

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

## Report 5

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### **Main conclusion**

We estimate that  $R_0$  has remained unchanged and is still below one. The number of contacts outside of the home has remained low for the past five weeks and there is no suggestion that these contacts are increasing overall or among different subgroups (age, social group, income, employment status, gender, whether their work is closed or not, whether they have isolated or quarantined for one day in the previous seven).

### **Aims**

1. Assess temporal changes in contact patterns and the reproduction number of COVID-19 under social distance measures in the UK.
2. Assess temporal changes in contact outside of the house by characteristics of individuals.
3. Compare sampling and mean contacts to BBC contact matrices

### **Methods**

CoMix is a behavioural survey, with a study sample recruited to be broadly representative of the UK adult (18+) population. It was launched on 24<sup>th</sup> of March 2020 and this analysis includes data collected up to the 27<sup>th</sup> of April. Data is collected weekly, using two different panels who are interviewed using the same questionnaire in alternate weeks. Participants recorded direct, face-to-face contacts that they 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, which is used as a baseline for social mixing in the UK under normal conditions.<sup>2</sup> The panels started with a sample size of 1,816 (Panel A) and 1,560 (Panel B) individuals, final data for Panel B Wave 2 (week 4 of the study) has 1,326 participants and Panel A Wave 3 (week 5 of the study) had 1,144 participants.

### *Change in contact patterns over time*

We calculated the average number of contacts in different settings for each of the five weeks of the survey.

We sample uniformly between the minimum and maximum age reported for the contact, as we do not record exact ages for contacts. We use the reciprocity of contacts to impute child-adult contacts from adult-child 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 impute child-child contacts using the POLYMOD UK data, setting school-contacts to 0 and adjusting contact in other settings (e.g. home) as observed for adults. Further details of the approach can be found here.<sup>1,3</sup>

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 Polymod 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 2,000 bootstrap samples of the CoMix and POLYMOD contacts matrices, and applying these ratios to 2,000 sampled values of  $R_0$ .

We repeated this process separately for each of the five weeks of data collection so far and present estimates of  $R_0$  for two scenarios: if transmission would be driven by all direct conversational (face-to-face) contacts, and if it would be driven by physical conversational contacts.

### *Temporal changes in contact outside of the house by characteristics of individuals*

The relationship between contacts and household size was assessed using boxplots to compare the total number of contacts, number of contacts outside the house, and contacts outside of work were compared to household size ignoring time.

Due to the household size and total contacts being associated, we focussed on contacts outside of the house as a metric of change in contact patterns over time. The distribution of contacts outside the home is skewed and therefore we present bar plots over time of the percentage of participants with zero, one, two, and three or more contacts outside of the home.

In order to assess changes in behaviour during the lockdown, area plots were used to show the changes in number of contacts outside of the home over time for age, social group, income, employment status, gender, whether their work is closed or not, whether they have isolated or quarantined for one day in the previous seven.

## Results

Between the 24<sup>th</sup> of March and the 27<sup>th</sup> of April we collected 7,172 observations from 3,504 individual participants, with information on 17,943 contacts. These consist of three full rounds of survey for Panel A and two full rounds for Panel B.

### *Change in contact patterns and estimation of reproduction number*

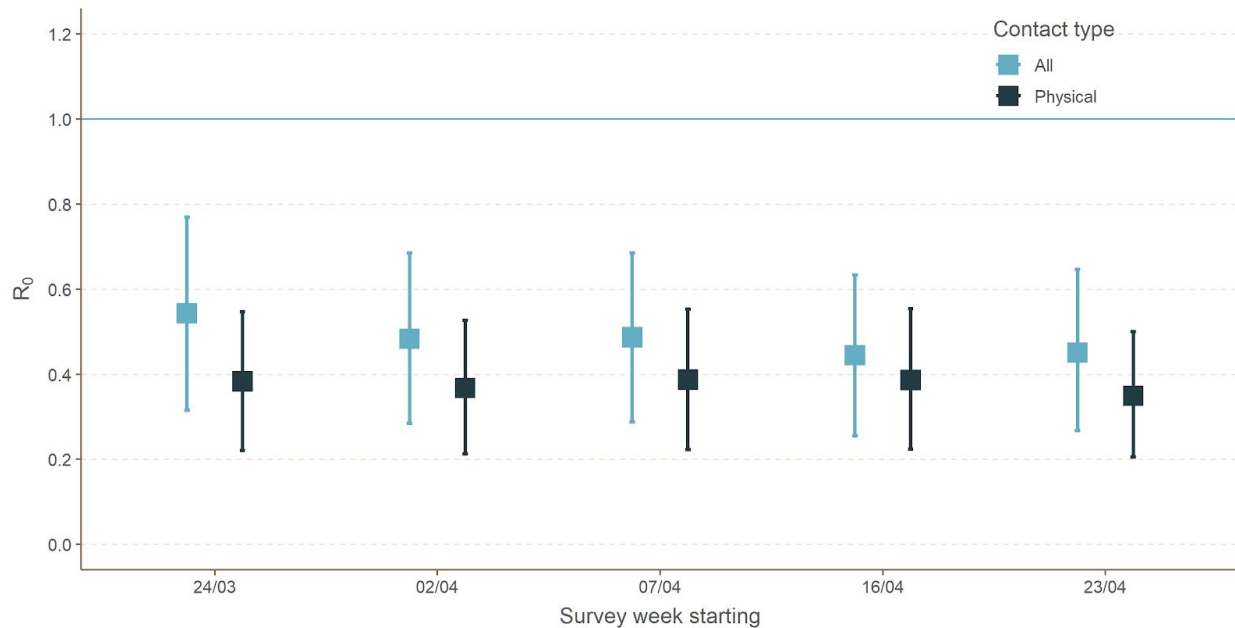
Table 1 gives the reported number of contacts made by the participants and the overall estimate of the reproduction number for the five weeks of the survey (also shown in Figure 1).

