and a Wales-type lockdown scenario, both with and without school closures, by applying the measured reduction in mobility in Northern Ireland and in Wales to England. We also varied the duration and timing of the lockdown interventions. Given that the UK Government subsequently opted for a four-week lockdown in England from 5th November 2020, similar to the Welsh lockdown scenario without school closures, we focus on this scenario for our assessment of the impact of a second lockdown in England, examining other possibilities as scenario analyses. By default, we assume that recovery from SARS-CoV-2 infection confers lifelong immunity to reinfection, but we also explore a scenario with waning protection. Additionally, by default we assume that - except for changes imposed by restrictions - contact rates remain constant at levels just before the imposition of the Tier system in October 2020; we also explore a scenario in which seasonal increases in contact patterns result in an increase in transmission over the winter period.

Regarding our analysis of tiered restrictions in England, UK government guidelines state that a local authority will be considered for admission to Tier 2 when the incidence of cases (as detected by tests administered by the NHS (Pillar 1) and commercial partners (Pillar 2)) exceeds 100 new cases per 100,000 population over a period of one week. There is no official guidance on the threshold needed to progress to Tier 3, but inspection of the seven-day case rates in regions that were placed under Tier 3 restrictions suggests a threshold of approximately 300 cases per 100,000 population over a seven-day period. Using ONS estimates for viral prevalence, we estimated that approximately 1 in 7 SARS-CoV-2 infections in the UK is detected by Pillar 1 or Pillar 2 surveillance. We fixed model thresholds for progressing into Tiers 2 or 3 at 700 new infections per 100,000 population and 2,100 new infections per 100,000 population over a seven-day period, respectively. In keeping with stated UK government guidelines, we assumed that tier classifications would be reviewed after 28 days for potential downgrading of a tier (i.e. from Tier 3 or Tier 2 to a lower tier). However, we assumed that regions could move into a higher tier immediately if they passed the threshold for a higher tier before the 28-day review period had passed.

As a sensitivity analysis, we estimated how the effect of interventions might vary under a scenario with a seasonal increase in contact rates and/or with waning immunity to reinfection by SARS-CoV-2. In both cases, we assumed that seasonal increases or waning would start only on 1 October 2020 and carry forward for the rest of the simulation. We assumed that seasonal changes in contact rates were uniform across age groups and followed a sinusoidal curve with an amplitude of 10% (i.e. peak-to-trough difference of 20%), peaking on 1 January 2021, and that waning immunity followed an exponential distribution with an average duration of protection of 40 weeks; estimates for seasonality and waning are adopted from a previous study[16].

Statement on data availability

All analysis code and data are available at https://github.com/nicholasdavies/covid-tiers.

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Ethics

Ethical approval for data collection and analysis by ISARIC4C was given by the South Central-Oxford C Research Ethics Committee in England (reference 13/SC/0149), and by the Scotland A Research Ethics Committee (reference 20/SS/0028). The ISARIC WHO CCP-UK study was registered at https://www.isrctn.com/ISRCTN66726260 and designated an Urgent Public Health Research Study by NIHR.

See appendix for working group authors and acknowledgments.

Results

Our fitted model captures the observed dynamics of community transmission of SARS-CoV-2 during the first wave and resurgence of the COVID-19 epidemic from mid-February to 13 October 2020 (**Fig. 1**), reproducing region-specific observed infections, seropositivity, deaths, hospitalisations, and ICU and hospital bed occupancy (see **Tables S1** and **S2**, and **Figs. S4–S6** for full model fitting results). In addition, the model was capable of accurately predicting the changes in deaths, hospital admissions, beds and ICU beds occupied during the autumn period (**Fig S7**).

Under our base-case assumptions of no waning immunity and no seasonal increase in contacts, and without the imposition of tiered restrictions or of any further intervention, the model suggests that hospital admissions would peak in the North West around mid-November, with other areas peaking somewhat later over the winter period (**Fig. S8**). By the end of such an epidemic around 35-45% of the population in each region might be expected to have been infected (**Fig. 1**). In this baseline scenario, without the introduction of tiered restrictions, the epidemic is projected to result in 195,000 (95% CI: 192,000–199,000) hospital admissions and 31,800 (30,200–32,500) deaths, with a peak ICU occupancy of 3,030 (2,960–3,130) beds (**Table 1**) from 1 October 2020 to 31 March 2021. This compares with our fitted model estimates for the first wave of 127,000 (125,000–128,000) hospital admissions, 36,900 (36,200–37,500) deaths, and a peak ICU occupancy of 3,090 (3,020–3,130) beds up to the end of September. That is, the expected scale of the second wave, without any interventions, is similar to the first on all three of these key metrics. Crucially, this “baseline” scenario for the second wave is not equivalent to a completely unmitigated epidemic, as social contacts have not returned to their pre-pandemic rates in England (**Fig. S1**), and the force of infection is also blunted by immunity acquired during the first wave (**Fig. 1**). There are, however, expected to be considerable differences between regions in the epidemic burden, with the greatest number of admissions and deaths projected for the Midlands, North East and Yorkshire, and North West regions (**Table S3**).

Our analysis of mobility indicators suggests that Tier 3 restrictions are associated with a substantially greater reduction in mobility than Tier 2 restrictions. In turn, both lockdowns are associated with a greater reduction in mobility than Tier 3, with the “firebreak” in Wales having a substantially greater effect than the “circuit breaker” in Northern Ireland (**Table 2**). When we introduce tiered restrictions into our model on 14 October 2020, the projected burden of COVID-19 from 1 October 2020 to 31 March 2021 decreases to 168,000 (164,000–171,000) admissions, 26,500 (25,400–27,500) deaths, and a peak ICU occupancy of 2,460 (2,400–2,530) beds.

The model projects a reduction in transmission across all NHS England regions following the introduction of a four-week Wales-type lockdown (**Fig. 2**), with the closure of schools resulting in additional reductions in transmission. The effective reproduction number (Rt) is suppressed to below one during lockdown periods. In many regions, following the end of the lockdown period, Rt initially increases above 1 before reducing over time. This rebound is because there is insufficient immunity in the population, and so as restrictions are eased, cases increase. In contrast, in the most heavily affected regions (e.g. the North West) the easing of lockdown is not expected to result in a bounce-back of infections as accumulated population immunity

retains Rt <1. We observe similar results (including reduction of Rt below 1 in all regions) upon the introduction of a Northern Ireland-type lockdown (**Fig. S9**), but with weaker effects. The impact of different lockdown options on the effective reproduction number in each of the regions is shown in **Tables S5** and **S6**. The effect on admissions, deaths, ICU burden, and length of time spent under different measures for different lockdown scenarios is shown in **Tables S7** to **S10**. The model predicts that the North West will exceed the peak ICU occupancy observed during the first wave for all four lockdown scenarios considered. The South West is predicted to exceed previous ICU occupancy in the Northern Ireland-type lockdown scenario with schools open.

For the tiers only scenarios (i.e. without a lockdown), Rt decreases over time and remains below the levels expected with the introduction of a lockdown. This difference is due to greater depletion of susceptible individuals compared with a lockdown, because lockdowns reduce infections in the short term and therefore result in less population immunity.

Lockdown measures consistently outperform the baseline and tiered restrictions in reducing cumulative deaths over the time period considered (**Fig. 3a and b**). The higher the stringency of the lockdown, and/or the longer the duration, the greater reduction in deaths. To significantly reduce pressure on the health service at least a Northern Ireland-type lockdown with schools closed (or Wales-type with schools open) seems to be required. Under a Wales-type lockdown with schools open, longer lockdown lengths result in lower numbers of cumulative deaths over time as well as reduced hospital pressure (**Fig. 3b**). However, the impact on hospital pressure is projected to be relatively similar for lockdown lengths between 4 and 6 weeks. Lockdowns also reduce the average amount of time spent in Tiers 2 and 3, illustrating that these interventions trade off against each other (**Fig. 3a** and **b**).

When a lockdown intervention is introduced earlier, the rise in deaths is suppressed sooner (**Fig. 3c**). However, the time horizon for our projections runs until the end of March 2021, and by then we observe that scenarios with earlier lockdown reach a higher cumulative number of deaths. This is because earlier lockdowns result in a longer period of inflated transmission following the end of the period of restrictions. In reality, we expect that additional interventions would be introduced before this level of transmission is reached.

The best timing of a single four-week lockdown, in terms of reductions in deaths and hospital pressure over the period considered, appears to be around November 5th (**Fig. 3c**). The effect on deaths, admissions, cases, infections, hospital burden, ICU burden and the average length of time under restrictions for different intervention strategies and lockdown lengths and lockdown timings for each NHS England region is also explored and shows substantial variation among regions, with the North West, North East and Yorkshire, and Midlands regions experiencing the greatest burdens (**Fig. S10**).

Table 3 shows the results of sensitivity analyses to waning immunity and seasonal increases in contact patterns for the Wales-type lockdown without school closures (as adopted in England). Both waning immunity and increases in mixing due to seasonal factors are expected to exacerbate the second wave. For instance, taking the tiers-only scenario, seasonality is expected to increase demand for hospital beds and deaths by about 20%, waning immunity by about 25-30% and both waning immunity and seasonality by about 55%. The increasing transmission over the winter period, as a result of either or both of these factors, diminishes

the impact of the temporary lockdown, both in absolute and relative terms. For instance, under the baseline scenario the 4-week November lockdown is expected to reduce hospitalisations by about 52,000 over the time frame (October 2020 to March 2021), a 31% reduction. However, if both waning immunity and seasonality occurs, the same temporary lockdown would only be expected to reduce hospitalisations by about 17,000 over the same time period (a 6.5% reduction) as the rebound in infections after the lockdown is more rapid under this scenario (**Figs. S11–S13**).

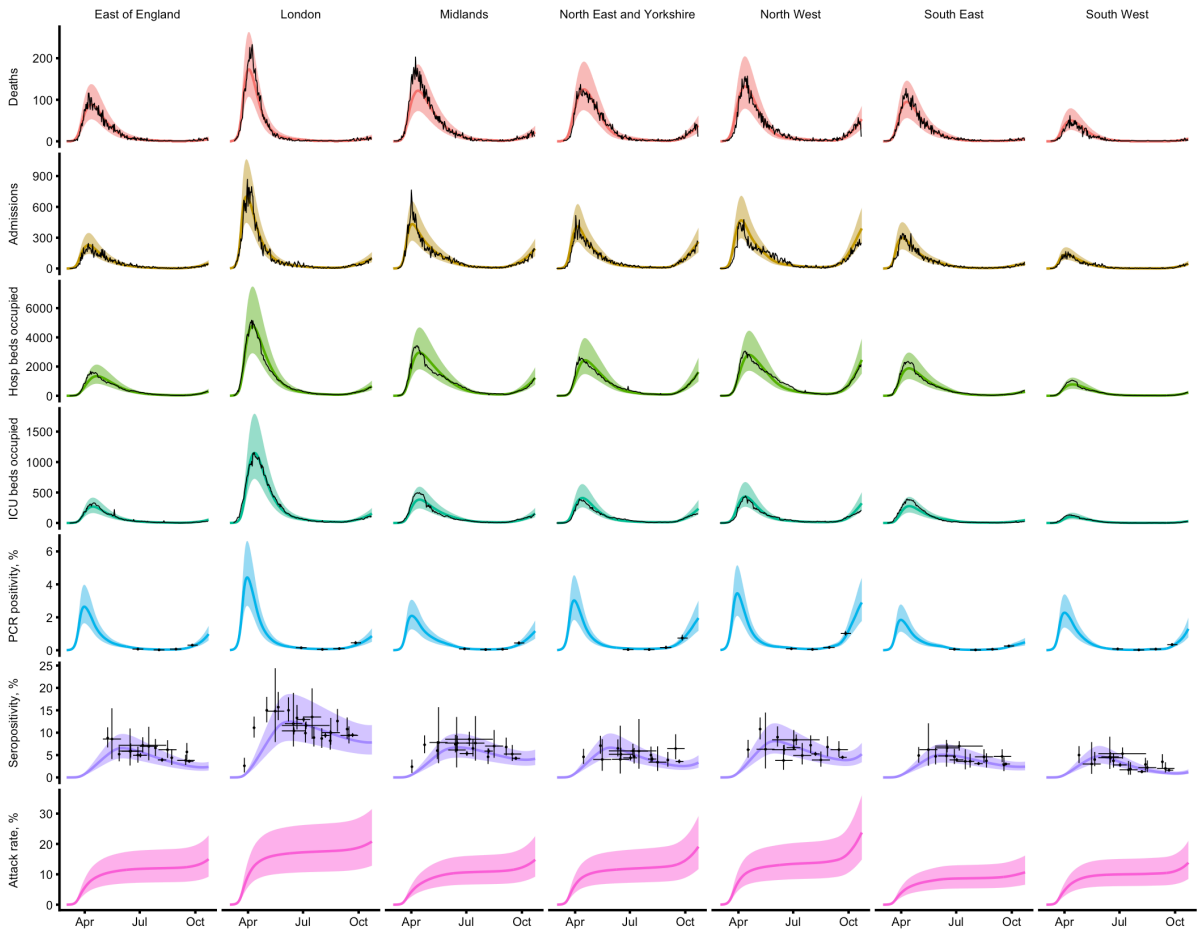

Figure 1. Model fit to region-specific data on the number of COVID-19 deaths, hospital admissions, all occupied hospital beds, occupied ICU beds, and of PCR prevalence and seroprevalence, as well as the implied regional attack rate (% ever infected), from 1 March to 14 October 2020.

