The effect of social distancing on the reproduction number and number of contacts in the UK from a social contact survey
Report 17

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Results

Social contacts and basic reproduction number

We estimate R_0 to be 0.75 (95% CI 0.42 to 1.13) for the UK and 0.77 (95% CI 0.44 to 1.13) for England, between the 7st and 15th July, calculated by truncating contacts to a maximum of 100 per participant (Table 1). The R_0 estimates including all contacts are 0.90 (95% CI 0.48 to 1.79) for the UK and 0.77 (95% CI 0.45 to 1.14) for England. The interquartile range remains 1 to 3 for the number of contacts per person. The maximum reported contacts within England this week was 73. Most of the changes in total contacts reflect differences in work contacts.

The median R_0 estimates for the different regions and countries of the UK are presented in Figure 1 and Table 2. The North East and Yorkshire and South West have median estimates slightly above 1. Four other regions/countries, the South West, East of England, Northern Ireland, and North West have median estimates very close to 1.0. The upper bound of the intervals are strongly driven by a small number of individuals with a high number of contacts. The change in the R0 estimate in Scotland is driven by one participant in the 40-49 year age group who reported more than 100 contacts for the first time out of the 13 participants who responded in that age group in week 17. Removing this participant results in an R0 estimate that is consistent with the previous weeks, indicating that regional results should be interpreted with caution in regions with few participants. Participants who responded to the week 17 survey between the ages 35 and 54 have reported an increase in the UK and Scotland in week 17 compared to recent weeks when contacts are truncated to 100 per participant, with England remaining relatively stable (figure 2). Week to week contacts are more stable when truncated to 50 contacts per participant (figure 3). Median contacts have decreased from 2.0 to 1.0 in 18 to 34 year olds and increased from 1.0 to 2.0 in 35 to 54 year olds since week 11. The median was 1.0 for participants age 55 and older for all 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 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*	16	B & D	08/07 to 15/07	1,159	3,573	3.31 (1 to 3)	2.56	0.84 (0.49 to 1.26)
UK* (truncate 100 contacts)	16	B & D	08/07 to 15/07	1,159	3,573	3.08 (1 to 3)	2.56	0.81 (0.47 to 1.20)
England*	16	B & D	08/07 to 15/07	972	2,840	2.92 (1 to 3)	2.58	0.80 (0.46 to 1.20)
England* (truncate 100 contacts)	16	B & D	08/07 to 15/07	972	2,840	2.92 (1 to 3)	2.58	0.80 (0.47 to 1.20)
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)