For week 5 (Between 16<sup>th</sup> April and 24<sup>th</sup> April) we estimated  $R_0$  to be 0.45 (95% CI 0.27 to 0.65) if transmission is driven by all direct contacts and 0.35 (95% CI 0.21 to 0.50) if transmission is driven by physical contacts only. There was a suggestion of a reduction in average number of daily contacts per person from 2.72 in week 1 to 2.27 in week 5 for all contacts, though interquartile ranges remain similar for all 4 weeks. Further, the average household size among participants has also decreased from 2.77 to 2.51. The ranges of  $R_0$  are consistent for all five weeks though the point estimates show some decrease. Caution should be taken not to over-interpret this as there are some changes in participants between the weeks. The average number of physical contacts and  $R_0$  for physical contacts only are very similar across the five weeks. The majority of contacts continue to occur within homes and other indoor settings, most participants report few contacts at work, with some outliers reaching over 50 contacts.

**Table 1. Numbers of participants, reported contacts and reproduction numbers by week.**

Numbers of participants (N) in each panel, their number of contacts reported and the estimate of the reproduction number,  $R_0$  by week and type of contact.

Week	Panel	Dates	N	Contact Type	Contacts	Mean (IQR)	HHsize	$R_0$ mean (95% CI)
1	A	24/03 to 01/04	1816	All	4941	2.72 (1 to 4)	2.77	0.53 (0.33 to 0.75)
				Physical	1522	0.84 (0 to 1)		0.39 (0.23 to 0.56)
2	B	02/04 to 10/04	1560	All	4002	2.57 (1 to 3)	2.66	0.48 (0.28 to 0.69)
				Physical	1266	0.81 (0 to 1)		0.37 (0.21 to 0.53)
3	A	07/04 to 15/04	1326	All	3263	2.46 (1 to 3)	2.58	0.49 (0.29 to 0.68)
				Physical	1119	0.84 (0 to 1)		0.39 (0.22 to 0.55)
4	B	16/04 to 21/04	1326	All	3139	2.37 (1 to 3)	2.49	0.44 (0.25 to 0.63)
				Physical	1132	0.85 (0 to 1)		0.39 (0.22 to 0.55)
5	A	23/04 to 27/04	1144	All	2598	2.27 (1 to 3)	2.51	0.45 (0.27 to 0.65)
				Physical	886	0.77 (0 to 1)		0.35 (0.21 to 0.50)