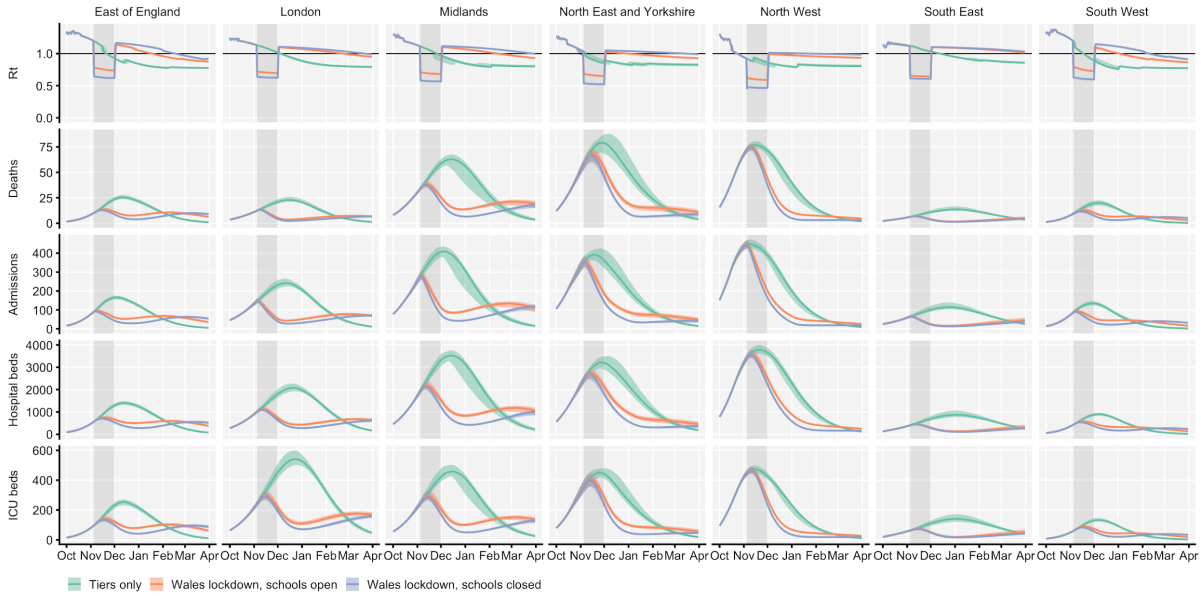

Figure 2. Projected impact of a Wales-type lockdown in England. The effective reproduction number Rt, as well as the daily incidence of deaths and hospital admissions and the daily prevalence of occupied hospital and ICU beds is contrasted across seven NHS regions for three difference scenarios: (i) tiered restrictions only, (ii) Wales-type lockdown with schools open, (iii) Wales-type lockdown with schools closed. Lockdowns extend from 5 November to 2 December 2020. Lines and shaded ribbons give the median and 95% credible interval for plotted quantities, while the shaded background area shows the lockdown period. Step changes in Rt show the introduction or relaxation of tiered restrictions and lockdown measures.

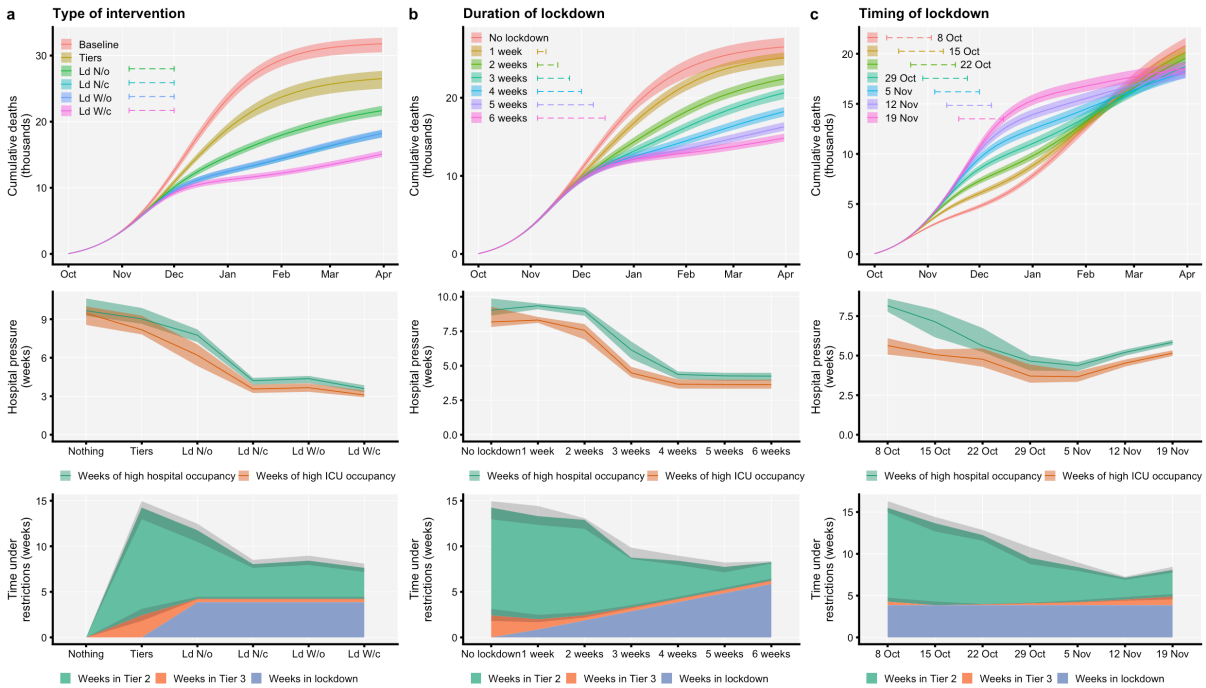

Figure 3. Contrasting alternative intervention strategies. **(a)** Type of intervention: baseline epidemic ("Baseline"), tiered restrictions only (tiers), Northern Ireland-type lockdown with schools open (Ld N/o) or with schools closed (Ld N/c), Wales-type lockdown with schools open (Ld W/o) or closed (Ld W/c). Note that the lines for Ld N/c and Ld W/o closely overlap in the top row. **(b)** Duration of lockdown: with tiered restrictions in place, commencing on 5 November 2020, Wales-type lockdowns with schools open with durations from 0 weeks (No lockdown) to 6 weeks are contrasted. **(c)** Timing of lockdown: four-week Wales-type lockdowns with schools open starting up to four weeks before or two weeks after 5 November 2020 are contrasted. Top row shows cumulative deaths over time under each scenario. Middle row shows hospital pressure, defined as the population-weighted average number of weeks that an NHS region's hospital (green) or ICU (orange) bed occupancy exceeds 50% of the peak occupancy for that region during the first wave of COVID-19 in England. Bottom row shows the expected number of weeks that a random individual in England spends under Tier 2, Tier 3, or lockdown restrictions for each scenario. All panels show medians with shaded regions defining 95% confidence intervals.

Table 1. Model projections, England. Burdens are summed over the period from 1 Oct 2020 to 31 March 2021. Weeks of high ICU occupancy is calculated by measuring the number of weeks in each region where ICU occupancy is 50% or greater than the peak occupancy during the first wave. In this table, weeks in Tier 2, weeks in Tier 3, weeks in lockdown, and weeks of high ICU occupancy are calculated as the population-weighted mean for these values across all 7 NHS England regions. Lockdowns are assumed to run from 5 November – 2 December 2020 inclusively. Medians and 95% projection intervals shown.

Indicator	No interventions	Tiers only	NI-type lockdown, schools open	NI-type lockdown, schools closed	Wales-type lockdown, schools open	Wales-type lockdown, schools closed
Admissions	195,000 (192,000 - 199,000)	168,000 (164,000 - 171,000)	138,000 (135,000 - 141,000)	118,000 (116,000 - 120,000)	116,000 (114,000 - 118,000)	97,100 (95,200 - 98,700)
Deaths	31,800 (30,700 - 32,500)	26,500 (25,400 - 27,500)	21,700 (21,100 - 22,300)	18,200 (17,800 - 18,700)	18,200 (17,700 - 18,700)	15,100 (14,700 - 15,400)
Peak ICU (rel. W1)	98% (96 - 102%)	80% (78 - 82%)	60% (58 - 62%)	57% (56 - 60%)	57% (55 - 60%)	56% (54 - 59%)
Peak ICU requirement	3,030 (2,960 - 3,130)	2,460 (2,400 - 2,530)	1,850 (1,790 - 1,920)	1,770 (1,710 - 1,840)	1,770 (1,710 - 1,840)	1,740 (1,680 - 1,810)
Weeks in Tier 2	0	11.8 (10.6 - 12.5)	7.53 (6.62 - 8.22)	3.8 (3.41 - 3.92)	4.19 (3.76 - 4.65)	3.4 (2.97 - 3.84)
Weeks in Tier 3	0	2.42 (1.81 - 3.13)	0.374 (0.338 - 0.545)	0.374 (0.338 - 0.545)	0.374 (0.338 - 0.545)	0.374 (0.338 - 0.545)
Weeks in lockdown	0	0	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)
Weeks of high ICU occupancy	9.46 (8.61 - 9.98)	8.17 (7.88 - 9.21)	6.2 (5.4 - 6.96)	3.56 (3.33 - 3.83)	3.66 (3.38 - 3.94)	3.1 (2.95 - 3.36)

Table 2. Effect of Tier 2 (England), Tier 3 (England), Northern Ireland lockdown, and Wales lockdown on Google Mobility indices.

Mobility indicator	Tier 2	Tier 3	Northern Ireland-type lockdown	Wales-type lockdown
Grocery and pharmacy	-1.41	-1.98	-0.78	-19.63
Retail and recreation	-1.99	-8.83	-13.87	-41.18
Transit stations	-1.32	-4.62	-9.8	-20.96
Workplaces	-0.36	-2.72	-14.42	-21.72

Table 3. Sensitivity analysis for scenarios with a seasonal increase in contact rates and/or waning immunity. Burdens are summed over the period from 1 Oct 2020 to 31 March 2021. Here, the lockdown scenario uses the assumption of a Wales-type lockdown with schools open. Lockdowns are assumed to run from 5 November – 2 December 2020 inclusively. Seasonal contact patterns and waning protection from reinfection take effect on 1 October 2020. Medians and 95% projection intervals shown.

Indicator	Tiers only	Lockdown	Tiers only + seasonality	Lockdown + seasonality	Tiers only + waning	Lockdown + waning	Tiers only + seasonality + waning	Lockdown + seasonality + waning
Admissions	168,000 (164,000 - 171,000)	116,000 (114,000 - 118,000)	200,000 (196,000 - 204,000)	164,000 (158,000 - 167,000)	217,000 (214,000 - 221,000)	189,000 (182,000 - 192,000)	261,000 (257,000 - 266,000)	244,000 (237,000 - 251,000)
Deaths	26,500 (25,400 - 27,500)	18,200 (17,700 - 18,700)	31,900 (30,700 - 32,700)	25,000 (23,800 - 25,800)	33,400 (32,400 - 34,300)	27,400 (26,100 - 28,300)	41,000 (39,600 - 41,900)	36,300 (34,600 - 37,600)
Peak ICU (rel. W1)	80% (78 - 82%)	57% (55 - 60%)	98% (96 - 100%)	69% (67 - 71%)	91% (90 - 93%)	78% (76 - 80%)	115% (113 - 118%)	97% (95 - 99%)
Peak ICU requirement	2,460 (2,400 - 2,530)	1,770 (1,710 - 1,840)	3,030 (2,970 - 3,080)	2,110 (2,050 - 2,180)	2,820 (2,770 - 2,870)	2,400 (2,340 - 2,470)	3,560 (3,500 - 3,630)	2,970 (2,910 - 3,040)
Weeks in Tier 2	11.8 (10.6 - 12.5)	4.19 (3.76 - 4.65)	10.6 (9.8 - 10.8)	10.3 (9.88 - 10.9)	12.9 (12.4 - 13.4)	14.2 (13.9 - 14.5)	11.1 (10.5 - 11.7)	14.5 (13.8 - 15.4)
Weeks in Tier 3	2.42 (1.81 - 3.13)	0.374 (0.338 - 0.545)	4.78 (4.78 - 5.39)	0.613 (0.524 - 0.695)	4.78 (4.78 - 4.78)	0.54 (0.426 - 0.634)	6.77 (6.77 - 7.39)	2.88 (2.17 - 3.62)
Weeks in lockdown	0	3.86 (3.86 - 3.86)	0	3.86 (3.86 - 3.86)	0	3.86 (3.86 - 3.86)	0	3.86 (3.86 - 3.86)
Weeks of high ICU occupancy	8.17 (7.88 - 9.21)	3.66 (3.38 - 3.94)	11.5 (11.1 - 11.7)	9.22 (8.6 - 9.54)	12.4 (11.9 - 12.7)	10.3 (9.66 - 10.7)	14.5 (14.3 - 14.7)	16 (15.5 - 16.3)

Discussion

Without additional restrictions the second wave of COVID-19 in England is projected to be approximately as severe as the first wave in terms of hospitalisations and deaths. Tiered restrictions, and in particular the most stringent Tier 3, has likely helped to slow transmission, though these restrictions have a much lesser effect on reducing hospitalisations and deaths compared to lockdown scenarios. We projected that a lockdown intervention will likely have a strong but temporary effect, reducing the reproduction number to well below one during the four week lockdown period with a sustained reduction in cases, deaths, and hospitalisations for several months afterwards. After easement of the lockdown we do not expect a large surge in cases if tiered restrictions remain in place, because in most NHS England regions we project that there will be sufficient depletion of susceptibles—given current contact rates—to keep R below or close to one. However, outbreaks could still occur, particularly in previously low incidence areas. If there is a seasonal increase in transmission during winter, substantial waning immunity, or a relaxation in control measures including tiered restrictions, there could be a larger resurgence.

