

# 1The effect of social distancing on the reproduction number and number of contacts in the UK from a social contact survey

## Report 11

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Date: 17th June 2020

### Main changes:

- Child to adults contacts are no longer imputed for week 7 onwards.
- Comparison is now made to BBC instead of Polymod matrix. This allows for consistency among regional and national estimates as we can only have contact matrices by region for BBC and not POLYMOD. This results in a higher estimate of  $R_0$ . week 1 median estimate was 0.47 using POLYMOD and 0.60 using BBC

### Results

We estimate  $R_0$  to be 0.71 (95% CI 0.43 to 1.01) for the UK and 0.74 (95% CI 0.43 to 1.07) for England, between the 5<sup>th</sup> June and 12<sup>th</sup> June, calculated with participants reporting fewer than 100 contacts. The  $R_0$  estimates with all participants are 0.94 (95% CI 0.39 to 1.24) for the UK and 1.00 (95% CI 0.52 to 1.76) for England, which are skewed by a very few participants reporting over 100 contacts. This is consistent with last week, when we estimated  $R_0$  to be 0.69 in the UK (Table 1). The interquartile range remains 1 to 3 for the number of contacts per person. The mean contacts are 3.78 in the UK overall, which is consistent with results since lockdown easing but may indicate an upward trend.

Children's contacts have been described separately from the adult contacts in Table 2. Most reported contacts occurring outside the home are at school, with all contacts closely aligned with household size for children not attending school. Roughly a third of parents who reported their child's school was open reported sending their child to class since schools began re-opening.

The  $R_0$  estimates for the different regions and countries of the UK are still consistently below one. London and Scotland have the lowest estimates with medians of 0.56 and 0.52 (Table 3). It should be noted that the study was not powered to give estimates of  $R_0$  by region but to detect differences in contacts between different weeks.

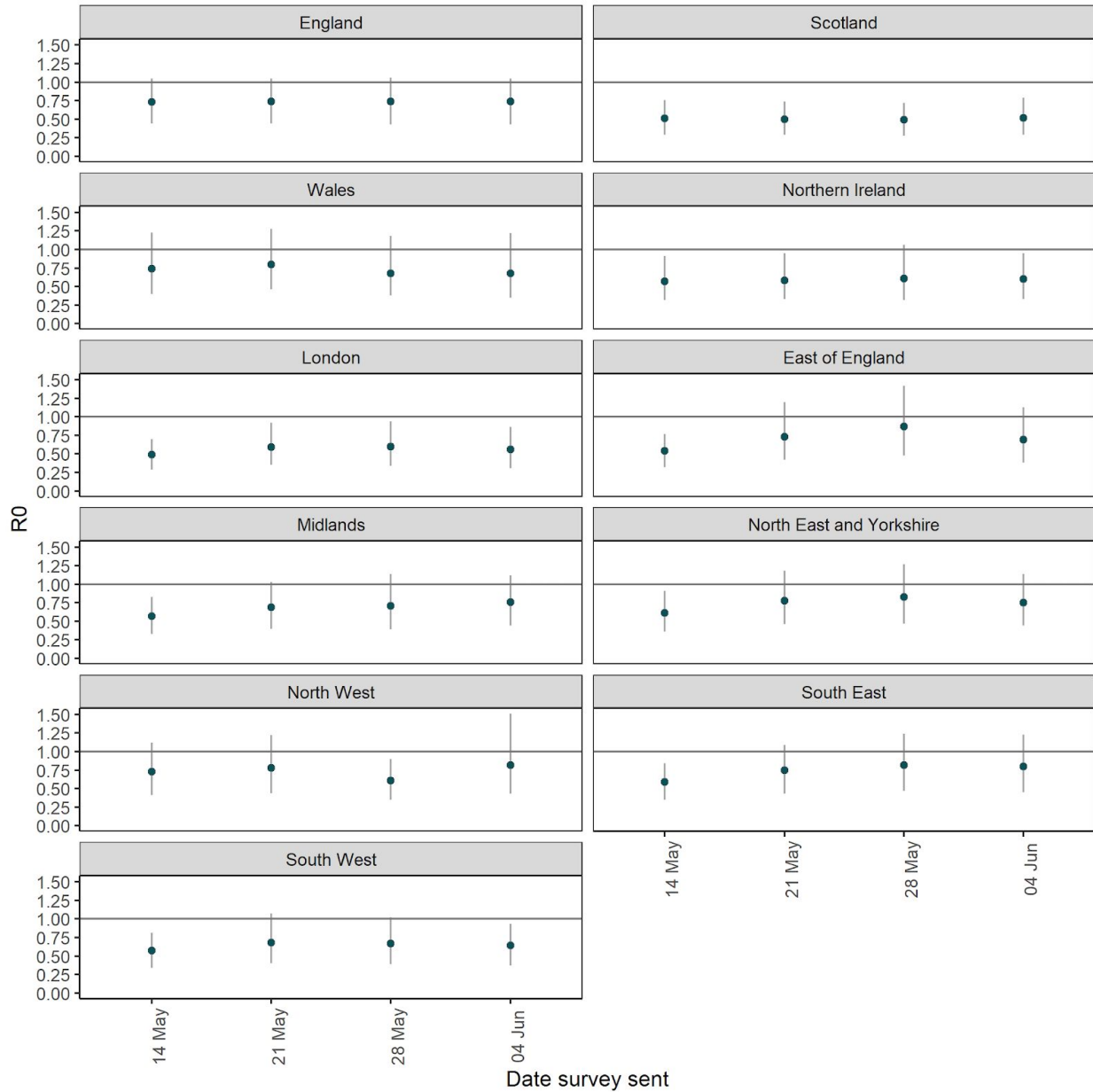
**Table 1. Numbers of participants, reported contacts and reproduction numbers.** Numbers of participants in each panel, their average number of contacts reported and the estimate of the reproduction number,  $R_0$ .

