The effect of social distancing on the reproduction number and number of contacts in the UK from a social contact survey
Report 14

Authors: Amy Gimma, Christopher Jarvis, Kevin Van Zandvoort, Petra Klepac, and John Edmunds on behalf of the LSHTM COVID-19 Modelling Team

Date: 8th July 2020

Summary:
- The overall estimate of R_0 for the UK is 0.87 (95% CI 0.52 to 1.29), though there is some evidence of differences between the nations of the UK, with Scotland and Wales reporting generally lower and stable R_0 estimates over time, whereas some regions of England have seen a gradual increase over recent weeks, as has Northern Ireland (though trends for NI are difficult to interpret due to small numbers).
- The North West and South West regions have median estimates of R_0 above 1. Both the East of England and South East have median estimates of R_0 of 1.
- Note, these data are up to 1st July. They do not include contacts measured after the recent easing of restrictions on the 4th July.

**Results**

Social contacts and basic reproduction number

We estimate R_0 to be 0.87 (95% CI 0.52 to 1.29) for the UK and 0.89 (95% CI 0.51 to 1.36) for England, between the 25th June and 1st July, calculated by truncating contacts to a maximum of 100 per participant (Table 1). The R_0 estimates including all data are 1.05 (95% CI 0.57 to 1.71) for the UK and 1.03 (95% CI 0.58 to 1.77) for England, though these estimates are skewed by a few participants reporting over 100 contacts. The interquartile range remains 1 to 3 for the number of contacts per person.

The median R_0 estimates for the different regions and countries of the UK are presented in Figure 1 and Table 2. The North West and South West have median estimates above 1, with the North West estimates above one for the past three weeks. All regional/country level estimates have wide confidence intervals, especially recent estimates for Northern Ireland. The width of the intervals are strongly driven by a small number of individuals with a high number of contacts.

Table 1. Numbers of participants, reported contacts and reproduction numbers. Numbers of participants in each panel, their average number of contacts reported and the estimate of the reproduction number, R_0 for the first two weeks of the survey (immediately after lockdown) and the most recent two weeks of the survey.

Group	Week	Panel	Dates	Observations	Contacts	Mean (IQR)	HH size	R_0 mean (95% CI)
UK	1,2	A & B	24/03 to 10/04	3,376	8,943	2.64 (1 to 3)	2.72	0.60 (0.35 to 0.85)
UK*	13	A & C	18/06 to 24/06	1,844	7,043	3.82 (1 to 3)	2.86	0.99 (0.58 to 1.41)
UK* (truncate 100 contacts)	13	A & C	18/06 to 24/06	1,844	5,950	3.23 (1 to 3)	2.86	0.81 (0.49 to 1.17)
England*	13	A & C	18/06 to 24/06	1,564	6,288	4.02 (1 to 3)	2.85	1.06 (0.63 to 1.48)
England* (truncate 100 contacts)	13	A & C	18/06 to 24/06	1,564	5,200	3.32 (1 to 3)	2.85	0.85 (0.47 to 1.25)
UK*	14	B & D	25/06 to 01/07	1,208	4,908	4.06 (1 to 3)	2.67	1.05 (0.57 to 1.71)
UK* (truncate 100 contacts)	14	B & D	25/06 to 01/07	1,208	3,995	3.30 (1 to 3)	2.67	0.87 (0.52 to 1.29)
England*	14	B & D	25/06 to 01/07	1,016	3857	3.79 (1 to 3)	2.69	1.03 (0.58 to 1.77)
England* (truncate 100 contacts)	14	B & D	25/06 to 01/07	1,016	3,369	3.32 (1 to 3)	2.69	0.89 (0.51 to 1.36)