Among the scenarios we considered involving a single lockdown in the context of tiered restrictions, the timing and duration of lockdown as enacted in England is roughly consistent with the largest reduction in deaths and least pressure on the health service. An earlier lockdown could have saved more lives up to the end of January 2021, but may have resulted in a larger resurgence in February and March 2021 in the absence of additional measures (**Fig. 3**). These conclusions are broadly in line with other studies considering the impact of tiered restrictions and lockdown interventions. A network-based study considering the effect of tiered restrictions in China concludes that later implementation of lockdowns and social distancing measures significantly increases the total number of infections[17]. Another study looking at short-term circuit breaker interventions in the UK finds that such interventions have the biggest impact when the growth rate is low. The authors conclude that such interventions are not long-term solutions but can buy time to improve other control measures such as testing, tracing and isolation[18].

We arrived at our conclusions by jointly fitting our age structured transmission model of SARS-CoV-2 to the following data sources: observed hospital admissions, hospital and ICU bed occupancy, seroprevalence, PCR positivity, and deaths. The model fits well to these data streams and predicted the time course of hospitalisations and deaths accurately over the course of the autumn, giving some confidence in the results shown here (**Fig. S7**). However, projecting the epidemic over long time frames is inherently uncertain for many reasons, not least of which being that new interventions (such as mass screening or vaccination) might be introduced. Accordingly, these results should be taken as indicative of what might be expected if current policies remain in place (with a return to tiered restrictions after lockdown) rather than forecasts or predictions. For these reasons, we also chose the end of March as the longest time-scale to model.

Our model is subject to certain limitations and uncertainties, a number of which have previously been discussed in detail[5,6]. First, we do not consider the implementation of any further interventions after the lockdown periods considered, aside from a continuation of tiered restrictions. Second, for the majority of scenarios considered we have assumed that once

individuals have been infected with SARS-CoV-2 and recovered, their immunity is permanent, at least over the time frames modelled. There is emerging evidence to suggest that reinfection with SARS-CoV-2 is possible[19]. At present it is unclear how widespread reinfection events are, on what timescale these reinfection events are expected to occur, and whether reinfection results in greater or lesser severity of disease[20]. Although this is not the main focus of the work, we have explored the effects of introducing seasonal contact patterns and waning protection from reinfection, both of which worsen outcomes (see **Table 3** for the full summary of results). Changes in behaviour are likely to occur over the time frames that we are modelling, particularly over the Christmas period. Behavioural changes are very difficult to predict, and it is possible that there will be a return to more normal behaviours after the lockdown, or indeed a continuation of cautious behaviours, as was observed after the spring lockdown ended. We have not attempted to capture these possible changes, and have assumed that mobility patterns observed in October 2020 remain constant except when they are modified by government interventions, or in our seasonal increase in contacts scenario. An improved understanding of how behaviours might alter in the light of changes in risk and government advice is urgently needed to improve the longer-term accuracy of modelling studies. Finally, it should be stressed that this model only considers direct COVID-19 related morbidity and mortality (and indeed may underestimate the latter due to the use of the UK-standard definition of deaths within 28 days of a patient's first COVID-19 test). There are a range of other COVID-19 related outcomes related to short-term illness and long-term sequelae that we do not consider here. There are also many indirect health effects that can result from disruption to the health service, which our measures of health service pressure are only a rough proxy for. Finally, there are multiple social, psychological, economic and (for children) developmental costs, both in the short and longer term, resulting from interventions. We focus on direct epidemiological implications for COVID-19 and do not attempt to measure wider effects here, but acknowledge that they must be taken into account when deciding on a course of action.

Faced with rising COVID-19 cases and resulting pressure on health systems, countries across Europe have tried to adopt measures that maximise the suppression of transmission whilst minimising social and economic harms. Many have chosen to reintroduce strict measures (lockdowns). In England, the government introduced a second national lockdown starting on 5 November 2020. We estimate that this will reduce COVID-19 deaths and ease the pressure on the health service over the winter of 2020-21. An earlier lockdown would likely have saved more lives in the short-term, but not necessarily if measured over the whole winter. More stringent or lengthy interventions could reduce deaths further, but would have little additional impact on relieving hospital pressures and would carry a heavier social and economic cost.

Contributions

NGD, RCB, and CIJ conducted analyses. All authors contributed to study design and drafting of the manuscript.

Declaration of interests

NGD, and WJE are participants of the Scientific Pandemic Influenza Group on Modelling. WJE and MGS attend the Scientific Advisory Group for Emergencies. All authors declare no competing interests.

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Supplementary Information

Mobility and contact rates

We analysed the relationship between mobility indices for England from the Google Community Mobility report [14] and surveyed social contact rates from the POLYMOD study [21]and the CoMix study[15].

Specifically, we conducted an exploratory analysis to determine which mobility indicators, if any, could be used to predict social contact rates—in home, work, school, or other settings—on a given day. We could not identify a convincing relationship between mobility indices and interpersonal contact in the home or school settings, which were better predicted by simple step functions following the first imposition of lockdown measures in England and school closures. We did, however, identify a clear relationship between workplace contacts reported in CoMix and the "workplace visits" indicator of Google Mobility, and between "other" contacts in social contact surveys and the "retail and recreation", "grocery and pharmacy", and "transit stations" indicators of Google Mobility. We characterised these relationships by fitting generalised additive models (GAM) of workplace and of "other" contacts to Google Mobility indicators using the R package mgcv[22], using workplace visits in Google Mobility as the predictor for workplace contacts in CoMix and using a weighted average of "retail and recreation", "grocery and pharmacy" and "transit station" visits in Google Mobility as the predictor for "other" contacts in CoMix. The optimal weighting of these three indicators was identified by optimising coefficients over the 3-simplex (i.e., 3 non-negative numbers summing to 1) to achieve the maximum deviance explained in the generalised additive model. Baseline levels of contact (those applying in the model prior to the first lockdown in March) were taken from the POLYMOD survey that collected contact data from the UK in 2006[21]. The changes in home and school contacts as a result of lockdown and school closures, and the relationship between workplace and other contacts and Google Mobility data is shown in **Fig. S1**.

We found that the average daily number of home contacts was well described by a step function transitioning from an average of 3.89 home contacts before March 23rd (the date of the first lockdown in the UK) to an average of 1.54 home contacts after March 23rd, with no evidence for substantial changes in the daily number of home contacts following lockdown in the UK (Fig. S1a). The average daily number of school contacts was well described by a step function transitioning from an average of 5.67 school contacts among individuals 18 or younger while schools were open, and zero school contacts when schools were closed (Fig. S1b). The average daily number of work contacts was well approximated by an approximately linear function of the number of "workplace" visits in the Google Mobility dataset, averaged across regions of England, extending from zero workplace contacts when workplace visits were at 23% of the baseline rate or lower, to 2.65 workplace contacts when workplace visits were at 100% of the baseline rate (Fig. S1c). Finally, the average daily number of "other" contacts was well approximated by a curved function of a weighted combination of transit station visits (44.5%), retail and recreation visits (34.5%), and grocery and pharmacy visits (21.0%; Fig. S1d). The particular functions for work and other contacts were obtained using thin-plate regression using the mgcv R package[23], while the coefficients used to weight transit station, retail and recreation, and grocery and pharmacy visits were obtained by optimising a thin-plate regression model for maximum deviance explained over the 3-simplex of potential coefficients summing to 100%.

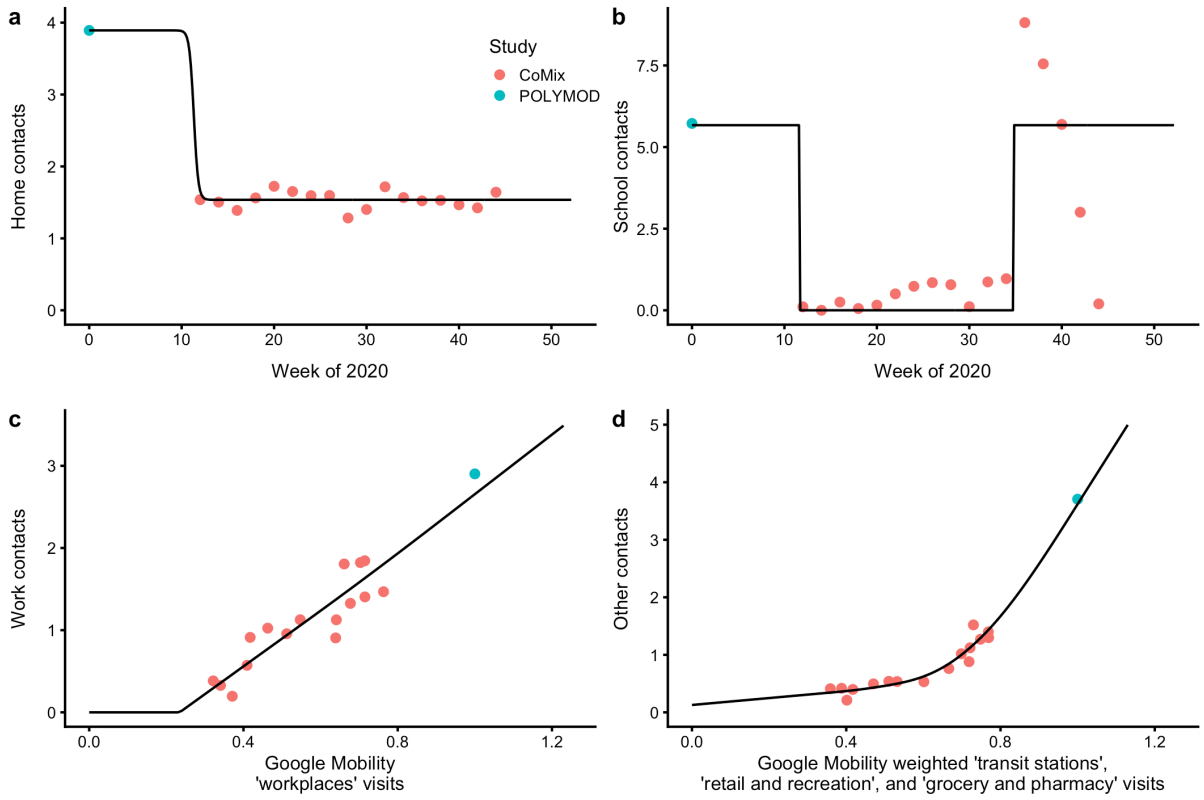

Fig. S1. Analysis of social contact rates during the SARS-CoV-2 epidemic in England. We illustrate the results of our analysis of social contact rates using the POLYMOD and CoMix contact surveys in the UK, using either the calendar date (a, b) or Google Community Mobility indices (c, d) as predictors. Shown are the obtained functions describing (a) home contacts (all individuals), (b) school contacts (among individuals 18 years of age or under), (c) work contacts (among individuals 18 to 65 years old), and (d) other contacts (among all individuals).

Impact of tiered restrictions (alert levels 1–3)

On October 14, 2020, the UK government announced a system of "Alert Level" tiered restrictions to be applied at the local authority level depending upon the local burden of disease. To estimate the impact of these tiered restrictions, we analysed how Google Community Mobility indicators in each region under restrictions (i.e., those in Tier 2 or Tier 3) changed relative to the regions without additional restrictions (i.e., those in Tier 1). We began by isolating Google Community Mobility indicators as a time series extending from 1 September to 27 October 2020, the most recent date available. There were 2,112 trend lines in total, representing six indicators for residential, workplace, park, grocery and pharmacy, retail and recreation, and transit station visits for each of 352 local regions tracked by Google Community Mobility in England. There was a substantial day of week effect in all trend lines, which we removed by fitting a generalised additive model to estimate the weekday effect using the mgcv R package, fitting a cyclic spline with 7 knots — one for each day of the week — to each trend line (i.e., for each region and indicator available), and then subtracting this effect from each trendline. We then estimated a national trend for each of the six indicators using a generalised additive model with thin-plate spline regression and subtracted this national trend from the trend lines with weekday effects removed. Finally, for each trend line, we estimated a "baseline" value by taking the mean mobility index over the last seven days of data prior to the start of tiered restrictions, i.e. from 7 to 13 October 2020. We estimated the effect of each

tier on mobility indices by comparing, for each region and mobility indicator, the difference between the baseline value and the mean mobility index over all days for which the region was under a given tier. This yielded 299 point estimates of the impact of Tier 1 relative to baseline, 104 point estimates of the impact of Tier 2 relative to baseline, and 35 estimates of the impact of Tier 3 relative to baseline, for each of the six indicators (Fig S2). We used the mean difference between Tier 2 and Tier 1 and the mean difference between Tier 3 and Tier 1 in these point estimates as a measure of the impact of Tiers 2 and 3 on mobility.