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	10	B	28/05 to 04/06	1,082	3,498	3.23 (1 to 3)	2.38	0.79 (0.45 to 1.19)
UK ( $< 100$ contacts)	10	B	28/05 to 04/06	1,079	2,733	2.53 (1 to 3)	2.39	0.69 (0.41 to 1.01)
England	10	B	28/05 to 04/06	907	2,252	2.76 (1 to 3)	2.40	0.72 (0.42 to 1.10)
England ( $< 100$ contacts)	10	B	28/05 to 04/06	906	2,506	2.49 (1 to 3)	2.40	0.68 (0.38 to 1.01)
UK*	11	A & C	05/06 to 12/06	1,850	6,997	3.78 (1 to 3)	2.89	0.94 (0.39 to 1.24)
UK* ( $< 100$ contacts)	11	A & C	05/06 to 12/06	1,847	5,492	2.97 (1 to 3)	2.89	0.71 (0.43 to 1.01)
England*	11	A & C	05/06 to 12/06	1,564	6,262	4.00 (1 to 3)	2.89	1.00 (0.52 to 1.76)
England* ( $< 100$ contacts)	11	A & C	05/06 to 12/06	1,561	4,747	3.05 (1 to 3)	2.89	0.74 (0.43 to 1.07)

\* observations includes Panel C, in which participants were asked to answer contact questions on behalf of one child in their household

**Table 2. Summary of participants and contacts in child contact survey.** Numbers of participants reporting on behalf of a child in their household in each panel, their average number of contacts reported overall and not home, and class size mean, minimum and maximum.

Description	Week	Participants	Contacts	All contacts Mean (IQR)	Not Home Contacts Mean (IQR)
All	7	564	1,740	3.09 (2 to 4)	0.2 (0 to 0)
	8	507	1,650	3.25 (2 to 4)	0.62 (0 to 0)
	9	512	1,992	3.89 (2 to 4)	0.79 (0 to 0)
	10	359	1,407	3.92 (2 to 4)	1.26 (0 to 0)
	11	511	2,616	5.12 (2 to 4)	2.31 (0 to 0)
Attended school	7	10	53	5.3 (3.25 to 6.75)	2.6 (0 to 3.75)
	8	17	100	5.88 (2 to 7)	4.06 (0 to 4)
	9	10	56	5.6 (3 to 7)	2.9 (0 to 4.75)
	10	16	171	10.69 (2.75 to 15.25)	8.56 (0 to 11.75)
	11	14	142	10.14 (4.25 to 15.25)	7.29 (0 to 11.75)



**Figure 1.  $R_0$  estimates by countries of the UK and NHS regions of England for the previous four weeks.** 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. Data prior to the 14th of May is not presented as we did not collect information on children contacts prior to the week before the 7th May.  $R_0$  assumed that the baseline  $R_0$  estimate followed a normal distribution with mean 2.6 and standard deviation 0.54 for all regions over time.

**Table 3  $R_0$  estimates by region in the UK.**  $R_0$  scaled assumed that the baseline  $R_0$  estimate followed a normal distribution with mean 2.6 and standard deviation 0.54 everywhere.

Area	$R_0$ Median (95%)
North West	0.82 (0.43 to 1.51)
South East	0.80 (0.45 to 1.23)
Midlands	0.76 (0.44 to 1.12)
North East and Yorkshire	0.75 (0.44 to 1.14)
East of England	0.69 (0.38 to 1.13)
Wales	0.68 (0.35 to 1.22)
South West	0.64 (0.37 to 0.93)
Northern Ireland	0.60 (0.33 to 0.95)
London	0.56 (0.31 to 0.86)
Scotland	0.52 (0.29 to 0.79)

## Methods

CoMix is a behavioural survey, with a study sample recruited to be broadly representative of the UK adult population. It was launched on 24<sup>th</sup> of March 2020 and this analysis includes data collected up to the 12<sup>th</sup> of June. 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<sup>1</sup>. 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<sup>2</sup>. 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.<sup>4</sup>. 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 1,000 bootstrap samples of the CoMix and BBC contacts matrices, and applying these ratios to 1,000 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).
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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).