 * observations includes Panel C or Panel D, as indicated, in which adult participants were asked to answer contact questions on behalf of one child in their household
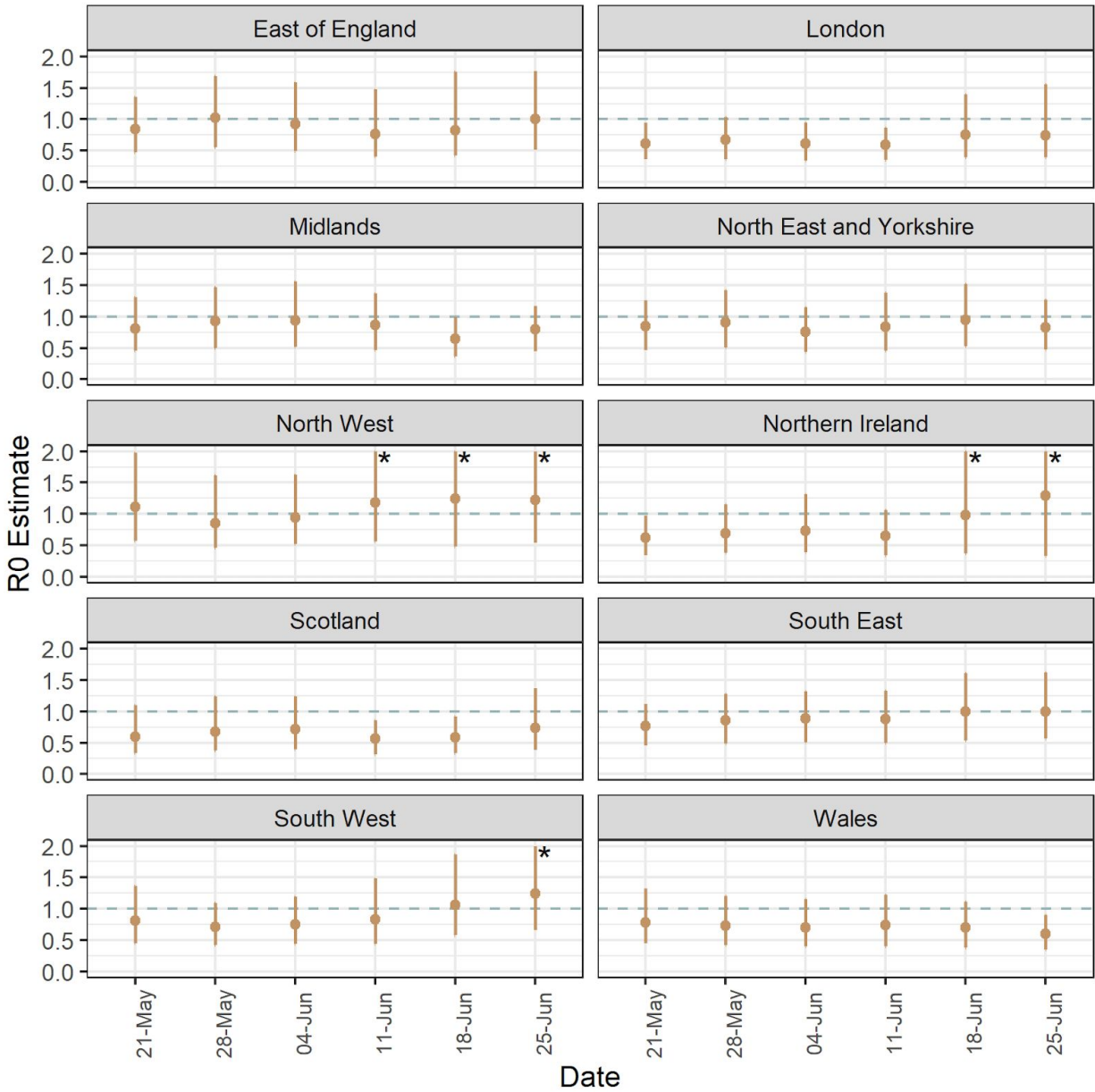
Figure 1. R₀ estimates by countries of the UK and NHS regions of England. The estimates for each week are a combination of the prior week and the current week. For example the survey sent out on the 21st of May includes the survey data sent out on the 14th of May through the 28th May. Data prior to the 21st of May is not presented as we did not collect information on children's contacts prior to the week before the 7th May. We assume that the baseline R_0 estimate followed a normal distribution with mean 2.6 and standard deviation 0.54 for all regions over time. * indicates that the data extends past the limits of the plot, see table 3 for estimates.

Table 2. R_0 estimates by region in the UK. R_0 scaled assuming that the baseline R_0 estimate followed a normal distribution with mean 2.6 and standard deviation 0.54. The data is a rolling average of two weeks in order to increase the sample size for the regional estimates.