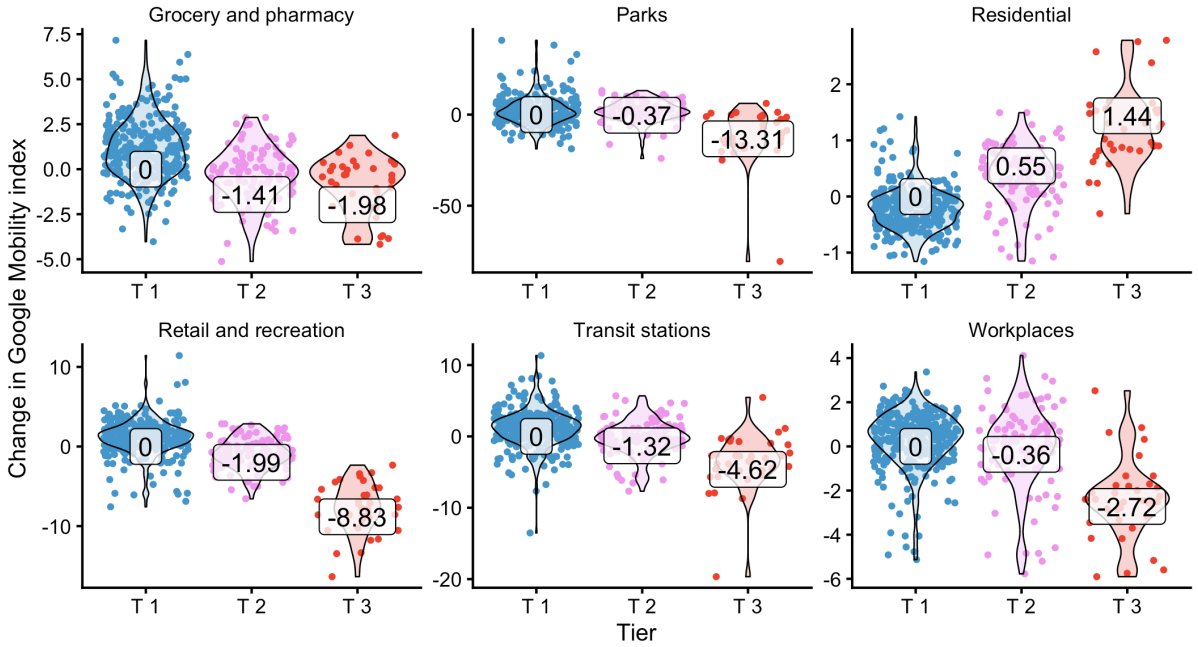

Fig. S2. Impact of tiered restrictions on mobility indices as measured by Google. Points show the individual within-region estimates of the impact of each tier relative to a pre-tiers baseline, with violin plots showing the distribution of points. Labelled values represent the difference between the mean of each respective tier effect and the mean of the tier effect for Tier 1, which we use to estimate an impact on mobility for Tiers 2 and 3 relative to Tier 1. Note that the Parks and Residential mobility indices are not used to inform changes in contact rates in our analysis.

Impact of lockdown restrictions in Northern Ireland and in Wales

In order to estimate the potential impact of lockdown restrictions in England, we used Google Community Mobility indices to estimate the impact of lockdown restrictions that were imposed in Northern Ireland from 16 October 2020 and in Wales from 23 October 2020. We began by averaging across the mobility indices for each local region in Northern Ireland and in Wales to obtain an overall mobility index for each country. Then, we compared each mobility index for each day during the lockdown periods (17 – 27 October in Northern Ireland, 24 – 27 October in Wales) to the value either two weeks prior (Northern Ireland) or one week prior (Wales) to account for any weekday effects. The average difference for each indicator and country was assumed to capture the impact of lockdown restrictions in Northern Ireland and in Wales (Fig. S3). We found a substantially greater impact of lockdown restrictions in Wales as compared to Northern Ireland.

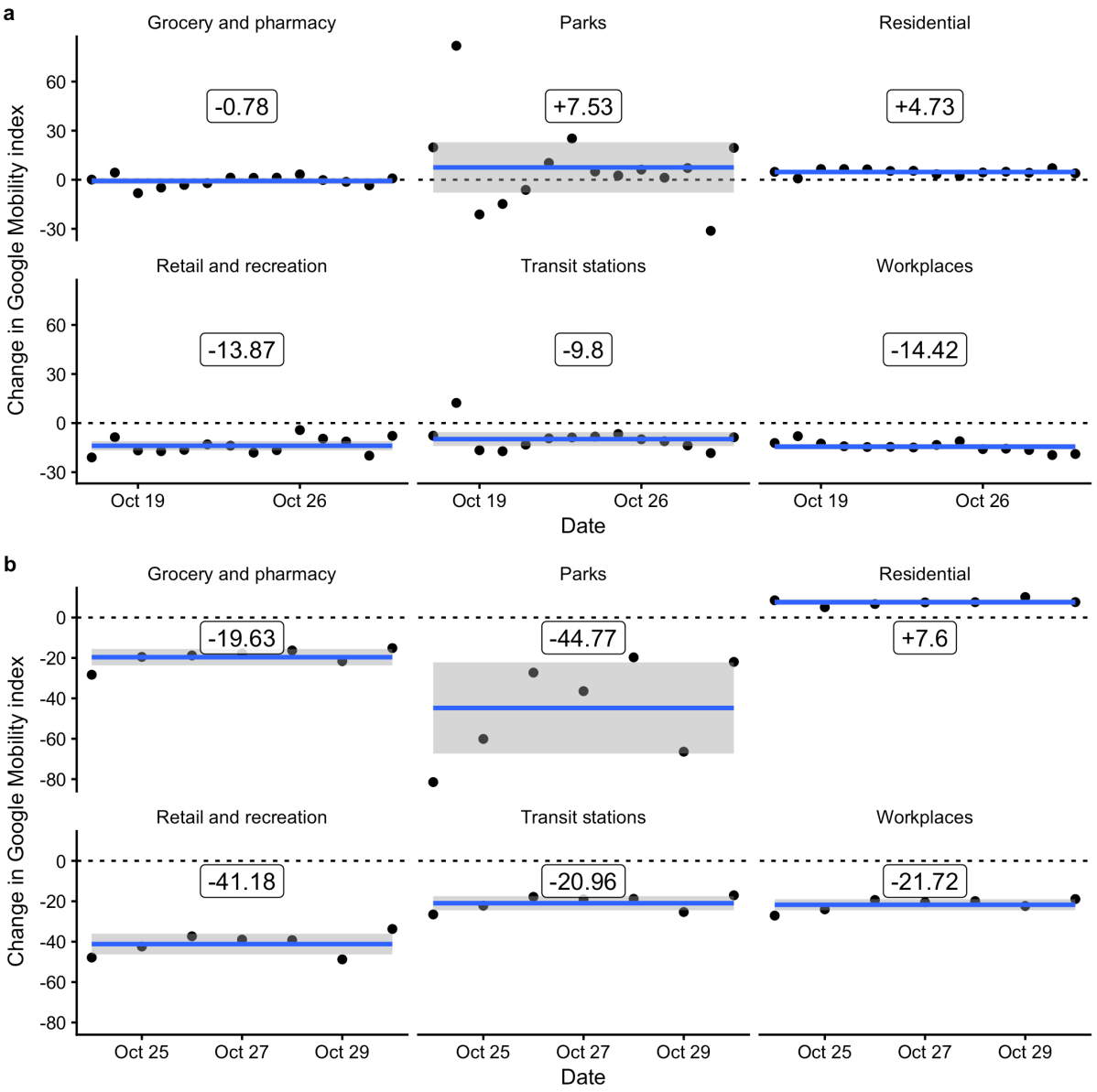

Fig. S3. Estimated mean change in mobility indices following lockdown restrictions imposed in (a) Northern Ireland and (b) Wales. Points show effects for individual days, while lines and shaded regions show mean effect and standard error of estimate. Note that the Parks and Residential mobility indices are not used to inform changes in contact rates in our analysis.

Model fitting

To fit the model to data on deaths, hospital admissions, hospital bed and ICU bed occupancy, PCR positivity, and seroprevalence for each of the 7 NHS England regions, we performed Bayesian inference using Markov chain Monte Carlo, employing the Differential Evolution MCMC algorithm[24]. For each posterior sample, we simulated epidemics from 1 January to 24 October 2020, using data that were current as of 23 October 2020. We used Google Community Mobility data up to 18 October 2020 to capture how interpersonal contact rates changed over the course of the epidemic, as detailed above.

As part of model estimation, we separately fit for each region: the start time of community transmission; the basic reproduction number R_0 prior to any changes in mobility or closure of schools; the delay from infection to hospital admission, to ICU admission, and to death; the length of stay in hospital and in ICU; a region-specific relative probability of hospital admission and of ICU admission given hospitalisation; the relative infection fatality ratio at the start and at the end of the simulation period, as fatality due to COVID-19 has dropped substantially over time in the UK; the delay between hospital admission and confirmation of SARS-CoV-2 infection and how this changed over time, as at the beginning of the epidemic there were substantial shortages of hospital testing capacity; a decreasing rate of effective contact between individuals over time, representing better practices of self-isolation and precautions against infection taken by individuals over the course of the year; the duration of antibodies as measured in seroprevalence studies, which was assumed to affect measured levels of seroprevalence but not immunity to SARS-CoV-2 (which we assumed in our base case was long-lasting); coefficients determining the relative mobility of younger people, around age 20, relative to the rest of the population, for the months of July, August, and September onwards; and the magnitude and timing of a boost to R_0 around the end of summer, which we hypothesize is related to the opening of schools, but which was not fully captured in our model by the resumption of school-specific contacts on September 1st. Full details of all fitted parameters, along with prior distributions assumed for each parameter, are in **Table S1**.

We use two parametric functions extensively in parameterising the model. The first,

$$logistic(x) = (exp\ x)/(1 + exp(x))$$

is the standard logistic curve. The second,

$$asc(x, y_0, y_1, s_0, s_1) = y_0 + (y_1 - y_0)(logistic(s_o + x(s_1 - s_0)) - logistic(s_0))/(logistic(s_1) - logistic(s_0))$$

is a logistic-shaped curve parameterized to be a smooth S-shaped function of x from 0 to 1, which goes from y_0 at x = 0 to y_1 at x = 1, with an inflection point at $x = -s_0/(-s_0 + s_1)$ if $s_0 < 0$ and $s_1 > 0$.

Basic epidemiological parameters were broadly informed from the literature and previously reported. We assumed an average incubation period for SARS-CoV-2 of 5 days[25], an average infectious period of 5 days[5], with roughly half of transmission from symptomatic individuals occurring before symptom onset[26] and an age-specific susceptibility to infection according to a previously-published analysis of case data from 6 countries[6]. All parameters that we adopted as assumptions are given in **Table S2**.

Table S1. Details of fitted parameters

Parameter	Description	Prior distribution	Notes
tS	Start date of epidemic in days after 1 January 2020	$\sim uniform(0,60)$	Determines date at which seeding begins in region; starting on this date, one random individual per day contracts SARS-CoV-2 for 28 days
u	Basic susceptibility to infection	$\sim normal(0.07,0.01)$	Determines basic reproduction number R_0
death_mean	Mean delay in days from start of infectious period to death	$\sim normal(15,2)$	Prior informed by analysis of CO-CIN data
death_shape	Shape parameter of gamma distribution for delay from start of infectious period to death	$\sim normal(1.9,0.2)$	Prior informed by analysis of CO-CIN data
admission	Mean delay in days from start of infectious period to hospital admission	$\sim normal(7.5, 1)$	Delay is assumed to follow a gamma distribution with shape parameter 0.71. Prior and shape of distribution informed by analysis of CO-CIN data.
nonicu_los	Mean length of stay in hospital	$\sim normal(8, 0.5)$	Length of hospital stay is assumed to follow a log-normal distribution with coefficient of variation 1.35. Prior and shape of distribution informed by analysis of CO-CIN data.
icu_admission	Mean delay in days from start of infectious period to ICU admission	$\sim normal(11.1, 1)$	Delay is assumed to follow a gamma distribution with shape parameter 1.91. Prior and shape of distribution informed by analysis of CO-CIN data.
icu_los	Mean length of stay in ICU	$\sim normal(10, 0.5)$	Length of ICU stay is assumed to follow a log-normal distribution with coefficient of variation 1.31. Prior and shape of distribution informed by analysis of CO-CIN data.
hosp_rlo	Log-odds of hospital admission, relative to age-specific probabilities of hospital admission given infection derived from Salje et al. [REF].	$\sim normal(0, 0.1)$	Based on Salje et al.[13], we assumed that the basic shape of the age-specific probability of hospitalisation given infection was $logistic(-7.37 + 0.068a)$, where *a* is the individual's age in years. This overall relationship is then adjusted according to the hosp_rlo parameter.
icu_rlo	Log-odds of ICU admission, relative to age-specific probabilities of ICU admission given hospital admission derived from CO-CIN data.	$\sim normal(0, 0.1)$	We fit a spline to CO-CIN data on hospital admission and ICU admission by age to derive the basic age-specific probability of ICU admission, which was then adjusted based on the icu_rlo parameter.
cfr_rel	Relative fatality rate of COVID-19 at beginning of 2020	$\sim normal(1, 0.05)$	Based on Levin et al.[12], we assumed the basic shape of the age-specific infection fatality ratio of SARS-CoV-2 was $logistic(-7.56 + 0.121a)$ (see entry for hosp_rlo). This is multiplied by cfr_rel to adjust the fatality rate for each region.
cfr_rel2	Relative fatality rate of COVID-19 at end of 2020	$\sim normal(0.45, 0.01)$	Based on CO-CIN data[11], we estimated that the mortality rate of COVID-19 decreased by approximately 55% by September 2020 relative to the beginning of the year. The product of cfr_rel and cfr_rel2 gives the mortality rate by September. Specifically, the IFR is multiplied by a factor $asc(t/$

