The effect of social distancing on the reproduction number and number of contacts in the UK from a social contact survey
Report 18

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Results

Social contacts and basic reproduction number

We estimate R_0 to be 0.88 (95% CI 0.49 to 1.27) for the UK and 0.85 (95% CI 0.48 to 1.26) for England, between the 22ndth and 28th July, calculated by truncating contacts to a maximum of 100 per participant (Table 1). The R_0 estimates including all contacts are 0.98 (95% CI 0.57 to 1.50) for the UK and 0.95 (95% CI 0.55 to 1.46) for England. The reproduction number for Scotland seems to have increased, with the median estimate of R_0 being above 1 since mid July. The North West, North East and Yorkshire and South East regions continue to have an estimated median reproduction number at or above one. The interquartile range remains 1 to 3 for the number of contacts per person. Mean contacts vary by age and gender, with increases in contacts among all age groups since the first stage of full lockdown since lockdown easement compared to full lockdown in weeks 1 to 5 (Figure 2).

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*	A 17 D 16	A & D	A 15/07 to 22/07 D 08/07 to 15/07	1,268	4,277	3.37 (1 to 3)	2.46	0.90 (0.48 to 1.79)
UK* (truncate 100 contacts)	A 17 D 16	A & D	A 15/07 to 22/07 D 08/07 to 15/07	1,268	3,672	2.90 (1 to 3)	2.46	0.75 (0.42 to 1.13)
England*	A 17 D 16	A & D	A 15/07 to 22/07 D 08/07 to 15/07	1,072	3,093	2.89 (1 to 3)	2.47	0.77 (0.45 to 1.14)
England* (truncate 100 contacts)	A 17 D 16	A & D	A 15/07 to 22/07 D 08/07 to 15/07	1,072	3,093	2.89 (1 to 3)	2.47	0.77 (0.44 to 1.13)
UK*	B 18 D 16	B & D	B 22/07 to 28/07 D 08/07 to 15/07	978	4,587	3.96 (1 to 3)	2.58	0.98 (0.57 to 1.50)
UK* (truncate 100 contacts)	B 18 D 16	B & D	B 22/07 to 28/07 D 08/07 to 15/07	978	3,883	3.35 (1 to 3)	2.58	0.88 (0.49 to 1.27)

England*	B 18 D 16	B & D	B 22/07 to 28/07 D 08/07 to 15/07	1,158	3,759	3.84 (1 to 3)	2.60	0.95 (0.55 to 1.46)
England* (truncate 100 contacts)	B 18 D 16	B & D	B 22/07 to 28/077 D 08/07 to 15/07	1,158	3,215	3.29 (1 to 3)	2.60	0.85 (0.48 to 1.26)

* Observations includes Panel C or Panel D, as indicated, in which adult participants were asked to answer social contact questions on behalf of one child in their household