**Figure 1: Weekly  $R_0$  estimates.**

*Regional differences in contacts for different settings across the UK.*

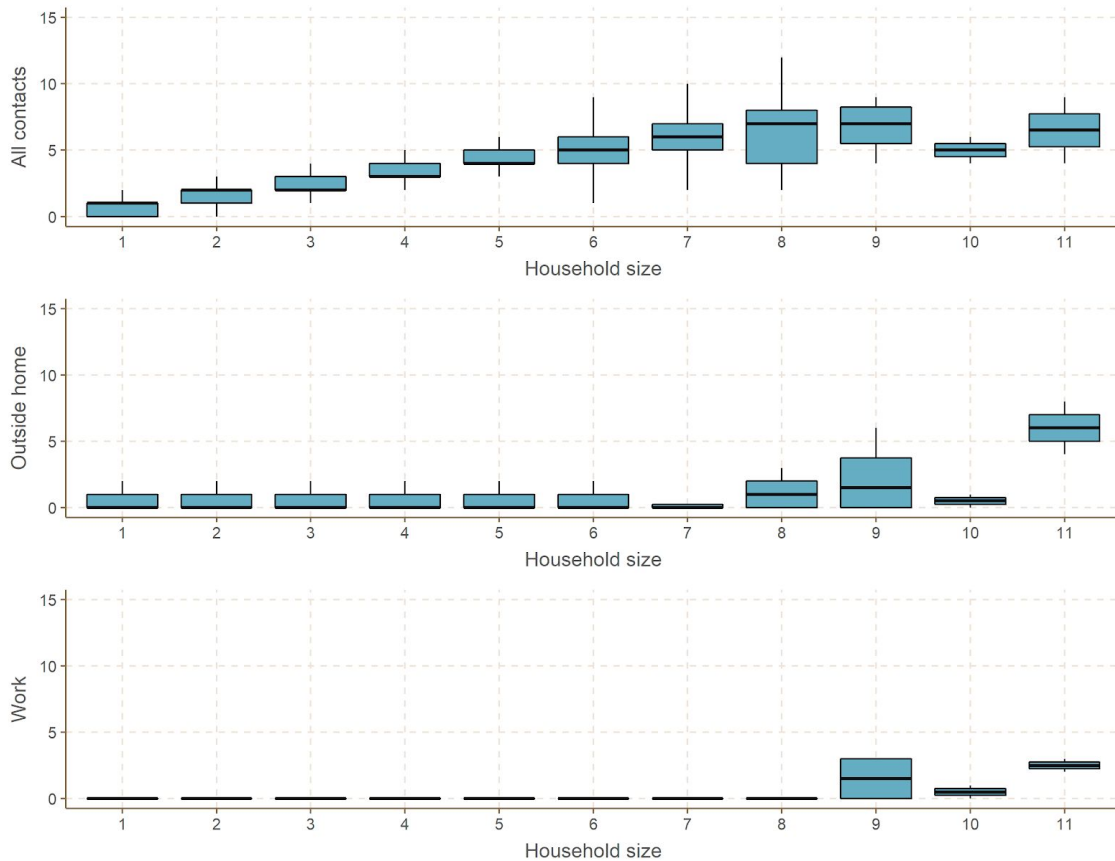
*Temporal changes in contact outside of the house by characteristics of individuals.*

The total number of contacts reported in the CoMix survey looks in part to be driven by the average household size as can be seen in Figure 2 and Table 1. The point estimates of the average number of total contacts has been decreasing over the five weeks of study from 2.72 to 2.27, and correspondingly the average house size of participants has also dropped from 2.77 to 2.51. In Figure 2, the total number of contacts rises linearly with the household size up to households of size seven, with only nine participants with a household larger than seven in our study.

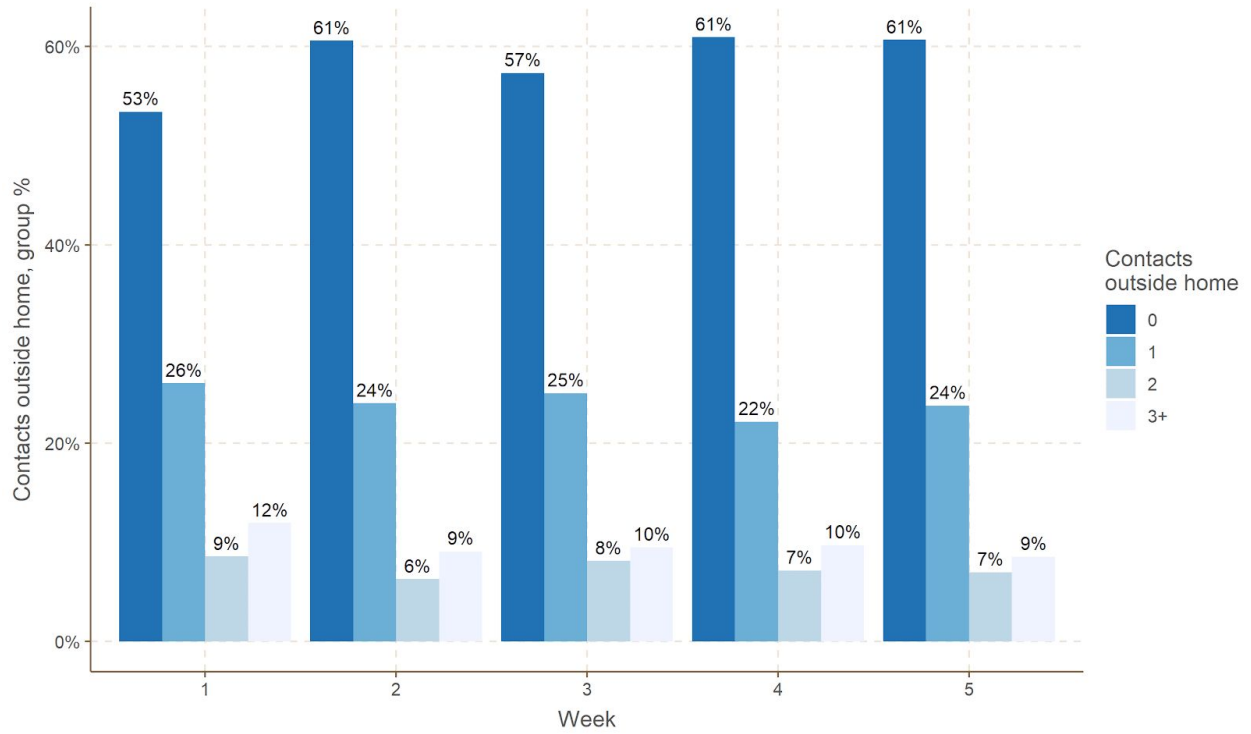
The number of contacts outside the home, and the number of work contacts do not appear to be associated with household size (Figure 2). The proportion of participants reporting zero work contacts was 93.1% in the previous week (week 5) of the survey, and 51.9% of working participants report their work is closed and likely many more working from home. Changes in work contacts at present are minimal, though this information will become useful as government restrictions are lifted.