			$366, cfr\_rel, cfr\_rel \times cfr\_rel2, -2.9, 7.8)$ where *t* is the time in days since 1 January 2020.
`contact_final`	Relative rate of effective contact at end of 2020	$\sim normal(1, 0.1)$ ≤ 1	To capture continued low incidence of SARS-CoV-2 infection in spite of rising contact rates as shown by mobility data and social contact surveys, we assume that the effective contact rate over time is multiplied by a factor $asc(t/366, 1, contact_{final}, -contact_{s0}, contact_{s1})$, where *t* is time in days since 1 January 2020.
`contact_s0`	Parameter for curve specified by `contact_final`	$\sim exponential(0.1)$	
`contact_s1`	Parameter for curve specified by `contact_final`	$\sim exponential(0.1)$	
`detect1`	Delay from hospital admission to positive test at beginning of 2020	$\sim halfnormal(0, 100)$	To capture substantial delays in testing at the beginning of the epidemic in the UK, we assume that the delay from hospital admission to confirmed SARS-CoV-2 infection is $asc(t/366, detect_1, detect_2, -detect_{s0}, detect_{s1})$, where *t* is time in days since 1 January 2020.
`detect2`	Delay from hospital admission to positive test at end of 2020	$\sim halfnormal(0, 0.25)$	
`detect_s0`	Parameter for curve specified by `detect1` and `detect2`	$\sim halfnormal(0, 20)$	
`detect_s1`	Parameter for curve specified by `detect1` and `detect2`	$\sim halfnormal(0, 20)$	
`waning`	Duration of SARS-CoV-2 seropositivity in days	$\sim normal(150, 100)$	We do not assume seroreversion results in lack of immunity to SARS-CoV-2 infection, but explore alternative scenarios with loss of immunity in sensitivity analyses.
`concentration1`	Increased contact among young people in July	$\sim normal(2, 0.5)$ ≥ 2	Because initial increases in SARS-CoV-2 prevalence from July in England were especially apparent in young people, we allow increases in mobility to be more emphasized in young people starting from July. We model a relative contact-rate multiplier for individuals of age *a* as $beta(a/100 \mid \alpha = 0.2(k-2)+1, \beta = 0.8(k-2)+1)$, where *k* is the concentration parameter and *beta* is the beta distribution probability density function. This gives flat contact rates across age groups when $k = 2$, and relatively higher contact rates in individuals around age 20 when $k > 2$.
`concentration2`	Increased contact among young people in August	$\sim normal(2, 0.4)$ ≥ 2	
`concentration3`	Increased contact among young people from September	$\sim normal(2, 0.2)$ ≥ 2	
`sep_boost`	Increase in transmission around 1 September 2020	$\sim normal(1, 0.05)$	After the date specified by `sep_when`, transmission is multiplied by the factor `sep_boost`. This is to capture a sudden increase in transmission rates observed around 1 September in England.
`sep_when`	Date of increase in transmission	$\sim uniform(224, 264)$ (i.e. 12 Aug–21 Sep)	

Table S2. Model parameters not subject to fitting.

Parameter	Description	Value	Reference
d_E	Latent period (E to I_P and E to I_S; days)	$\sim gamma(\mu = 2.5, k = 4)$	Set to 2.5 so that incubation period (latent period plus period of preclinical infectiousness) is 5 days [25]
d_P	Duration of preclinical infectiousness (I_P to I_C; days)	$\sim gamma(\mu = 2.5, k = 4)$	Assumed to be half the duration of total infectiousness in clinically-infected individuals [26]
d_C	Duration of clinical infectiousness (I_C to R; days)	$\sim gamma(\mu = 2.5, k = 4)$	Infectious period set to 5 days, to result in a serial interval of approximately 6 days[27–29]
d_S	Duration of subclinical infectiousness (I_S to R; days)	$\sim gamma(\mu = 5.0, k = 4)$	Assumed to be the same duration as total infectious period for clinical cases, including preclinical transmission
y_i	Probability of clinical symptoms given infection for age group *i*	Estimated from case distributions across 6 countries	[6]
f	Relative infectiousness of subclinical cases	50%	Assumed[5,6]
c_{ij}	Number of age-*j* individuals contacted by an age-*i* individual per day, prior to changes in mobility	UK-specific contact matrix	[21]
N_i	Number of age-*i* individuals	From demographic data	[30]
Δt	Time step for discrete-time simulation	0.25 days	
$P(ICU)_i$	Proportion of hospitalised cases that require critical care for age group *i*	Estimated from CO-CIN data	[11]

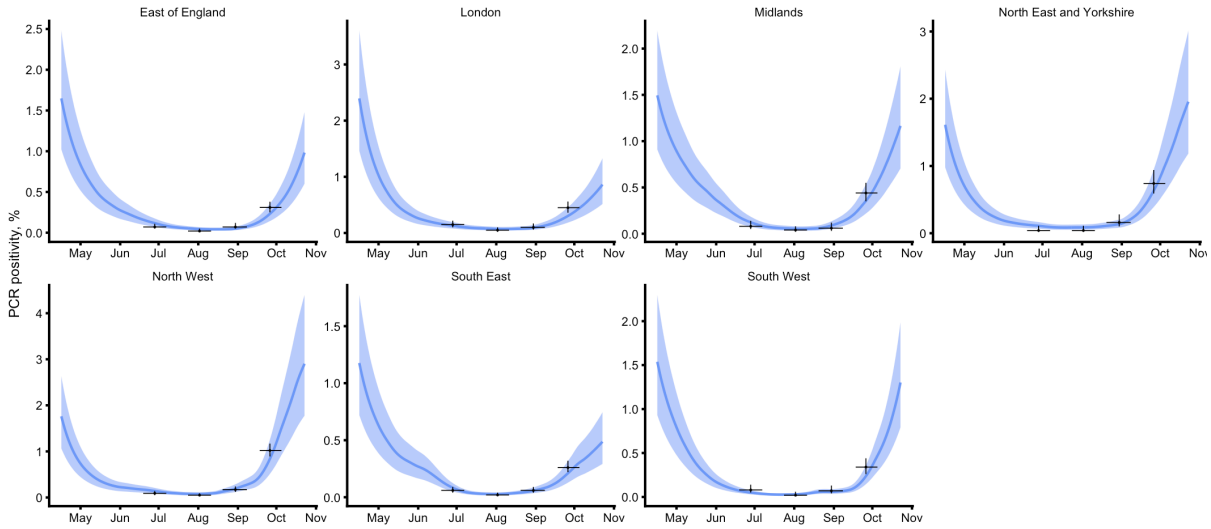

Fig. S4. PCR positivity from model fitting. This is an enlarged version of PCR positivity from Fig. 1, main text. Vertical bars represent 95% confidence intervals for data, horizontal bars represent span of dates measured.

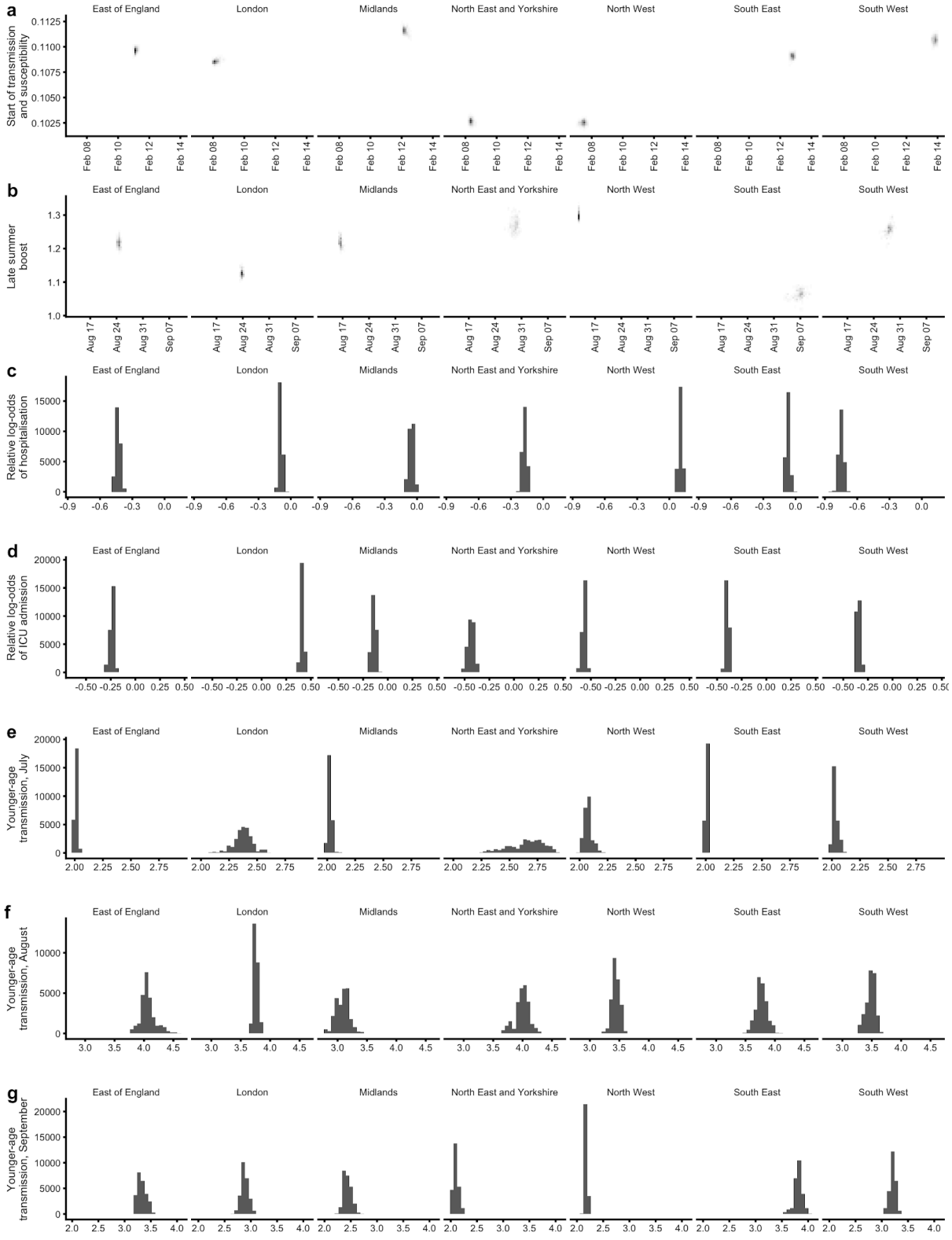

Fig S5. Posterior distributions from model fitting, pt. 1. See Table 2 for parameter definitions: **(a)** `t_S` (x axis) and `u` (y axis); **(b)** `sep_when` (x axis) and `sep_boost` (y axis); **(c)** `hosp_rlo`; **(d)** `icu_rlo`; **(e)** `concentration1`; **(f)** `concentration2`; **(g)** `concentration3`.

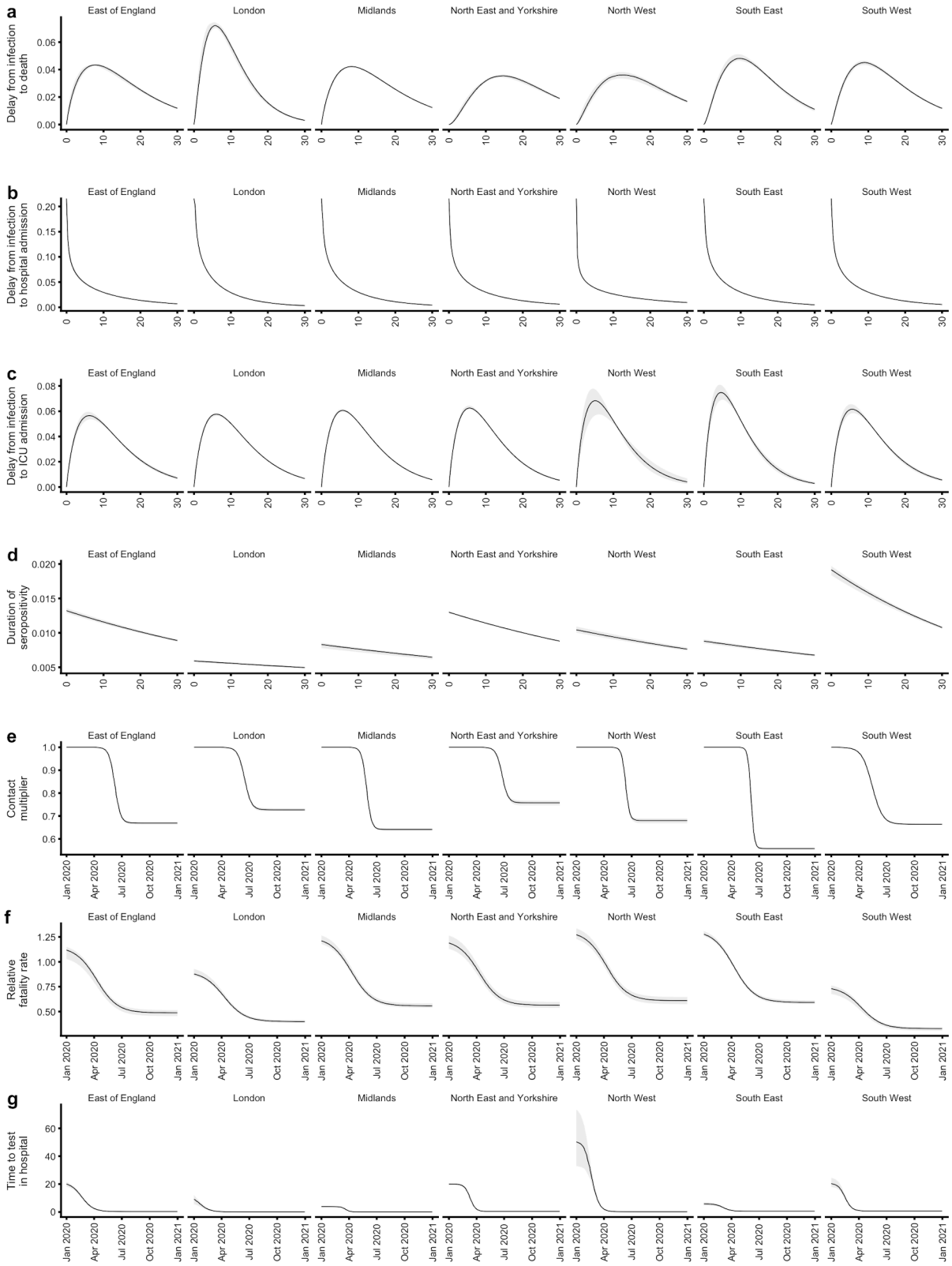

Fig S6. Posterior distributions from model fitting, pt. 2. See Table 2 for parameter definitions: **(a)** `death_mean`, `death_shape`; **(b)** `admission`; **(c)** `icu_admission`; **(d)** `waning`; **(e)** `contact_final`, `contact_s0`, `contact_s1`; **(f)** `cfr_rel`, `cfr_rel2`; **(g)** `detect1`, `detect2`, `detect_s0`, `detect_s1`.

