The effect of social distancing on the reproduction number and number of contacts in the UK from a social contact survey
Report for survey week 34

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Report for SPI-M-O and SAGE, 24th November 2020
Data up to 18th of November

Summary

- We estimate R_0 for England to be 1.0 (95% interval 0.6 1.4) for the period of the 4th of November to the 18th of November.
- Estimates *of* R_0 in England have remained consistently at 1.0 (0.6 1.4) since the 7th of October having decreased from 1.7 (1.0 2.4) in mid-September.
- R_0 in Wales and Scotland is estimated as 1.4 (0.8 2.0) for the 11th - 18th of November.
- Wales was consistently estimated at below one since the 22nd of October, whereas Scotland has been consistently estimated above one.
- *Estimates of* R_0 in Northern Ireland remain below one with a markedly lower estimate of 0.5 (0.3 0.7) for the week 11th November to the 18th of November.
- R_t estimates will be somewhat lower than R_0 estimates due to the accumulation of immunity. This effect will be greatest in those areas which have experienced the highest rates of infection.

Estimating R_0 in UK countries

We present two-weekly rolling estimates of R_0 from August 13th (Figure 1). Over the most recent 6 estimates (October 7th until November 18th), England has remained consistently between 0.6 and 1.4 (Table 1). Northern Ireland has been estimated between 0.4 and 1.3 since early October, with a lower estimate for the latest time period which only contains one weeks worth of data. Scotland has been consistently estimated above one for the last four time periods. Estimates of R_0 for Wales have been consistently below one since the 22 Oct, with a higher estimate of 1.4 (0.8 2.0) for the most recent estimate. We estimate markedly different trajectories and estimates of R_0 between countries (Figure 2).

Table 1: Estimate of R_0 by country, comparing CoMix with POLYMOD over time. Values of R_0 for two week periods, excluding the most recent estimate with 95% intervals.

Country	2020-10-07 to 2020-10-20	2020-10-15 to 2020-10-28	2020-10-22 to 2020-11-04	2020-10-29 to 2020-11-10	2020-11-04 to 2020-11-18	2020-11-11 to 2020-11-18
England	1.1 (0.7 1.6)	1.0 (0.6 1.4)	1.0 (0.6 1.4)	1.0 (0.6 1.4)	1.0 (0.6 1.4)	1.0 (0.6 1.4)
Northern Ireland	0.8 (0.5 1.1)	0.7 (0.4 1.1)	0.9 (0.5 1.2)	0.9 (0.5 1.3)	0.7 (0.4 1.0)	0.5 (0.3 0.7)
Scotland	0.8 (0.5 1.1)	1.0 (0.6 1.4)	1.3 (0.8 1.9)	1.3 (0.8 1.9)	1.2 (0.7 1.8)	1.4 (0.8 2.0)
Wales	1.4 (0.8 2.0)	1.0 (0.6 1.4)	0.8 (0.5 1.1)	0.8 (0.5 1.2)	0.9 (0.6 1.3)	1.4 (0.8 2.0)