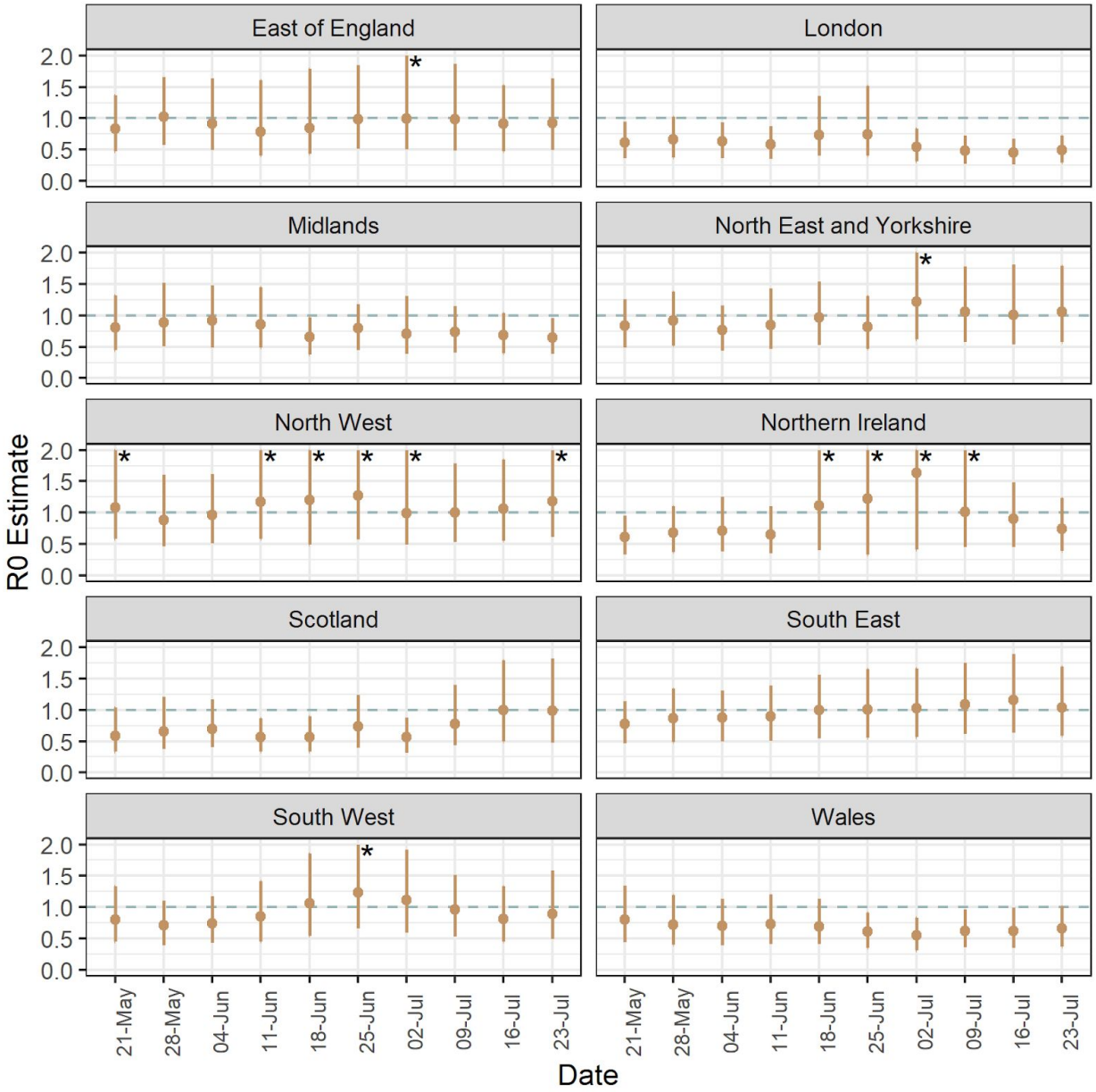


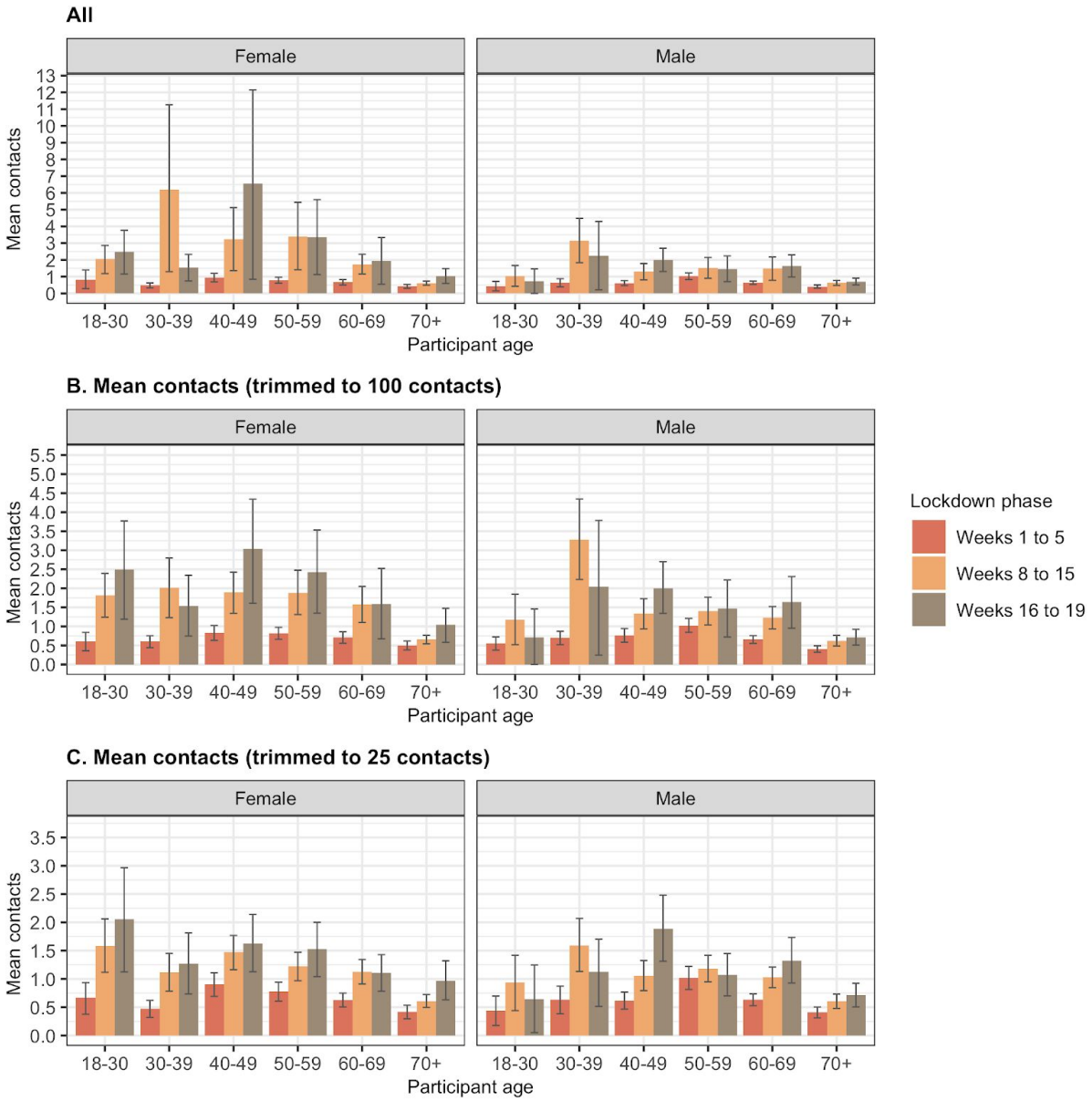
Figure 1. R_0 estimates by countries of the UK and NHS regions of England. The week starting 2nd July contains data between 2nd July and 9th July. The other estimates for prior to 2nd July are a combination of the prior week and the current week. For example the survey sent out on the 21st of May includes 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 2 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. Data before. Date in brackets corresponds to date given in the graph above.