PCR positivity

We obtained estimates for the probability of testing PCR positive on a given day since infection from an unpublished study which included both symptomatic and asymptomatic individuals. We assumed that the time from infection to PCR positivity and the time from PCR positivity to loss of PCR positivity were uncorrelated, and could each be described by a separate gamma distribution with a mean and shape parameter to be estimated. Adopting uniform priors for the mean and shape of both gamma distributions, we performed Bayesian inference using MCMC to estimate the parameters of both gamma distributions, which yielded an average duration of PCR positivity of 8.5 days.

Supplementary Figures

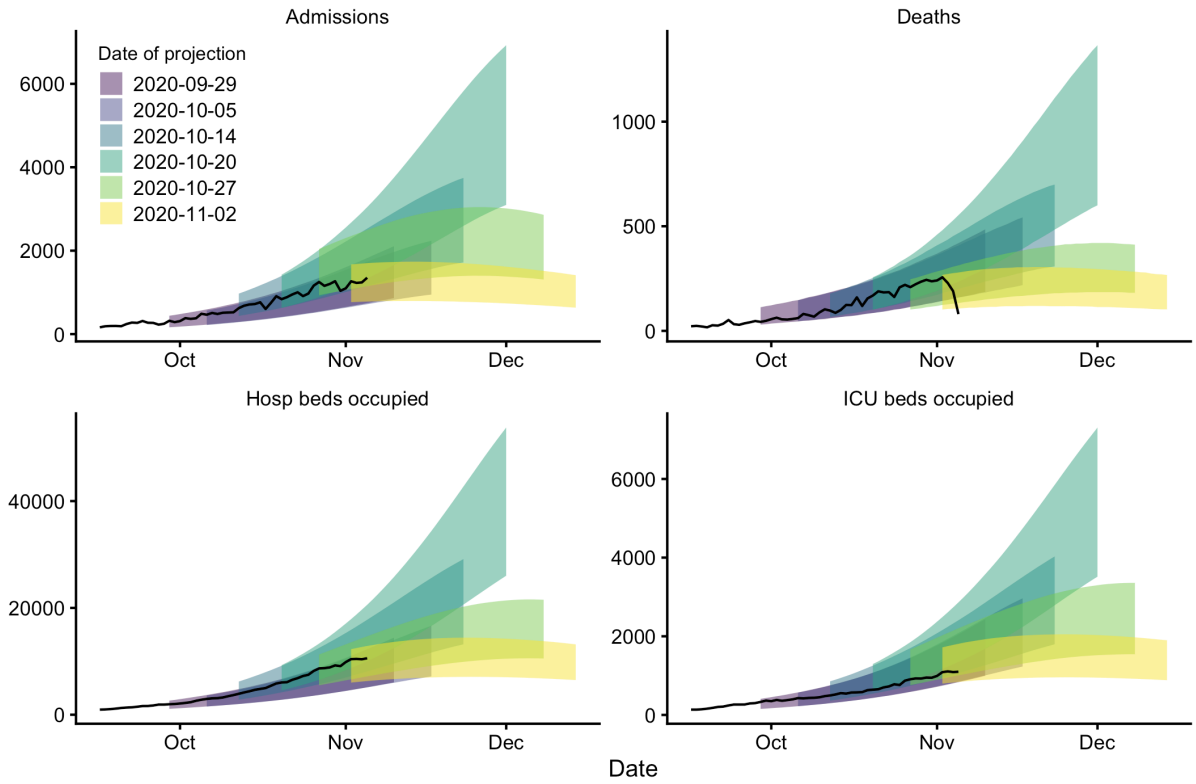

Fig S7. Model fits to data up to specific dates. These were six-week medium-term projections prepared for SPI-M[31] using the model described in this paper and fitted to data up to the date shown in the legend. Shaded areas show 95% projection intervals. Note that there have been small changes in methodology over time as the model is continually under development. The black lines are the data.

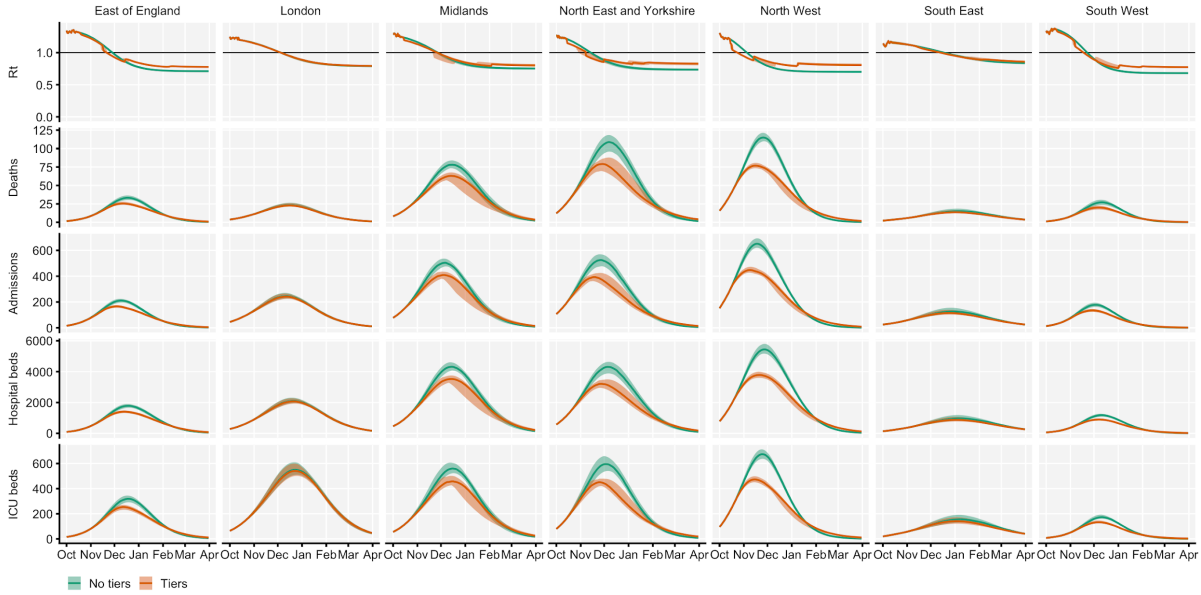

Fig S8. No tiered restrictions versus tiered restrictions introduced on 14 October 2020. The effective reproduction number Rt, as well as the daily incidence of deaths and hospital admissions and the daily prevalence of occupied hospital and ICU beds is contrasted across seven NHS regions. Lines and shaded ribbons give the median and 95% credible interval for plotted quantities, while the shaded background area shows the lockdown period. Step changes in Rt show the introduction or relaxation of tiered restrictions.

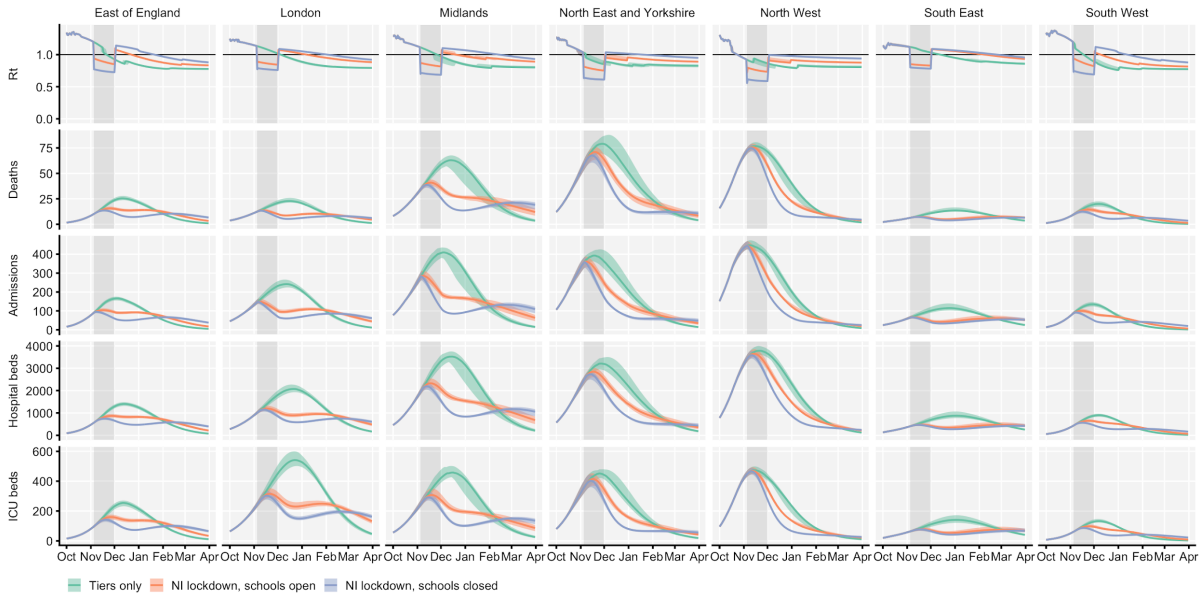

Fig S9. Projected impact of a Northern Ireland-type lockdown, with and without schools open. The effective reproduction number Rt, as well as the daily incidence of deaths and hospital admissions and the daily prevalence of occupied hospital and ICU beds is contrasted across seven NHS regions. Lockdowns extend from 5 November to 2 December 2020. Lines and shaded ribbons give the median and 95% credible interval for plotted quantities, while the shaded background area shows the lockdown period. Step changes in Rt show the introduction or relaxation of tiered restrictions and lockdown measures.

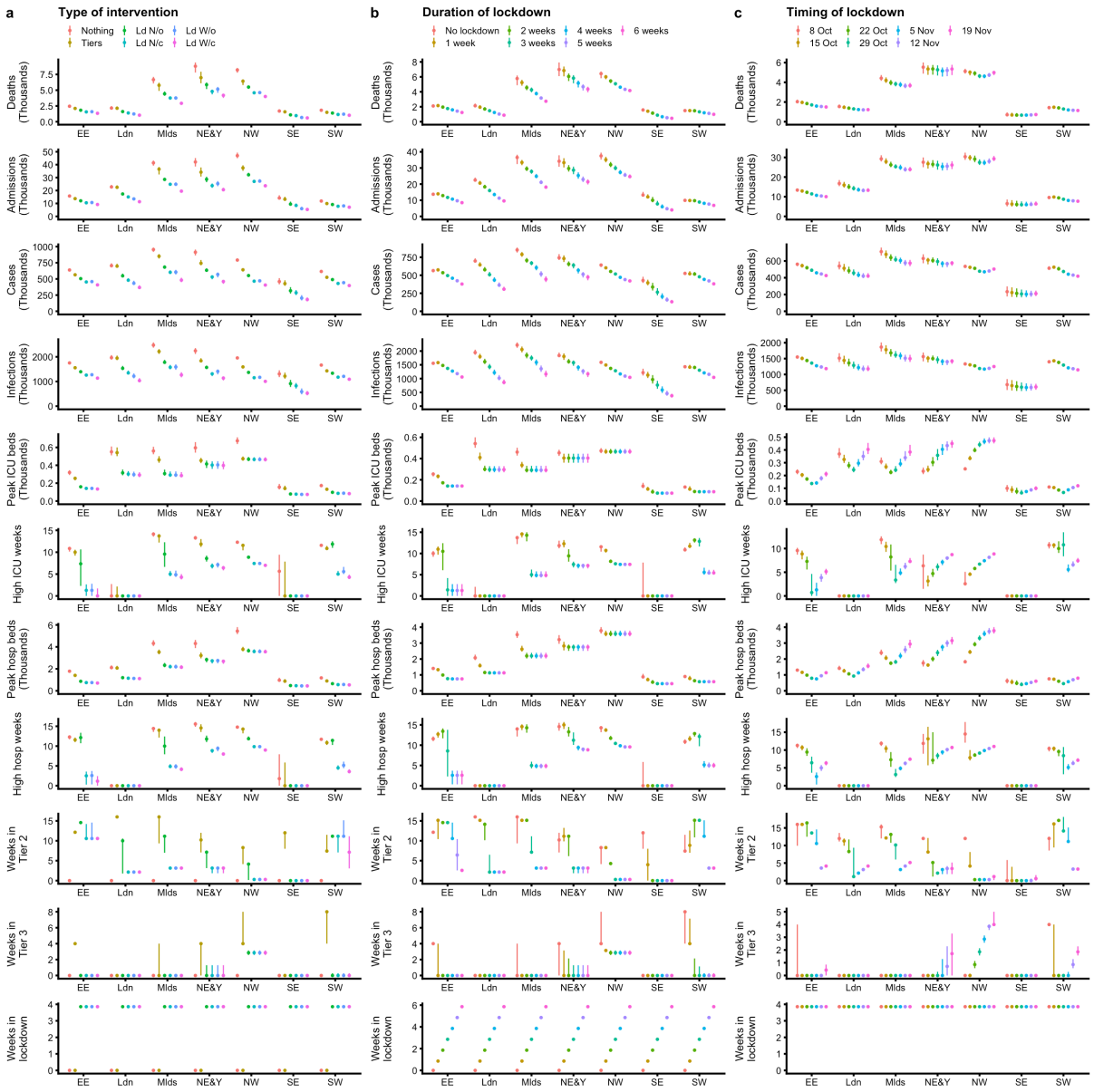

Fig S10. Region-specific alternative scenarios. These show region-specific values for the scenarios compared in Fig. 3 of the main text. Points and line ranges show median and 95% projection intervals.