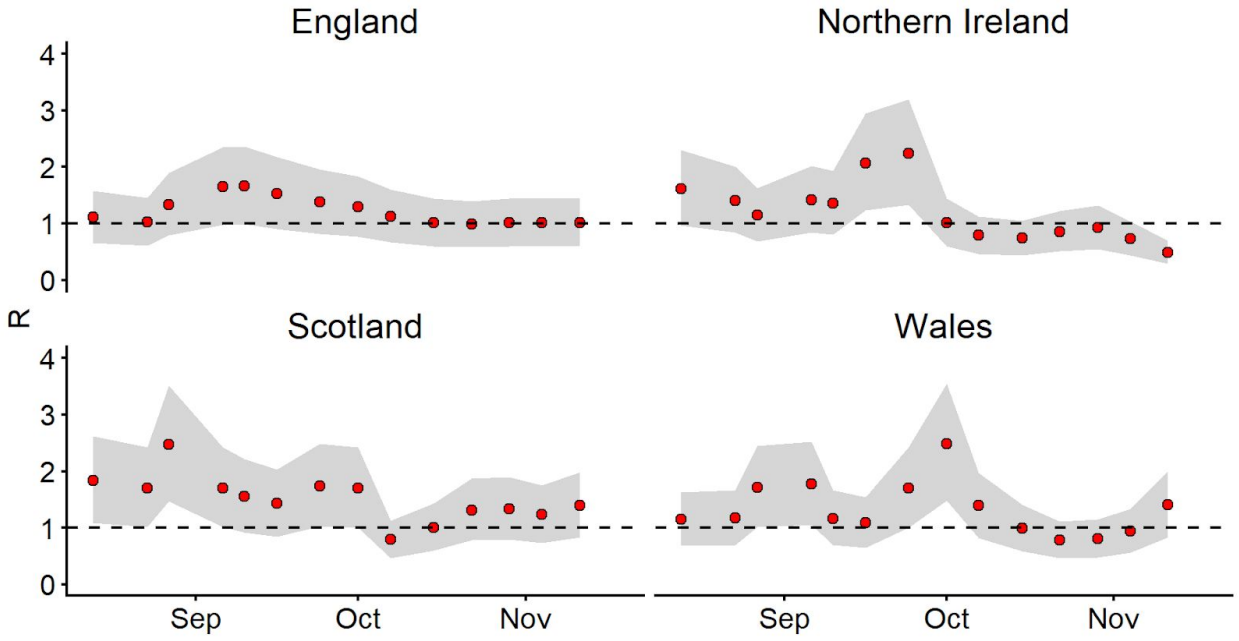

Figure 1: Estimates of R_0 from CoMix by country. Estimates of R_0 by country of the UK, using truncation at 200. R_0 was calculated by applying the ratio of the dominant eigenvalues of CoMix and POLYMOD to an assumed R_0 of 2.6. Excluding the most recent estimate, observations were combined across two weeks to smooth panel variation.

Methods

CoMix is a behavioural survey, launched on 24th of March 2020. The sample is broadly representative of the UK adult population. Participant's are invited to respond to the survey once every two weeks. We collect weekly data by running two alternating panels. Parent's complete the survey on behalf of children (17 years old or younger). Participants record 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[2].

We constructed age-stratified contact matrices for nine age-groups (0-4, 5-11, 12-17, 18-29, 30-39, 40-49, 50-59, 60-69, and 70+). For children participants and contacts, we did not have exact ages and therefore sampled from the reported age-group uniformly. We fitted a truncated negative binomial model to calculate the mean contacts between each participant and contact age-groups. To find the population normalised symmetrical contact matrix, we multiplied the columns of the matrix by the mean-normalised proportion of the UK population in each age-group. For rounds one to six and 17 to 19, where no child participants were surveyed, we used contacts reported by children in rounds seven and eight to construct a full contact matrix. To account and correct for variation in contact patterns at weekends, we calculated rates of contact between age groups for weekends and weekdays separately and combined them by taking the weighted mean for each combination of age-groups .

Using the same approach, we constructed an age-stratified contact matrix for POLYMOD with the same age bands. Since contacts in polymod are right censored at 29, we corrected for this by fitting a truncated negative binomial distribution. For all participants with 29 recorded contacts, we increased the number of contacts according to the fitted distribution with a left censor at 28, and assigned age-groups proportionally to the contacts the participant reported.

We estimated R_0 by applying a scaling factor of the ratio of the dominant eigenvalues of the CoMix contact matrix over the POLYMOD contact matrix. This scaling factor was applied to an estimate of R_0 sampled from a normal distribution with mean of 2.6 and standard deviation of 0.56. We applied this approach to each UK nation with a truncation of 200 per participant contact age group pair.

Supplementary material

Estimating R_0 in England

The estimates of the R_0 using POLYMOD[2] and CoMix[1] appear consistent with the R_t estimates from the REACT1[3] survey (Figure 1). Truncating the contacts reduces the variation around the estimates. Truncating at 50 appears to smooth the data to be more similar to the two round (green) estimates from REACT1 whereas truncating at 200 appears to follow the single round (blue) estimates more closely. Note that R_0 should be higher than R_t as it does not take immunity in the population into account.