Due to the above reasons, we therefore explored the number of contacts outside of the home over the course of the longitudinal survey to assess for changes in contact patterns among different individual level characteristics. The data has been collected on the same participants every two weeks and is therefore less affected by between person sampling variability.

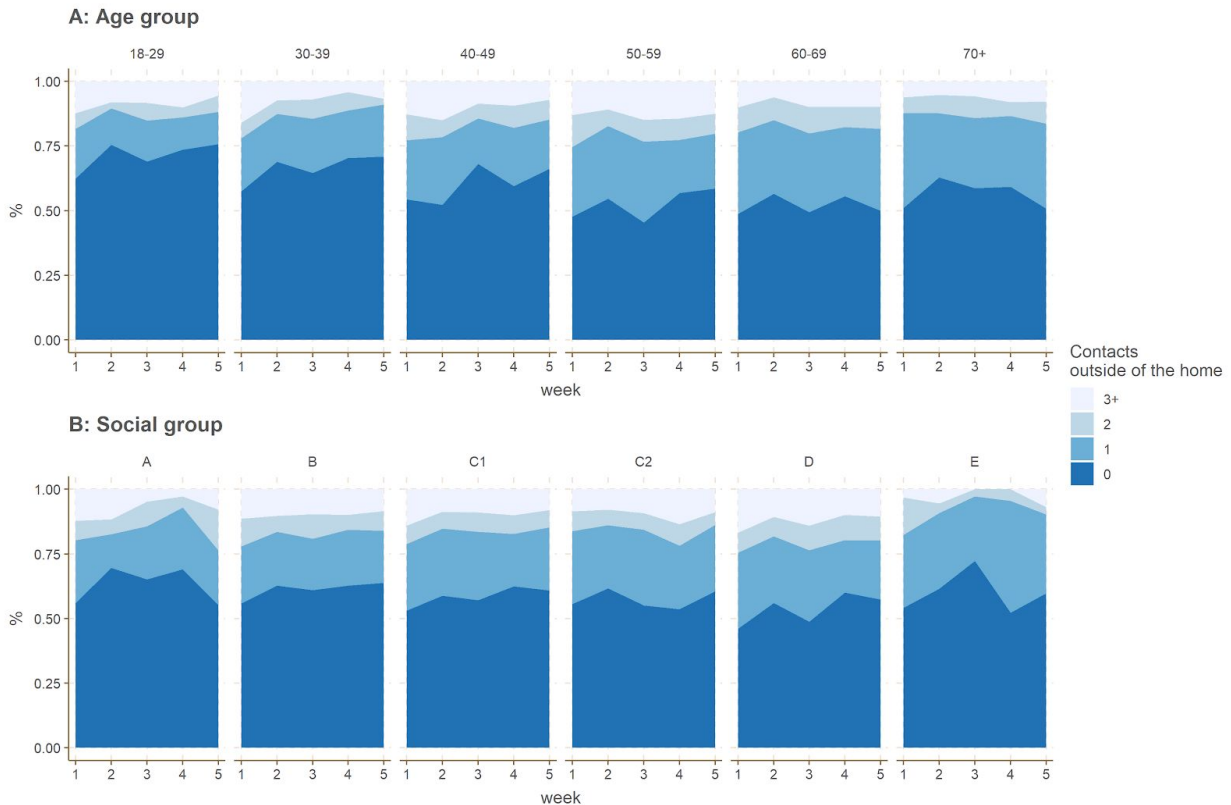
The distribution of contacts outside the home is skewed with approximately 10% of participants having three contacts or more and the majority of participants reporting zero contacts as can be seen in Figure 3. The distribution is consistent across all five weeks of the survey, with the slight suggestion the proportion of people reporting zero contacts outside of the home may be increasing. This may be a selection bias, as individuals who are working and therefore have more contacts may be less likely to respond to the survey multiple times. For the participants that responded three times 34.3% were employed full time versus 42.1% for participants who only responded once.