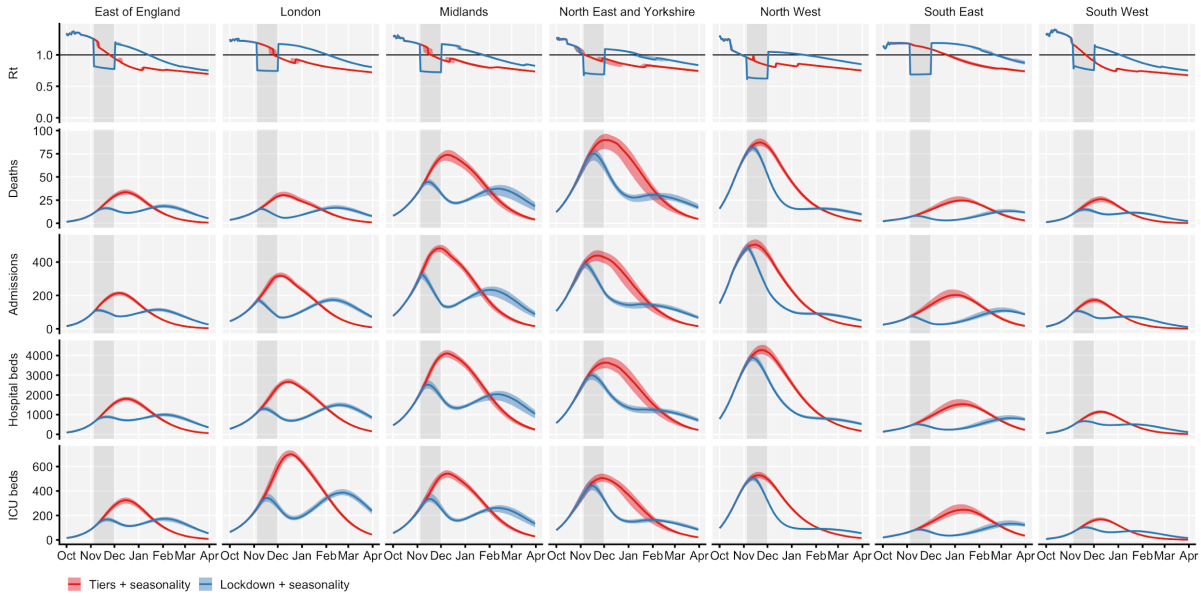

Fig S11. Alternative scenario: tiered restrictions only versus lockdown, with seasonality. The effective reproduction number Rt, as well as the daily incidence of deaths and hospital admissions and the daily prevalence of occupied hospital and ICU beds is contrasted across seven NHS regions. Lockdowns extend from 5 November to 2 December 2020. Lines and shaded ribbons give the median and 95% credible interval for plotted quantities, while the shaded background area shows the lockdown period. Step changes in Rt show the introduction or relaxation of tiered restrictions and lockdown measures.

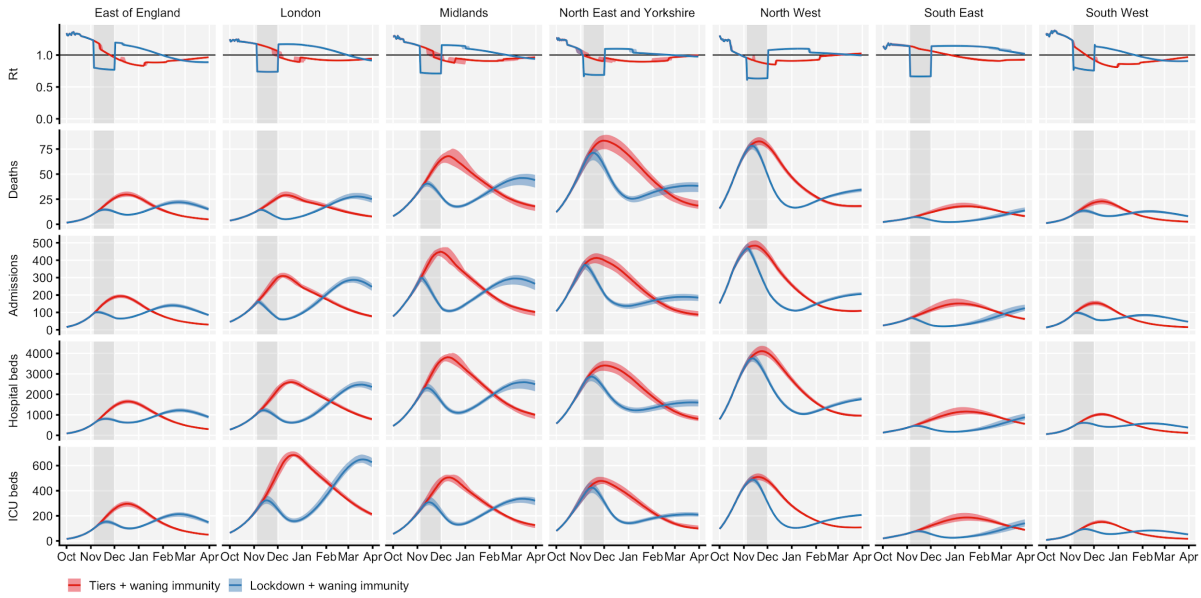

Fig S12. Alternative scenario: tiered restrictions only versus lockdown, with waning immunity. The effective reproduction number Rt, as well as the daily incidence of deaths and hospital admissions and the daily prevalence of occupied hospital and ICU beds is contrasted across seven NHS regions. Lockdowns extend from 5 November to 2 December 2020. Lines and shaded ribbons give the median and 95% credible interval for plotted quantities, while the shaded background area shows the lockdown period. Step changes in Rt show the introduction or relaxation of tiered restrictions and lockdown measures.

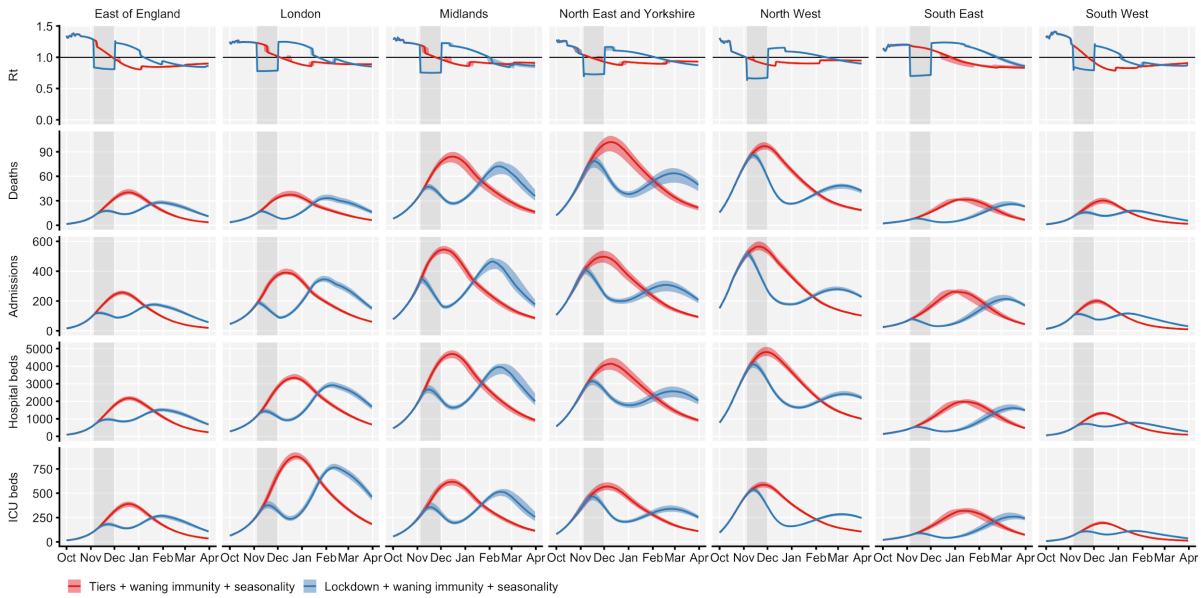

Fig S13. Alternative scenario: tiered restrictions only versus lockdown, with seasonality and waning immunity. The effective reproduction number Rt, as well as the daily incidence of deaths and hospital admissions and the daily prevalence of occupied hospital and ICU beds is contrasted across seven NHS regions. Lockdowns extend from 5 November to 2 December 2020. Lines and shaded ribbons give the median and 95% credible interval for plotted quantities, while the shaded background area shows the lockdown period. Step changes in Rt show the introduction or relaxation of tiered restrictions and lockdown measures.

Table S3. Region-specific results, baseline scenario (no tiered restrictions, no lockdown). Burdens are summed over the period from 1 Oct 2020 to 31 March 2021. Weeks of high ICU occupancy is calculated by measuring the number of weeks in each region where ICU occupancy is 50% or greater than the peak occupancy during the first wave. Medians and 95% projection intervals shown.

Indicator	England	East of England	London	Midlands	North East and Yorkshire	North West	South East	South West
Admissions	195,000 (192,000 - 199,000)	15,800 (14,900 - 16,600)	22,800 (22,000 - 24,100)	41,400 (39,700 - 43,100)	42,100 (39,100 - 45,000)	47,000 (45,600 - 49,200)	14,200 (13,300 - 16,100)	11,900 (11,200 - 12,500)
Deaths	31,800 (30,700 - 32,500)	2,450 (2,300 - 2,650)	2,160 (2,060 - 2,410)	6,660 (6,130 - 7,110)	8,800 (7,870 - 9,350)	8,210 (7,820 - 8,510)	1,690 (1,590 - 1,870)	1,820 (1,630 - 2,000)
Peak ICU (rel. W1)	98% (96 - 102%)	117% (108 - 125%)	47% (44 - 51%)	144% (136 - 155%)	142% (132 - 156%)	153% (147 - 160%)	55% (47 - 66%)	162% (151 - 175%)
Peak ICU requirement	3,030 (2,960 - 3,130)	319 (297 - 343)	551 (516 - 601)	560 (531 - 604)	595 (551 - 651)	674 (649 - 704)	156 (132 - 186)	173 (162 - 187)
Weeks in Tier 2	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Weeks in Tier 3	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Weeks in lockdown	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Weeks of high ICU occupancy	9.46 (8.61 - 9.98)	10.9 (10.3 - 11.1)	0 (0 - 2.16)	14.1 (13.6 - 14.6)	13.3 (12.9 - 13.6)	12.3 (12 - 12.4)	5.64 (0 - 9.29)	11.6 (11.4 - 11.9)

Table S4. Region-specific results, tiered restrictions only. Burdens are summed over the period from 1 Oct 2020 to 31 March 2021. Weeks of high ICU occupancy is calculated by measuring the number of weeks in each region where ICU occupancy is 50% or greater than the peak occupancy during the first wave. Lockdowns are assumed to run from 5 November – 2 December 2020 inclusively. Medians and 95% projection intervals shown.

