1 Estimating the impact of reopening schools on the reproduction number
2 of SARS-CoV-2 in England, using weekly contact survey data

3 *James D Munday*[1a], Christopher I Jarvis*[1b], Amy Gimma[1c], Kerry LM Wong[1d], Kevin van*

4 *Zandvoort[1e], CMMID COVID-19 Working Group, Sebastian Funk[1f], W. John Edmunds[1g]*

5 *1 Centre for Mathematical Modelling of Infectious Disease, London School of Hygiene and*

6 *Tropical Medicine.*

7 *a: James.Munday@lshtm.ac.uk (Corresponding Author)*

8 *b: Christopher.Jarvis@lshtm.ac.uk*

9 *c: Amy.Gimma@lshtm.ac.uk*

10 *d: Kerry.Wong@lshtm.ac.uk*

11 *e: Kevin.Van-Zandvoort@lshtm.ac.uk*

12 *f: Sebastian.Funk@lshtm.ac.uk*

13 *g: John.Edmunds@lshtm.ac.uk*

14 **Abstract**

15 *Background*

16 Schools have been closed in England since the 4th of January 2021 as part of the national

17 restrictions to curb transmission of SARS-CoV-2. The UK Government plans to reopen

18 schools on the 8th of March. Although there is evidence of lower individual-level

19 transmission risk amongst children compared to adults, the combined effects of this with

20 increased contact rates in school settings are not clear.

21 *Methods*

22 We measured social contacts when schools were both open or closed, amongst other

23 restrictions. We combined these data with estimates of the susceptibility and infectiousness

24 of children compared with adults to estimate the impact of reopening schools on the

25 reproduction number.

26 *Results*

27 Our results suggest that reopening all schools could increase R from an assumed baseline

28 of 0.8 to between 1.0 and 1.5, or to between 0.9 and 1.2 reopening primary or secondary

29 schools alone.

30 *Conclusion*

31 Our results suggest that reopening schools is likely to halt the fall in cases observed in

32 recent months and risks returning to rising infections, but these estimates rely heavily on the

33 current estimates or reproduction number and the current validity of the susceptibility and

34 infectiousness profiles we use.

35 **Keywords**: School closure, SARS-CoV-2, COVID-19, Social Contacts, Reproduction
36 Number, CoMix

Introduction

School closures have been implemented in many countries as part of a broader response to the COVID-19 pandemic [1]. It is well established that children are at low risk of hospitalisation and death as a direct result of infection [2, 3]. Despite this lower risk, there is concern that allowing transmission amongst younger age-groups increases risk of infection in adults, who are at substantially higher risk. The role of schools in transmission is therefore an important question. On the 4th of January 2021, a third national lockdown was announced in England to curb transmission of SARS-CoV-2 [4]. This included the closure of schools, a measure the UK government plans to reverse on the 8th of March.

The direct and indirect impact of school closures and eventual reopening is still unclear. There is mixed evidence around the role of schools in community transmission. Existing studies of transmission within schools have wide ranging results [5–7]. Other work demonstrates an increased prevalence amongst school-aged-children when schools return [8, 9] and a higher risk of infections entering households through children than adults. However, the evidence that schools drive transmission in the community remains scarce [10, 11]. A particular challenge for many analyses is bias resulting from the age-dependence in case ascertainment due to varying rates of asymptomatic infection [12]. This challenge is then further complicated by changes in epidemiology due to the emergence of new variants [13].

The potential change in transmission of SARS-CoV-2 upon reopening schools predominantly depends on a combination of two factors. Firstly, the age-specific risk of transmission upon contact. Secondly, the likely increased rate of contact between members of the population due to school reopening. Multiple studies aimed at understanding the relative transmission risk associated with children indicate lower susceptibility [14–16] and some indicate lower infectiousness [14]. However, evidence of lower transmission risk amongst children alone is insufficient to quantify the impact of reopening schools. There is a need to combine the

63 estimates of reduced susceptibility and infectiousness with age specific contact patterns in

64 this age-group social contacts amongst school-aged-children.

65 There is abundant evidence that children's contacts increase when schools are open,

66 presenting opportunities for increased infectious disease transmission which is well

67 documented in other pathogens such as influenza [17]. Nonetheless, it is important to

68 capture how these contacts vary under the specific conditions presented during the current

69 pandemic response, where social distancing and other mitigations are in effect within

70 schools.

71 CoMix is a large-scale comprehensive social contact survey which has collected data on

72 social contacts in the UK on a weekly basis since the 24th of March 2020 [18]. In this paper,

73 we estimate the impact of opening schools on the reproduction number in England, by

74 combining social-contact data collected during periods where schools were open and closed

75 [18] with estimates of age-stratified susceptibility and infectiousness [14–16].

4

Methods

CoMix Data

CoMix is a longitudinal behavioural survey, launched on the 24th of March 2020. The sample

is broadly representative of the UK adult population with data collected from approximately

2000 individuals per week. Participants are invited to respond to the survey once every two

weeks. We collected weekly data by running two alternating panels. Parents 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 the contact occurred (e.g. at home, work, while undertaking leisure

activities, etc). Further details have been published elsewhere [18]. The contact survey is

based on an approach developed for the POLYMOD contact survey [19]. We provide a brief

descriptive analysis of the contacts recorded during the November and January lockdown

periods by age group and geographical region.