**Figure 2:** Comparison of household size and the average number of contacts for all contacts, contacts outside of the home, and contacts at work. Increasing household size results in an increase in the number of reported contacts, the majority of which occur at home. Contacts outside of the home, and at work are not associated with household size, with the average number of work contacts being near zero in almost all household sizes.



**Figure 3:** Percentage of individuals who had 0, 1, 2, or 3+ contacts outside of the home by week. A higher percentage of zero contacts means more people have reported zero contacts outside of the house.



**Figure 4.1:** Area plot showing the percentage of participants that have zero, one, two, and three or more contacts outside of the home by A: Age group and B: social group. Social group: A - Upper middle class, B - Middle class, C1 - Lower middle class, C2 - Skilled working class, D - Working class, E - Lower level of subsistence.

In Figure 4.1 panel A, the proportion of participants with zero contacts outside of the home appears to decrease as age increases, though all ages have more than half of participants reporting zero contacts across the five weeks. The time trends within age groups are suggestive of an increase in the number of participants with no contacts, but no clear suggestions of a change in overall number of contacts.

In 4.1 panel B the patterns are mostly consistent across social groups, with again a large proportion reporting zero contacts. The proportion of participants reporting three or more contacts remains steady across the five weeks. There are more pronounced changes within social group A - Upper middle class and E - lower level of subsistence but these groups have the fewest participants with less 70 in each category versus 200-550 in other categories.