Indicator	England	East of England	London	Midlands	North East and Yorkshire	North West	South East	South West
Admissions	168,000 (164,000 - 171,000)	13,700 (13,000 - 14,400)	22,500 (21,700 - 23,800)	36,500 (34,600 - 38,100)	34,200 (31,000 - 36,600)	37,500 (35,400 - 39,100)	13,200 (12,500 - 14,900)	9,930 (9,380 - 10,500)
Deaths	26,500 (25,400 - 27,500)	2,110 (1,980 - 2,280)	2,130 (2,030 - 2,370)	5,780 (5,270 - 6,160)	6,980 (6,160 - 7,840)	6,430 (6,070 - 6,640)	1,570 (1,480 - 1,730)	1,490 (1,330 - 1,630)
Peak ICU (rel. W1)	80% (78 - 82%)	93% (87 - 98%)	46% (43 - 50%)	119% (111 - 128%)	108% (103 - 115%)	107% (104 - 112%)	50% (43 - 59%)	123% (116 - 133%)
Peak ICU requirement	2,460 (2,400 - 2,530)	254 (238 - 269)	541 (507 - 591)	461 (433 - 499)	453 (430 - 481)	473 (456 - 492)	141 (121 - 167)	132 (124 - 143)
Weeks in Tier 2	11.8 (10.6 - 12.5)	12.1 (11.9 - 12.4)	16 (16 - 16)	16 (9.71 - 16)	10.2 (7.28 - 12)	8.29 (4.14 - 8.43)	12 (8 - 12)	7.43 (7.14 - 7.57)
Weeks in Tier 3	2.42 (1.81 - 3.13)	4 (4 - 4)	0 (0 - 0)	0 (0 - 4)	4 (0 - 4)	4 (4 - 8)	0 (0 - 0)	8 (8 - 8)
Weeks in lockdown	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Weeks of high ICU occupancy	8.17 (7.88 - 9.21)	10 (9.29 - 10.6)	0 (0 - 1.17)	13.7 (12.8 - 14.1)	11.9 (11.3 - 12.7)	11.6 (10.6 - 11.9)	0 (0 - 7.58)	10.9 (10.6 - 11.3)

Table S5. Impact on effective reproduction number Rt, Northern Ireland-type lockdown

Population	Pre-lockdown	Post-lockdown, schools open	Post-lockdown, schools closed	Reduction, schools open	Reduction, schools closed
East of England	1.2 (1.2 - 1.21)	0.935 (0.93 - 0.939)	0.769 (0.762 - 0.777)	0.267 (0.266 - 0.269)	0.433 (0.421 - 0.443)
London	1.14 (1.13 - 1.14)	0.887 (0.883 - 0.892)	0.788 (0.78 - 0.795)	0.249 (0.248 - 0.251)	0.347 (0.34 - 0.362)
Midlands	1.12 (1.11 - 1.12)	0.869 (0.866 - 0.873)	0.714 (0.704 - 0.722)	0.249 (0.247 - 0.25)	0.405 (0.393 - 0.417)
North East and Yorkshire	1.04 (0.961 - 1.05)	0.81 (0.803 - 0.816)	0.639 (0.625 - 0.65)	0.229 (0.158 - 0.231)	0.393 (0.325 - 0.414)
North West	0.926 (0.922 - 0.931)	0.796 (0.793 - 0.8)	0.615 (0.607 - 0.623)	0.13 (0.13 - 0.131)	0.311 (0.304 - 0.319)
South East	1.12 (1.11 - 1.14)	0.851 (0.843 - 0.863)	0.8 (0.795 - 0.805)	0.27 (0.267 - 0.274)	0.321 (0.305 - 0.339)
South West	1.2 (1.19 - 1.21)	0.935 (0.929 - 0.941)	0.744 (0.733 - 0.754)	0.267 (0.264 - 0.269)	0.457 (0.439 - 0.467)

Table S6. Impact on effective reproduction number Rt, Wales-type lockdown

Population	Pre-lockdown	Post-lockdown, schools open	Post-lockdown, schools closed	Reduction, schools open	Reduction, schools closed
East of England	1.2 (1.2 - 1.21)	0.782 (0.778 - 0.785)	0.643 (0.637 - 0.649)	0.42 (0.418 - 0.423)	0.559 (0.548 - 0.569)
London	1.14 (1.13 - 1.14)	0.718 (0.715 - 0.723)	0.639 (0.632 - 0.644)	0.418 (0.416 - 0.421)	0.498 (0.491 - 0.51)
Midlands	1.12 (1.11 - 1.12)	0.707 (0.704 - 0.71)	0.581 (0.573 - 0.587)	0.411 (0.409 - 0.413)	0.538 (0.528 - 0.547)
North East and Yorkshire	1.04 (0.961 - 1.05)	0.683 (0.677 - 0.687)	0.538 (0.527 - 0.547)	0.357 (0.284 - 0.36)	0.495 (0.426 - 0.513)
North West	0.926 (0.922 - 0.931)	0.619 (0.617 - 0.622)	0.478 (0.472 - 0.485)	0.307 (0.305 - 0.308)	0.448 (0.442 - 0.454)
South East	1.12 (1.11 - 1.14)	0.654 (0.647 - 0.663)	0.615 (0.611 - 0.619)	0.467 (0.462 - 0.473)	0.507 (0.492 - 0.524)
South West	1.2 (1.19 - 1.21)	0.791 (0.785 - 0.795)	0.629 (0.619 - 0.637)	0.412 (0.408 - 0.415)	0.573 (0.557 - 0.582)

Table S7. Region-specific results, Northern Ireland-type lockdown with schools open. Burdens are summed over the period from 1 Oct 2020 to 31 March 2021. Weeks of high ICU occupancy is calculated by measuring the number of weeks in each region where ICU occupancy is 50% or greater than the peak occupancy during the first wave. Lockdowns are assumed to run from 5 November – 2 December 2020 inclusively. Medians and 95% projection intervals shown.

Indicator	England	East of England	London	Midlands	North East and Yorkshire	North West	South East	South West
Admissions	138,000 (135,000 - 141,000)	12,100 (11,400 - 12,700)	17,300 (16,600 - 18,400)	28,600 (27,700 - 29,700)	28,700 (26,800 - 30,500)	32,200 (31,300 - 33,500)	9,460 (8,530 - 10,900)	9,170 (8,670 - 9,700)
Deaths	21,700 (21,100 - 22,300)	1,830 (1,720 - 1,980)	1,610 (1,530 - 1,790)	4,420 (4,130 - 4,770)	5,860 (5,250 - 6,180)	5,490 (5,230 - 5,670)	1,080 (998 - 1,230)	1,370 (1,230 - 1,510)
Peak ICU (rel. W1)	60% (58 - 62%)	58% (53 - 64%)	27% (25 - 30%)	79% (74 - 90%)	99% (91 - 106%)	106% (102 - 110%)	28% (24 - 33%)	91% (85 - 100%)
Peak ICU requirement	1,850 (1,790 - 1,920)	160 (145 - 175)	315 (296 - 349)	307 (290 - 350)	415 (382 - 445)	468 (451 - 487)	78.9 (68.2 - 93.7)	97.6 (90.9 - 107)
Weeks in Tier 2	7.53 (6.62 - 8.22)	14.6 (14.3 - 14.7)	10 (2 - 10.6)	11.1 (7 - 11.1)	7.14 (3.14 - 7.14)	4.14 (0.286 - 4.43)	0 (0 - 0)	11.1 (11 - 11.1)
Weeks in Tier 3	0.374 (0.338 - 0.545)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1.14)	2.86 (2.71 - 3.14)	0 (0 - 0)	0 (0 - 0.143)
Weeks in lockdown	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)
Weeks of high ICU occupancy	6.2 (5.4 - 6.96)	7.36 (2.56 - 10.6)	0 (0 - 0)	9.57 (6.99 - 12.2)	8.57 (8.14 - 9.14)	8.86 (8.71 - 9.14)	0 (0 - 0)	11.9 (11.1 - 12.4)

Table S8. Region-specific results, Northern Ireland-type lockdown with schools closed. Burdens are summed over the period from 1 Oct 2020 to 31 March 2021. Weeks of high ICU occupancy is calculated by measuring the number of weeks in each region where ICU occupancy is 50% or greater than the peak occupancy during the first wave. Lockdowns are assumed to run from 5 November – 2 December 2020 inclusively. Medians and 95% projection intervals shown.

Indicator	England	East of England	London	Midlands	North East and Yorkshire	North West	South East	South West
Admissions	118,000 (116,000 - 120,000)	10,500 (9,900 - 11,000)	15,100 (14,400 - 16,000)	24,800 (24,000 - 26,000)	23,800 (22,200 - 25,100)	27,000 (26,200 - 28,100)	8,440 (7,790 - 9,660)	7,830 (7,480 - 8,270)
Deaths	18,200 (17,800 - 18,700)	1,560 (1,460 - 1,680)	1,390 (1,320 - 1,540)	3,760 (3,540 - 4,000)	4,800 (4,380 - 5,060)	4,590 (4,380 - 4,740)	965 (900 - 1,080)	1,150 (1,030 - 1,250)
Peak ICU (rel. W1)	57% (56 - 60%)	52% (47 - 56%)	26% (24 - 28%)	75% (71 - 85%)	96% (89 - 104%)	106% (102 - 110%)	27% (24 - 31%)	81% (75 - 88%)
Peak ICU requirement	1,770 (1,710 - 1,840)	142 (129 - 154)	302 (284 - 334)	292 (277 - 330)	402 (372 - 434)	465 (449 - 484)	77.2 (67.2 - 86.4)	86.3 (80.4 - 94.5)
Weeks in Tier 2	3.8 (3.41 - 3.92)	10.6 (10.3 - 10.7)	2.14 (1.86 - 2.57)	3.14 (3 - 3.14)	3.14 (2 - 3.14)	0.286 (0 - 0.429)	0 (0 - 0)	11.1 (7.14 - 11.1)
Weeks in Tier 3	0.374 (0.338 - 0.545)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1.14)	2.86 (2.71 - 3.14)	0 (0 - 0)	0 (0 - 0.143)
Weeks in lockdown	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)
Weeks of high ICU occupancy	3.56 (3.33 - 3.83)	1.29 (0 - 2.57)	0 (0 - 0)	5 (4.57 - 5.71)	6.86 (6.56 - 7.29)	7.43 (7.43 - 7.71)	0 (0 - 0)	5 (4.71 - 5.44)

Table S9. Region-specific results, Wales-type lockdown with schools open. Burdens are summed over the period from 1 Oct 2020 to 31 March 2021. Weeks of high ICU occupancy is calculated by measuring the number of weeks in each region where ICU occupancy is 50% or greater than the peak occupancy during the first wave. Lockdowns are assumed to run from 5 November – 2 December 2020 inclusively. Medians and 95% projection intervals shown.

Indicator	England	East of England	London	Midlands	North East and Yorkshire	North West	South East	South West
Admissions	116,000 (114,000 - 118,000)	10,700 (10,100 - 11,200)	13,500 (12,700 - 14,500)	24,800 (23,900 - 26,100)	25,300 (23,600 - 27,200)	27,300 (26,300 - 28,500)	5,950 (5,260 - 7,020)	8,110 (7,710 - 8,570)
Deaths	18,200 (17,700 - 18,700)	1,590 (1,490 - 1,710)	1,230 (1,170 - 1,380)	3,760 (3,570 - 4,020)	5,160 (4,620 - 5,460)	4,620 (4,420 - 4,790)	668 (608 - 777)	1,200 (1,080 - 1,310)
Peak ICU (rel. W1)	57% (55 - 60%)	52% (47 - 57%)	25% (24 - 28%)	75% (71 - 85%)	97% (89 - 104%)	106% (102 - 110%)	26% (23 - 29%)	82% (77 - 90%)
Peak ICU requirement	1,770 (1,710 - 1,840)	142 (129 - 155)	296 (278 - 327)	291 (276 - 331)	405 (373 - 436)	465 (449 - 484)	74.4 (64.9 - 83.3)	87.8 (81.8 - 96.4)
Weeks in Tier 2	4.19 (3.76 - 4.65)	10.6 (10.3 - 14.6)	2.14 (1.86 - 2.57)	3.14 (3 - 3.14)	3.14 (2 - 3.14)	0.286 (0 - 0.429)	0 (0 - 0)	11.1 (11 - 15.1)
Weeks in Tier 3	0.374 (0.338 - 0.545)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1.14)	2.86 (2.71 - 3.14)	0 (0 - 0)	0 (0 - 0.143)
Weeks in lockdown	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)
Weeks of high ICU occupancy	3.66 (3.38 - 3.94)	1.29 (0 - 2.71)	0 (0 - 0)	4.86 (4.56 - 5.71)	7.14 (6.71 - 7.57)	7.43 (7.29 - 7.71)	0 (0 - 0)	5.57 (5 - 6.43)

Table S10. Region-specific results, Wales-type lockdown with schools closed. Burdens are summed over the period from 1 Oct 2020 to 31 March 2021. Weeks of high ICU occupancy is calculated by measuring the number of weeks in each region where ICU occupancy is 50% or greater than the peak occupancy during the first wave. Lockdowns are assumed to run from 5 November – 2 December 2020 inclusively. Medians and 95% projection intervals shown.

Indicator	England	East of England	London	Midlands	North East and Yorkshire	North West	South East	South West
Admissions	97,100 (95,200 - 98,700)	9,190 (8,670 - 9,620)	11,400 (10,700 - 12,200)	19,500 (18,800 - 20,600)	20,600 (19,500 - 21,900)	23,700 (22,800 - 24,700)	5,340 (4,820 - 6,150)	7,090 (6,770 - 7,490)
Deaths	15,100 (14,700 - 15,400)	1,330 (1,260 - 1,430)	1,040 (982 - 1,150)	2,920 (2,800 - 3,080)	4,180 (3,830 - 4,390)	4,000 (3,830 - 4,130)	601 (556 - 684)	1,020 (913 - 1,120)
Peak ICU (rel. W1)	56% (54 - 59%)	49% (45 - 54%)	25% (23 - 27%)	73% (69 - 83%)	95% (88 - 103%)	105% (102 - 109%)	26% (23 - 29%)	78% (72 - 85%)
Peak ICU requirement	1,740 (1,680 - 1,810)	135 (123 - 146)	291 (274 - 321)	285 (270 - 323)	398 (368 - 431)	464 (448 - 482)	74 (64.6 - 82.6)	83 (77.3 - 90.8)
Weeks in Tier 2	3.4 (2.97 - 3.84)	10.6 (10.3 - 10.7)	2.14 (1.86 - 2.57)	3.14 (3 - 3.14)	3.14 (2 - 3.14)	0.286 (0 - 0.429)	0 (0 - 0)	7.14 (3.14 - 11.1)
Weeks in Tier 3	0.374 (0.338 - 0.545)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1.14)	2.86 (2.71 - 3.14)	0 (0 - 0)	0 (0 - 0.143)
Weeks in lockdown	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)	3.86 (3.86 - 3.86)
Weeks of high ICU occupancy	3.1 (2.95 - 3.36)	0 (0 - 1.71)	0 (0 - 0)	4.29 (3.99 - 5)	6.43 (6 - 6.72)	7 (6.86 - 7.14)	0 (0 - 0)	4.29 (3.86 - 4.71)

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