* 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

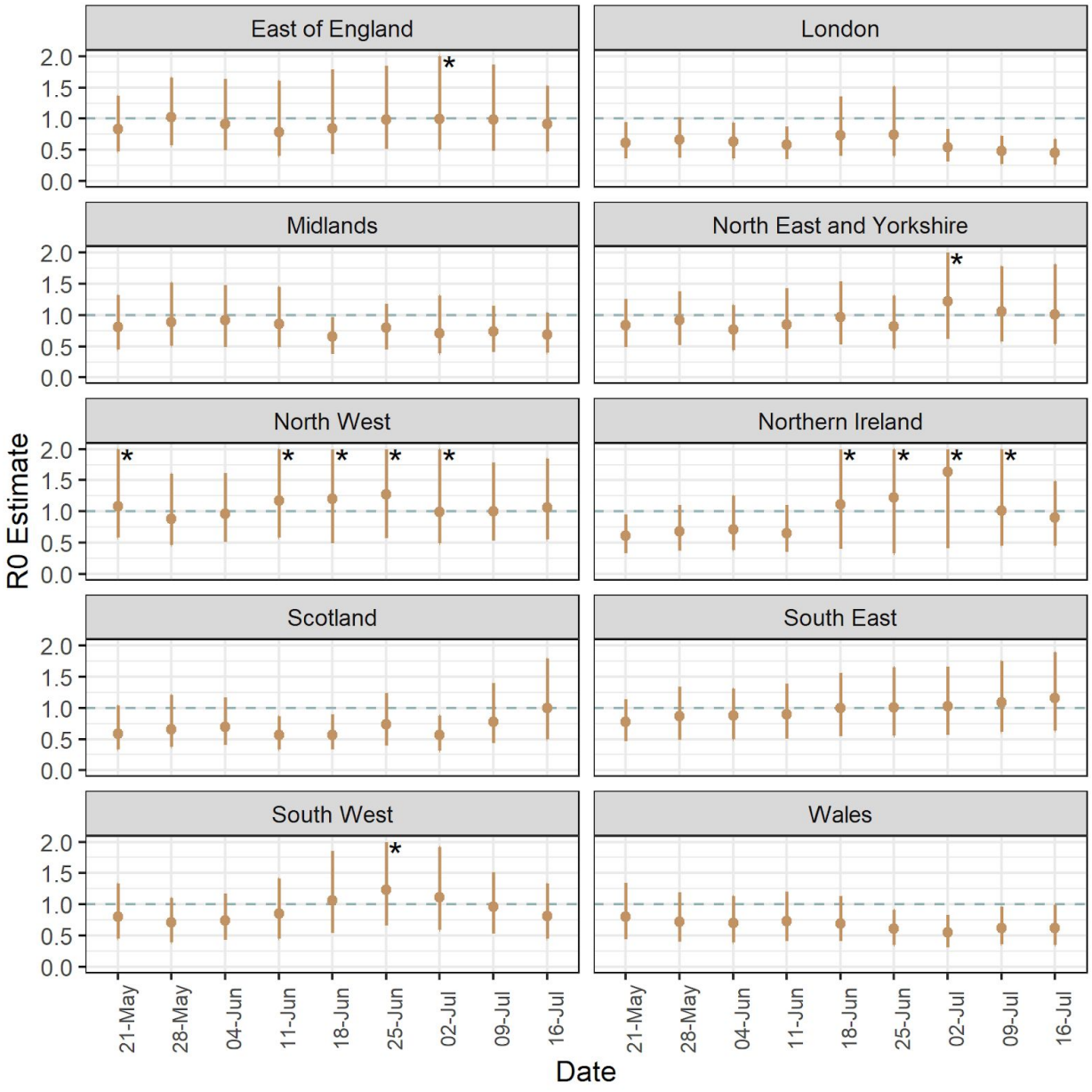

Figure 1. R_0 estimates by countries of the UK and NHS regions of England. The week starting 2nd July contains data between 2nd July and 9th July. The other estimates for prior to 2nd July are a combination of the prior week and the current week. For example the survey sent out on the 21st of May includes 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) 11 June to 25 June (18 June)	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)
East of England	0.84 (0.43 to 1.79)	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)
London	0.73 (0.4 to 1.36)	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)
Midlands	0.66 (0.38 to 0.97)	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)
North East and Yorkshire	0.97 (0.53 to 1.54)	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)
North West	1.2 (0.49 to 2.83)	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)
Northern Ireland	1.11 (0.4 to 4.15)	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)
Scotland	0.57 (0.33 to 0.9)	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)
South East	1 (0.55 to 1.56)	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)
South West	1.06 (0.54 to 1.86)	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)
Wales	0.69 (0.41 to 1.13)	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)