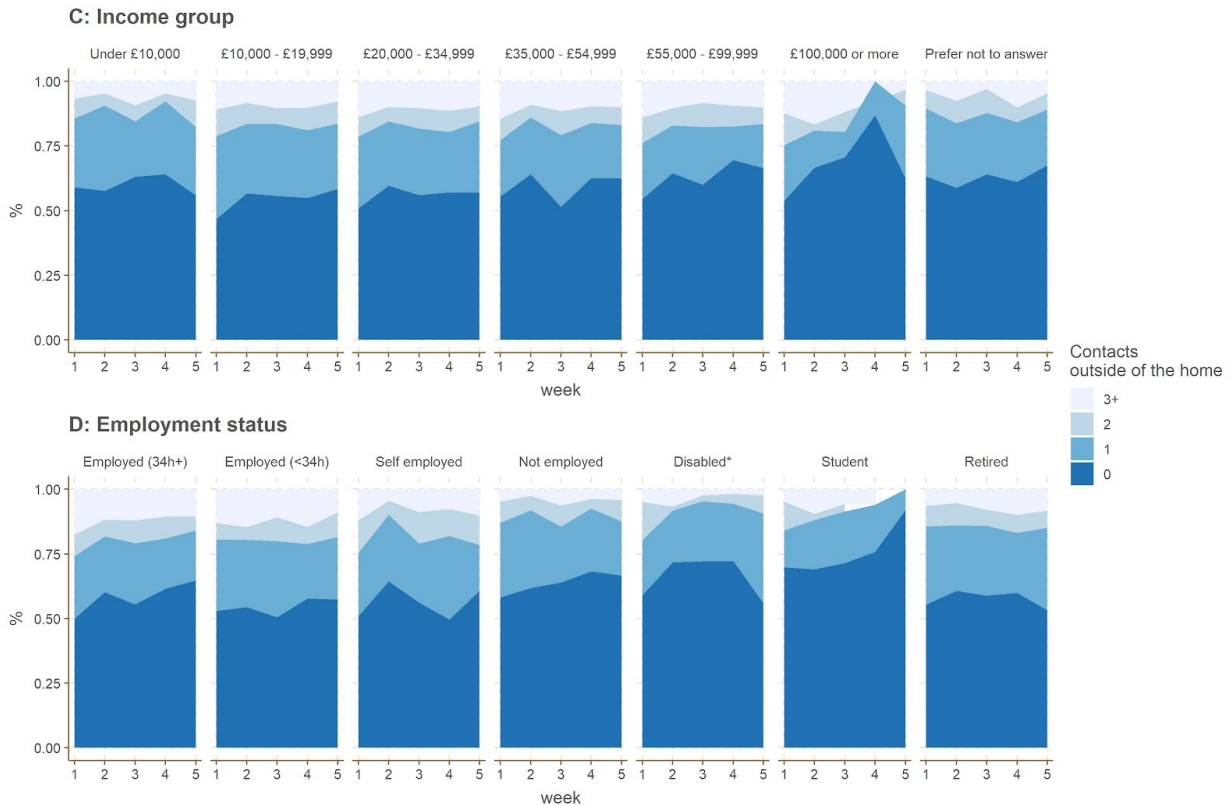
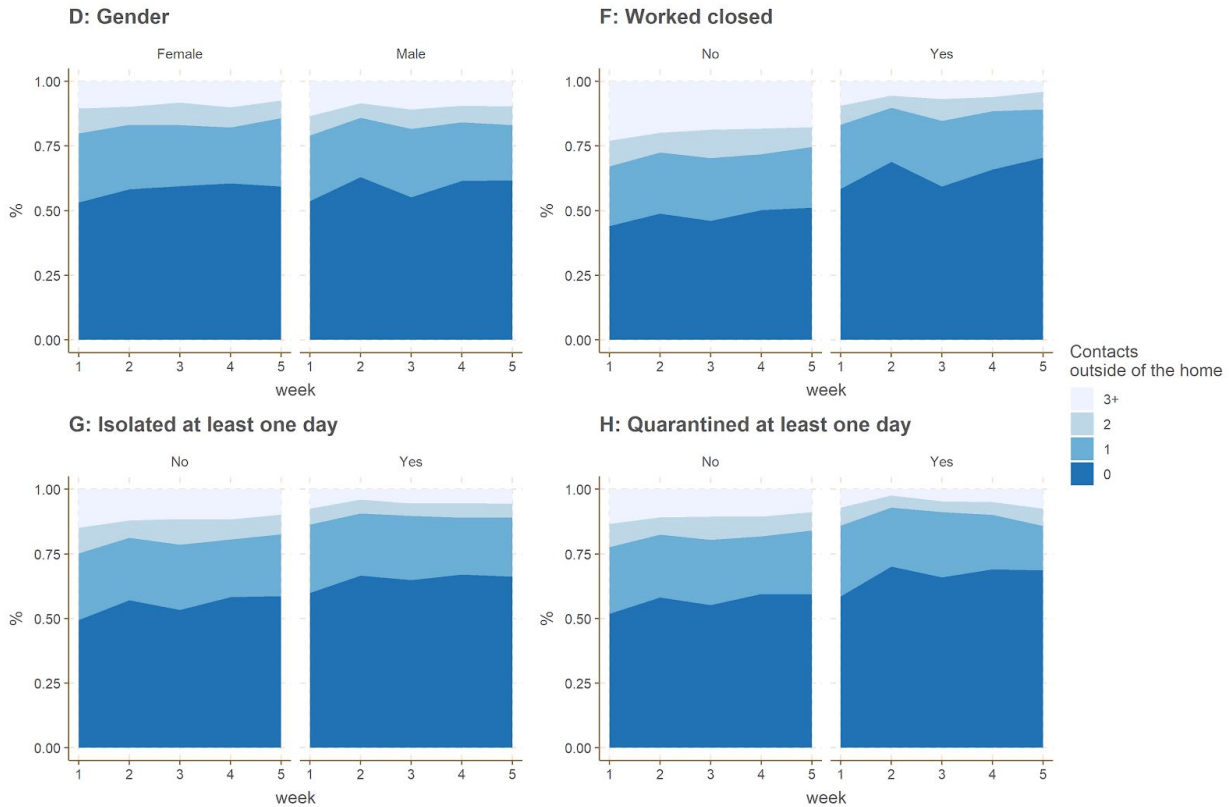


Figure 4.2: Area plot showing the percentage of participants that have zero, one, two, and three or more contacts outside of the home by C: Income group and D: Employment status. \* Disabled and long-term sick

Figure 4.2 panel C, the patterns of contacts are fairly consistent across incomes, with more than 50% of participants reporting zero contacts across the five week. There is a slight suggestion of a larger number of participants reporting three or more contacts from incomes £10,000 onwards. There are fewer than 65 participants earning £100,000 or more and the increase in participants reporting zero contacts is likely due to only 32 participants being reported in that category for week 5.

In 4.2 panel D, the proportion of people with 3 or more contacts seems to be slightly larger for employed and self-employed compared to individuals who are not employed. However, the proportion of people with zero contacts is consistent with employment status with higher numbers of participants with zero contacts among students, though students and people living with disabilities have the fewest number of individuals, with 70 participants in each group per week.