Region	R0 median (95% CI) 21 May to 4 Jun	R0 median (95% CI) 28 May to 11 June	R0 median (95% CI) 4 Jun to 18 June	R0 median (95% CI) 11 Jun to 24 June	R0 median (95% CI) 18 Jun to 1 July
East of England	1.02 (0.55 to 1.69)	0.92 (0.49 to 1.59)	0.76 (0.4 to 1.48)	0.82 (0.42 to 1.76)	1.00 (0.51 to 1.77))
London	0.67 (0.36 to 1.03)	0.61 (0.34 to 0.94)	0.59 (0.35 to 0.86)	0.75 (0.39 to 1.4)	0.74 (0.39 to 1.56)
Midlands	0.93 (0.5 to 1.47)	0.94 (0.52 to 1.56)	0.87 (0.47 to 1.37)	0.65 (0.37 to 0.99)	0.80 (0.45 to 1.17)
North East and Yorkshire	0.91 (0.51 to 1.42)	0.76 (0.44 to 1.15)	0.84 (0.46 to 1.38)	0.95 (0.53 to 1.52)	0.83 (0.48 to 1.27)
North West	0.85 (0.46 to 1.62)	0.94 (0.52 to 1.63)	1.18 (0.56 to 2.34)	1.24 (0.48 to 2.64)	1.22 (0.54 to 2.43)
Northern Ireland*	0.69 (0.38 to 1.15)	0.73 (0.39 to 1.31)	0.65 (0.34 to 1.06)	0.98 (0.37 to 3.99)	1.29 (0.33 to 4.58)
Scotland	0.68 (0.37 to 1.24)	0.72 (0.39 to 1.24)	0.57 (0.31 to 0.86)	0.59 (0.33 to 0.92)	0.74 (0.38 to 1.37)
South East	0.86 (0.49 to 1.28)	0.89 (0.51 to 1.32)	0.88 (0.5 to 1.33)	1.00 (0.54 to 1.61)	1.00 (0.57 to 1.62)
South West	0.71 (0.42 to 1.09)	0.75 (0.44 to 1.19)	0.83 (0.44 to 1.48)	1.06 (0.58 to 1.87)	1.24 (0.66 to 2.14)
Wales	0.73 (0.42 to 1.2)	0.70 (0.4 to 1.15)	0.74 (0.4 to 1.22)	0.70 (0.38 to 1.11)	0.60 (0.35 to 0.90)

*Northern Ireland contains few participants with 70 in total for the latest estimate.

Methods

CoMix is a behavioural survey, with a study sample recruited to be broadly representative of the UK adult population. It was launched on 24th of March 2020 and this analysis includes data collected up to the 1st of July, with contact data representing the day prior to the survey date. Data is collected weekly, using two different panels each for adults and children who are interviewed using the same questionnaire in alternate weeks. The questionnaires for children are completed by a parent within their household as a proxy. Participants recorded direct, face-to-face contacts made on the previous day, specifying certain characteristics for each contact including the age and sex of the contact, whether contact was physical (skin-to-skin contact), and where contact occurred (e.g. at home, work, while undertaking leisure activities, etc). Further details have been published elsewhere[1]. The contact survey is based on the POLYMOD contact survey. The BBC social contact survey is now used as a baseline for social mixing in the UK under normal conditions[2]. Previously we used POLYMOD. In two additional panels (C and D), participants are asked to answer the contact questions on behalf of a child in their household, and returning participants will be asked about the same child each week. The panels started with a sample size of 1,816 in Panel A, 1,560 in Panel B, 564 in Panel C, and 507 in Panel D.

We calculated the average number of contacts in the settings home, work, school, and other. We sample uniformly between the minimum and maximum age reported for the contact, as we do not record exact ages for contacts. We set the age bands for under 18s to 0-4, 5-12, 13-17 to be consistent with the BBC Pandemic study. We take the mean of reciprocated contacts to form symmetric matrices.

We assume that R_0 prior to physical distancing measures were in place follows a normal distribution with a mean of 2.6 and sd of 0.54. We then apply a scaling factor of the ratio of dominant eigenvalues between CoMix and BBC contact matrices to estimate R_0 under the observed contacts patterns in our study following the approach found in Wallinga et al.[4] This assumes that all other elements of the Next Generation Matrix remain constant, such as transmissibility by age group, which may not be the case. Uncertainty in the estimates of reduction in R_0 is obtained using 200 bootstrap samples of the CoMix and BBC contacts matrices, and applying these ratios to the corresponding number of sampled values of R_0.

Estimating R_0 by region

Each regional estimate of R_0 is a combination of the week reported and the week prior. For example, week 9 includes data from week 8 and 9, week 10 includes data from week 9 and 10. This was chosen to maximise the amount of data we have per region. It does mean that the estimate will be slower to react to a jump in reproduction number but as can be seen the uncertainty is quite large around the estimates and calculating for one region for a single week would lead to greater uncertainty. Since the 9th of May (week 7) we have collected contacts on children by proxy by asking their parents to report on their contacts. We no longer impute the children data from POLYMOD but calculate the contacts directly. In addition to this we have moved to using the BBC as the main comparison for the contact matrix as it allows for consistency between overall and regional R_0 calculations.

References

1. Jarvis, C. I. *et al.* Quantifying the impact of physical distance measures on the transmission of COVID-19 in the UK. *medRxiv* (2020) doi:10.1101/2020.03.31.20049023.

2. Mossong, J. *et al.* Social contacts and mixing patterns relevant to the spread of infectious diseases. *PLoS Med.* **5**, e74 (2008).

3. Klepac, P. *et al.* Contacts in context: large-scale setting-specific social mixing matrices from the BBC Pandemic project. *Epidemiology* (2020) doi:10.1101/2020.02.16.20023754.

4. Wallinga, J., Teunis, P. & Kretzschmar, M. Using data on social contacts to estimate age-specific transmission parameters for respiratory-spread infectious agents. *Am. J. Epidemiol.* **164**, 936–944 (2006).