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

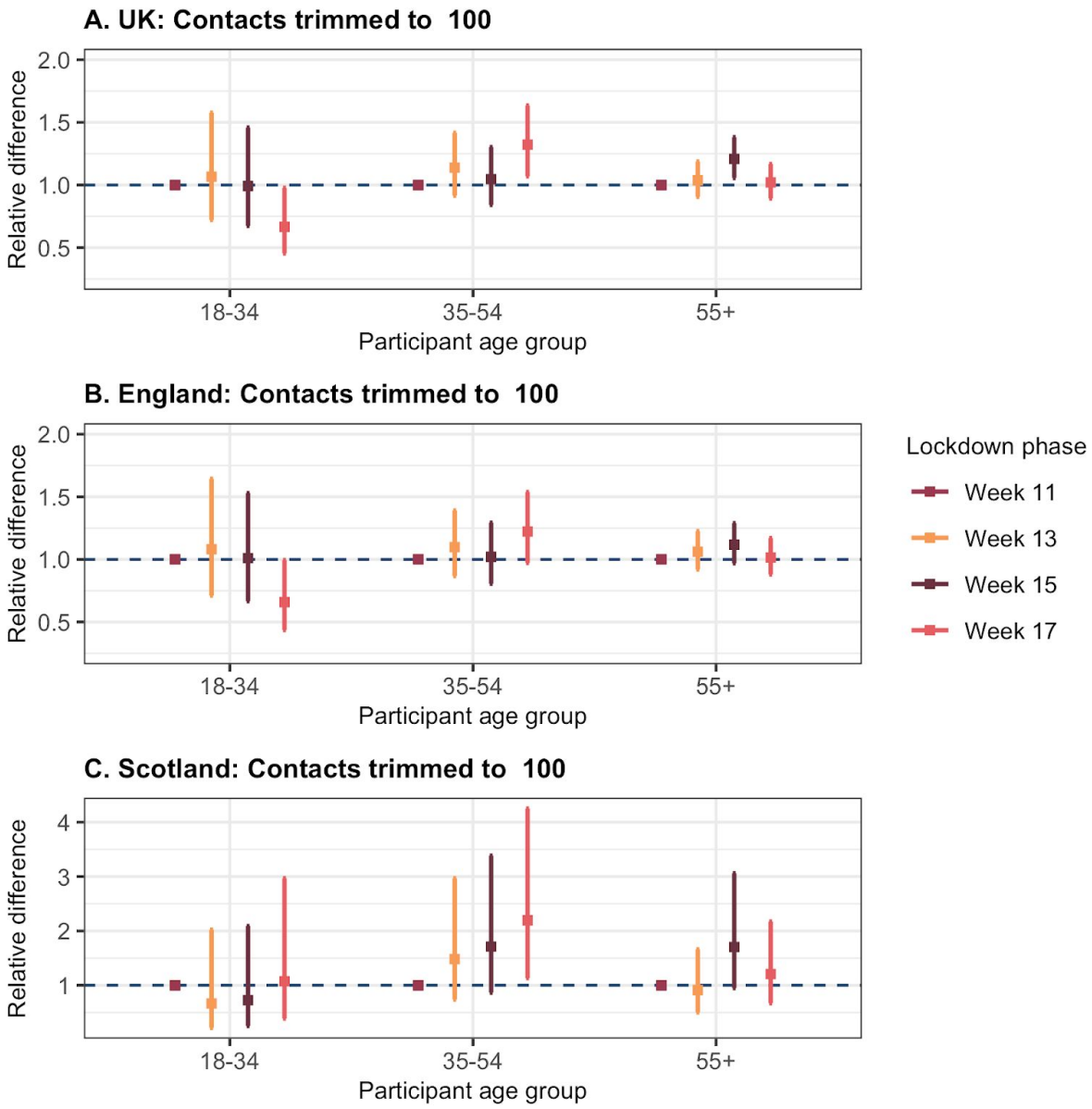

Figure 2. Mean difference in contacts (truncated to 100 contacts per participant). Difference in mean contacts per participant when truncated to 100 contacts in CoMix from Panel A in weeks 11, 13, 15, and 17, with week 11 as the reference week for the UK (A), England (B), and Scotland (C). Only participants who participated in week 17 are included.