*Figure 4.3: Area plot showing the percentage of participants that have zero, one, two, and three or more contacts outside of the home. D: Gender, F: Whether the participant has their work closed. G: If the participant has been in isolation at least one day in the seven days prior to the survey. H: If the participant has been in quarantine at least one day in the seven days prior to the survey.*

There are minimal, if any differences in the number of contacts outside of the home between Males and Females (Figure 4.3 panel D). Less than half of individuals who report their work as open (work not closed) report zero contacts outside of the home. There is also a larger proportion of individuals reporting three or more contacts (Figure 4.3 panel F). The patterns across time for the number of reported contacts are stable for participants with their work closed and open. Figure 4.3 panel G and H reflects the number of contacts outside of the home for individuals who have either been isolated or quarantined for at least one day in the seven days prior to the survey. There appears to be a slightly higher proportion of individuals reporting three or more contacts amongst those who have not isolated or quarantined, though differences are small. Changes over time appear to be small.

## Discussion

In the fifth week of the study and UK lockdown, we estimate that the reproduction number has remained consistently below one since the beginning of lockdown (assuming that it was 2.6 on average before physical distancing interventions). The average household size is positively associated with the number of total contacts, particularly as at present few contacts are reported outside of the home.

We considered changes in the number of contacts outside of the home for the five weeks of the lockdown. The patterns present in week 1 are consistent with those seen across the five weeks, and there is little suggestion of increases in contacts outside of the home. Differences in contact patterns appear small comparing the social group, income, employment status, gender, whether their work is closed or not, and whether they have been isolated or quarantined for one day in the previous seven. There are differences in age and whether an individual's work is still open or closed. However, these main differences appear to be between different characteristics as opposed to within a characteristic.

A major potential limitation is that this study may not be capturing individuals who are breaking lockdown rules and there may be a social desirability bias which results in an underreporting of the number of contacts.

## References

- 1 Jarvis CI, Van Zandvoort K, Gimma A, *et al.* Quantifying the impact of physical distance measures on the transmission of COVID-19 in the UK. *Epidemiology*. 2020; published online April 3. DOI:10.1101/2020.03.31.20049023.
- 2 Mossong J, Hens N, Jit M, *et al.* Social contacts and mixing patterns relevant to the spread of infectious diseases. *PLoS Med* 2008; **5**: e74.
- 3 Klepac P, Kucharski AJ, Conlan AJK, *et al.* Contacts in context: large-scale setting-specific social mixing matrices from the BBC Pandemic project. *Epidemiology*. 2020; published online Feb 19. 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* 2006; **164**: 936–44.

## Appendix

### BBC Pandemic Survey Comparison

We have compared the mean household size and mean number of contacts from CoMix and BBC Pandemic surveys by age and region to cross reference results in Figure S1. Age-specific contact patterns seem consistent across regions in both the BBC and CoMix survey.