Region	R0 median (95% CI) 18 Jun to 1 July (25 June)	R0 median (95% CI) 2 July to 9 July (2 July)*	R0 median (95% CI) 2 July to 16 July (9 July)	R0 median (95% CI) 9 July to 23 July (16 July)	R0 median (95% CI) 16 July to 30 July (23 July)
East of England	0.98 (0.51 to 1.85)	0.99 (0.5 to 2.15)	0.98 (0.48 to 1.87)	0.91 (0.47 to 1.53)	0.92 (0.49 to 1.64)
London	0.74 (0.4 to 1.52)	0.54 (0.31 to 0.83)	0.48 (0.27 to 0.72)	0.45 (0.26 to 0.67)	0.49 (0.29 to 0.72)
Midlands	0.8 (0.45 to 1.18)	0.71 (0.39 to 1.31)	0.74 (0.41 to 1.15)	0.69 (0.40 to 1.04)	0.65 (0.39 to 0.96)
North East and Yorkshire	0.82 (0.47 to 1.31)	1.22 (0.62 to 2.38)	1.06 (0.58 to 1.78)	1.01 (0.54 to 1.81)	1.06 (0.58 to 1.79)
North West	1.27 (0.57 to 2.65)	0.99 (0.49 to 2.22)	1.00 (0.53 to 1.79)	1.06 (0.55 to 1.85)	1.18 (0.61 to 2.23)
Northern Ireland	1.22 (0.33 to 5.27)	1.64 (0.41 to 5.37)	1.01 (0.45 to 2.31)	0.90 (0.45 to 1.48)	0.74 (0.39 to 1.23)
Scotland	0.74 (0.39 to 1.24)	0.57 (0.31 to 0.88)	0.78 (0.43 to 1.40)	1.00 (0.50 to 1.79)	0.99 (0.48 to 1.82)
South East	1.01 (0.56 to 1.65)	1.03 (0.57 to 1.66)	1.09 (0.62 to 1.75)	1.16 (0.64 to 1.89)	1.04 (0.59 to 1.69)
South West	1.23 (0.66 to 2.08)	1.11 (0.59 to 1.92)	0.96 (0.53 to 1.51)	0.81 (0.45 to 1.33)	0.89 (0.49 to 1.58)
Wales	0.61 (0.35 to 0.91)	0.55 (0.31 to 0.83)	0.62 (0.36 to 0.96)	0.62 (0.35 to 0.99)	0.66 (0.37 to 1.01)

*Due to changes in lockdown restriction the R estimate for the week 2 July to 9 July was calculated as one week only.

Figure 2. Mean contacts by age and gender. Contact means with bootstrapped confidence intervals for the mean in weeks 1 to 5 (full lockdown), weeks 8 to 15 (partial lockdown), and weeks 16 to 19 (partial lockdown with pubs, restaurants, etc open).



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.

Mean contacts by lockdown phase

Mean contacts were calculated for weeks 1 through 5, the first stage of lockdown in the UK, and weeks 8 to 17 with lifted lockdown restrictions with 95% confidence interval means of 1000 bootstrapped contact counts.

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).