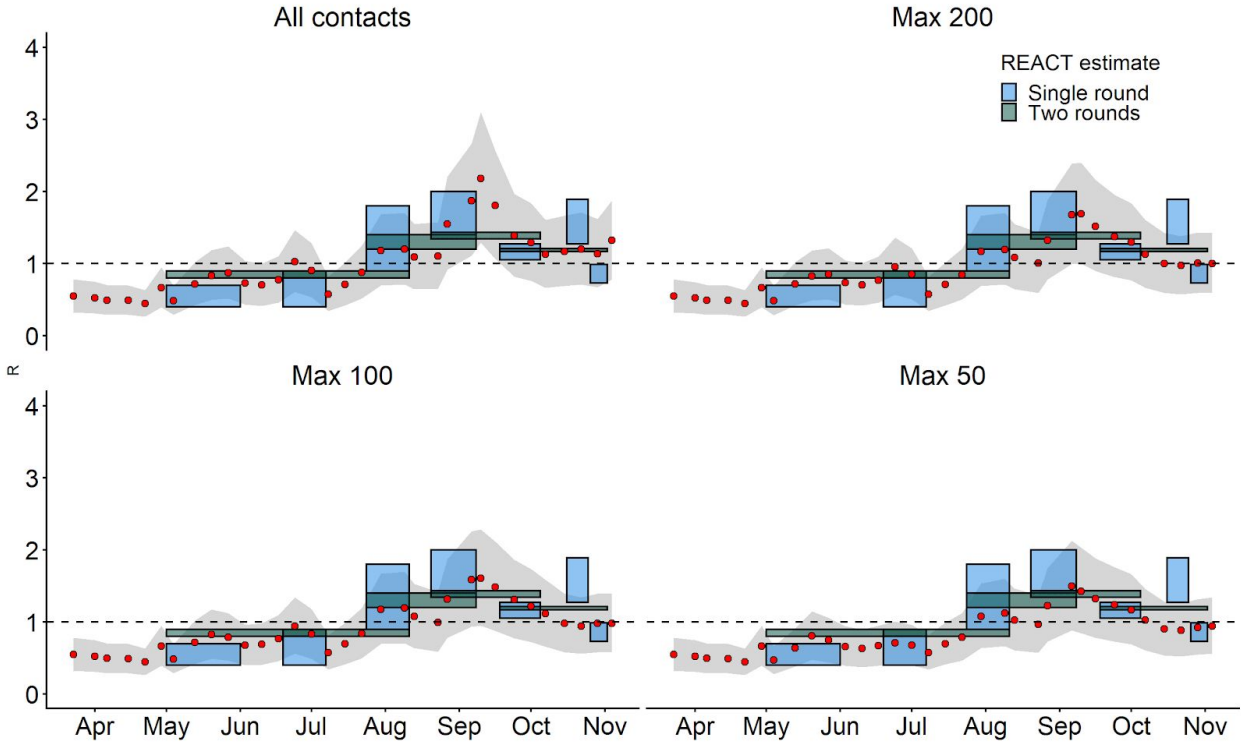

Figure S1: Estimates of R_0 from CoMix compared to R_t from REACT study for England over time. Estimates of R_0 were calculated by applying the ratio of the dominant eigenvalues of CoMix and POLYMOD to an assumed R_0 of 2.6. A truncated negative binomial model was applied to the number of contacts for each participant. The graph displays the impact of no truncations, truncating at 200, 100, and 50, per age-group contact. Excluding the most recent estimate, observations were combined across two weeks to smooth panel variation. For the first 6 weeks, children's data was not collected, as previously shown children's contacts were consistent from the early weeks (schools were closed at the time) and therefore we used children's data from survey week 6 and 7 for weeks that did not collect information on children.

References

1. Jarvis, C. I. *et al.* Quantifying the impact of physical distance measures on the transmission of COVID-19 in the UK. *BMC Med.* **18**, 124 (2020).
2. Mossong, J. *et al.* Social contacts and mixing patterns relevant to the spread of infectious diseases. *PLoS Med.* **5**, e74 (2008).
3. Real-time Assessment of Community Transmission findings. https://www.imperial.ac.uk/medicine/research-and-impact/groups/react-study/real-time-assessment-of-community-transmission-findings/.