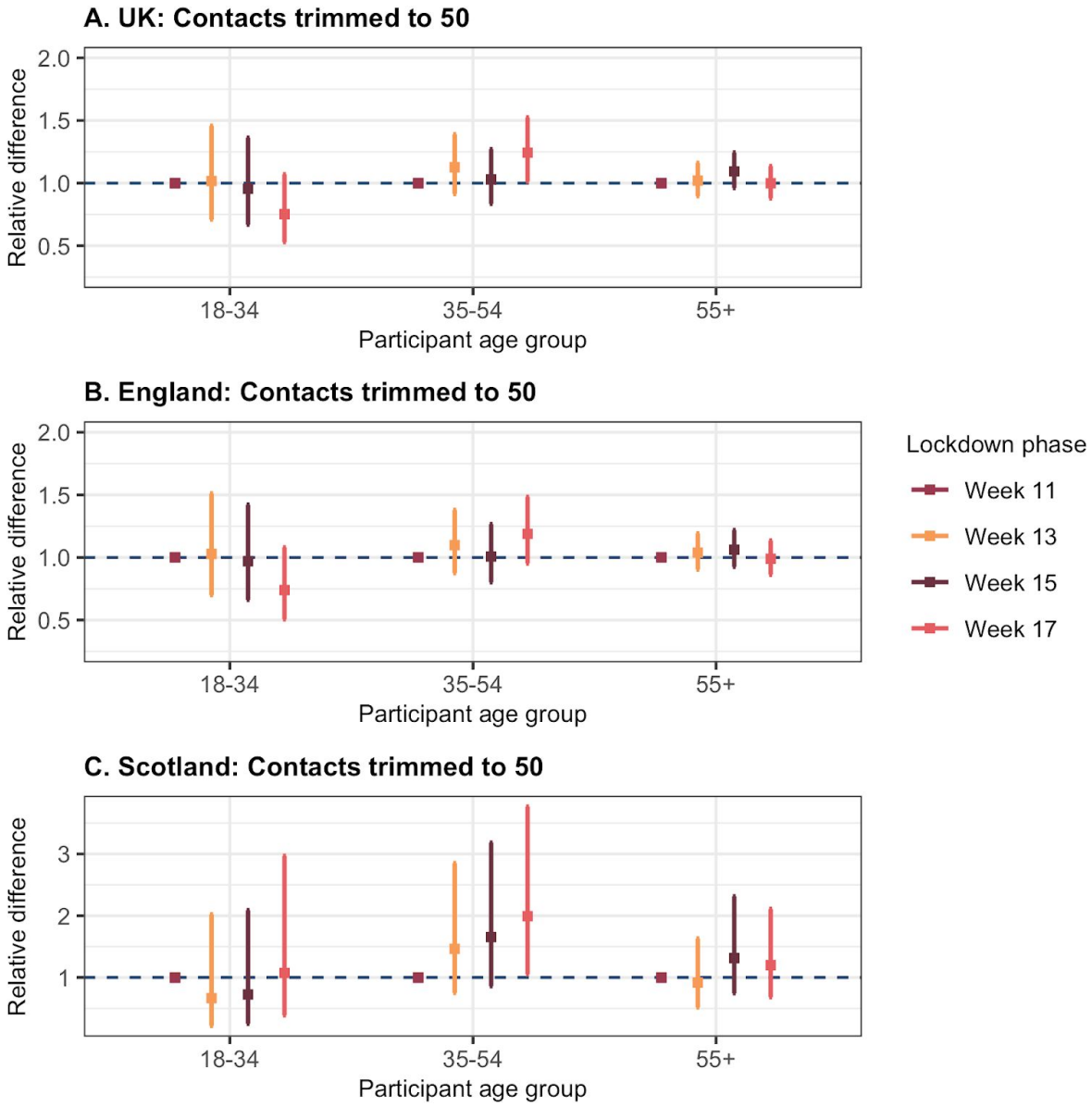

Figure 3. Mean difference in contacts (truncated to 50 contacts per participant). Difference in mean contacts per participant when truncated to 50 contacts in CoMix from Panel A in weeks 11, 13, 15, and 17, with week 11 as the reference week for the UK (A), England (B), and Scotland (C). Only participants who participated in week 17 are included.

Table 3. Median contacts for participants. The median and interquartile range (IQR) for contacts of participants who participated in week 17.

	Contact Median (IQR)		
Week	**Age 18-34**	**Age 35-54**	**Age 55+**
11	2 (1 to 3)	1 (1 to 3)	1 (1 to 2)
13	2 (1 to 3)	1 (1 to 3)	1 (1 to 3)
15	1 (1 to 3)	1 (0 to 3)	1 (1 to 2)
17	1 (1 to 2)	2 (0 to 3)	1 (1 to 2)

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.

Weekly differences in contacts

We assessed regional differences in contacts reported in all settings using a generalised additive model (GAM) to calculate the relative difference in number of contacts by week for Panel A weeks 11, 13, 15, and 17. We used a negative binomial distribution (modelled using a log link function), with smoothed terms for household size, fixed terms for week and age group, and a random effect for participants.

References

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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).