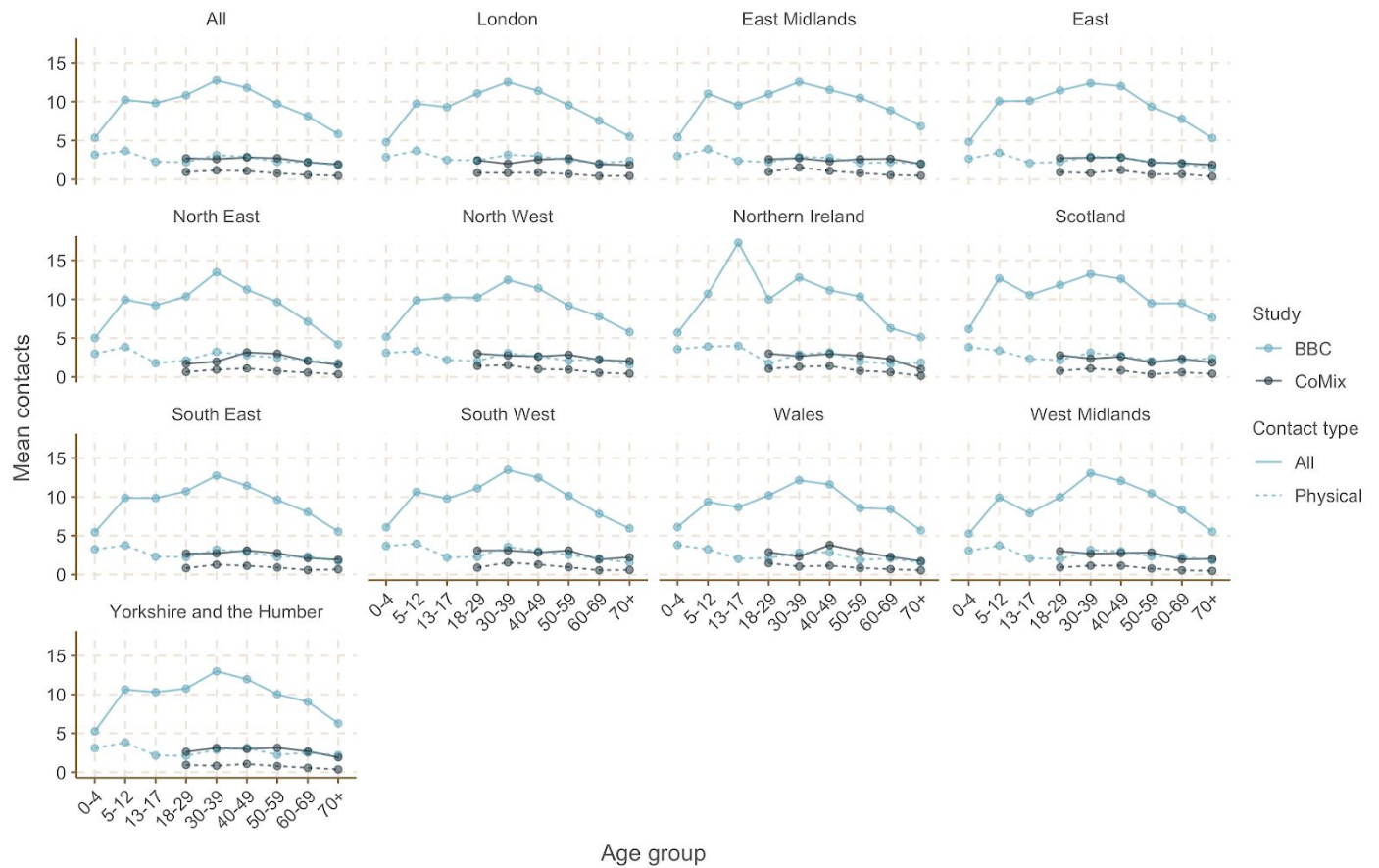


Figure S1. Mean contacts by age group and region from the BBC Pandemic and CoMix surveys for all contacts and physical contacts.

We compare our mean household size overall between CoMix, BBC Pandemic, and POLYMOD surveys overall, and by region for CoMix and BBC Pandemic surveys in Figure S2. The mean household size is higher in the BBC Pandemic study, which suggests that we may be underestimating household contacts. Though the household size is consistent across regions for CoMix and BBC. We will continue to monitor our sample for changes, and will account for household size differences in future analyses.

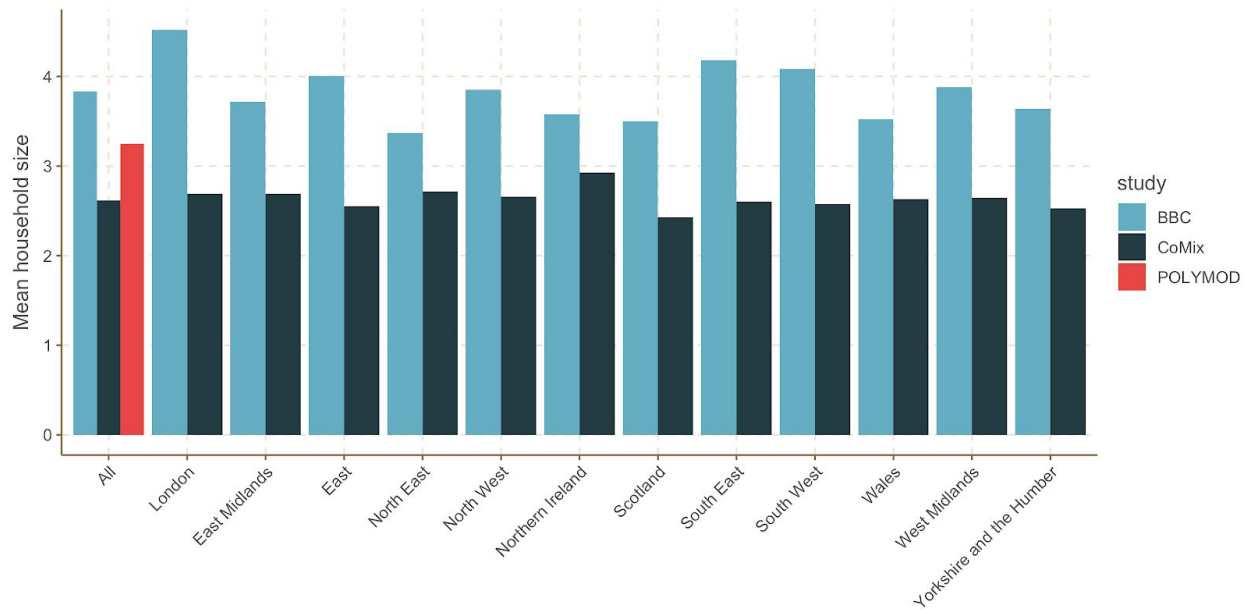


Figure S2. Mean household size overall and by region for the BBC Pandemic, CoMix, and POLYMOD surveys. Regional results from the POLYMOD survey are not available.