Constructing contact matrices and estimating reproduction number

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+). Participants did not report exact ages of contacts, we

therefore sampled from the reported age-group with a weighting consistent with contacts

reported in the POLYMOD survey. We fitted a truncated negative binomial model to calculate

the mean contacts between each participant and contact age-groups. To ensure reciprocity

in contacts, we multiplied the matrix by population size vector for England, using United

Nations World Population Prospects data [20], before taking the cross-diagonal mean and

then dividing by the same population vector again.

Profiles of Age-dependent transmission risk

We consider five age-dependent susceptibility and infectiousness profiles (Table 1):

101 The first profile (i) assumed equal susceptibility and infectiousness in all age groups. This is

102 unlikely to reflect reality but provides an upper limit as a reference point to compare the other

103 profiles.

104 For the second profile (ii) we used results from a mathematical modelling study by Davies et.

105 al [14]. which estimated relative susceptibility and clinical fraction in 9 age groups. The work

106 also reports estimates of 50% infectiousness of sub-clinical cases and reports clinical

107 fraction by age. We used this to calculate infectiousness per age group further detailed in

108 Table 1.

109 The third profile (iii), was based on analyses of household transmission patterns from the

110 Office for National Statistics (ONS) Community Infection Study [15]; 50% susceptibility in

111 children relative to adults but equal infectiousness.

112 For the fourth profile (iv), we performed a meta-analysis of prevalence studies included in a

113 systematic review by Viner et al [16]. We used a random effects model based on the data

114 from Figure 4 of their paper. This resulted in 64% (51% - 81%, 95% confidence interval [CI])

115 susceptibility in children relative to adults, we assumed equal infectiousness between

116 children and adults [16];

117 For the fifth profile (v), we used an independent estimate of relative susceptibility in children

118 (31%, see results section), quantified by comparing reproduction numbers estimated from

119 CoMix data and using a well-established time-series method developed by Abbott et. al [21],

120 which uses a time-series of cases to determine the instantaneous reproduction number

121 under an assumed generation interval and infection to reporting delay distribution.

6

122 **Table 1** Susceptibility and infectiousness profiles taken from Davies et.al.[14], ONS reports
123 and Viner et al[16]

Study	Age groups	Susceptibility	Infectiousness	Clinical Fraction
Davies et al[1]	0-4	0.4 (0.25, 0.57)	0.61	0.29 (0.18, 0.44)
	5-10	0.4 (0.25, 0.57)	0.61	0.29 (0.18, 0.44)
	11-17	0.4 (0.27, 0.53)	0.61	0.21 (0.12, 0.31)
	18-29	0.79 (0.59, 0.96)	0.64	0.27 (0.18, 0.38)
	30-39	0.86 (0.69, 0.98)	0.67	0.33 (0.24, 0.43)
	40-49	0.80 (0.61, 0.96)	0.70	0.40 (0.28, 0.52)
	50-59	0.82 (0.63, 0.97)	0.75	0.49 (0.37, 0.60)
	60-69	0.88 (0.70, 0.99)	0.82	0.63 (0.49, 0.76)
	70+	0.74 (0.56, 0.90)	0.85	0.69 (0.57, 0.82)
		Susceptibility	Infectiousness	
ONS[2]	0-4	0.5 (0.35, 0.75)	1.0 (0.7, 1.5)	
	5-10	0.5 (0.35, 0.75)	1.0 (0.7, 1.5)	
	11-17	0.5 (0.35, 0.75)	1.0 (0.7, 1.5)	
	18-29	1.0	1.0	
	30-39	1.0	1.0	
	40-49	1.0	1.0	
	50-59	1.0	1.0	
	60-69	1.0	1.0	
	70+	1.0	1.0	
		Susceptibility	Infectiousness	
Viner et al[3]	0-4	0.64 (0.51, 0.81)	1.0 (assumed)	
	5-10	0.64 (0.51, 0.81)	1.0 (assumed)	
	11-17	0.64 (0.51, 0.81)	1.0 (assumed)	
	18-29	1.0	1.0	
	30-39	1.0	1.0	
	40-49	1.0	1.0	
	50-59	1.0	1.0	
	60-69	1.0	1.0	
	70+	1.0	1.0	
		Susceptibility	Infectiousness	
CoMix fit	0-4	0.31 (0.30, 0.31)	1.0	
	5-10	0.31 (0.30, 0.31)	1.0	
	11-17	0.31 (0.30, 0.31)	1.0	
	18-29	1.0	1.0	
	30-39	1.0	1.0	
	40-49	1.0	1.0	
	50-59	1.0	1.0	
	60-69	1.0	1.0	
	70+	1.0	1.0	

[1] 95% Credible Intervals

[2] Approximate results inferred from plot in[15] unknown quantification of uncertainty

[3] 95% Confidence Interval

Inferring age dependent transmission risk using CoMix data

125 We established independent estimates of susceptibility and infectiousness in children

126 relative to adults. We did this by comparing estimates of *R* using CoMix contact data with

127 estimates of the time-varying reproduction number in England calculated using case data

128 [21]. To capture the change in contact rates as schools returned in September 2020

129 We calculated a reproduction number resulting from two-weekly rolling contact matrices $\mathbf{C}_t$

130 and assumed relative susceptibility and infectiousness vectors **s** and **i** to be:

$$R = r\ Eig\left(\mathbf{C}_t \circ (\mathbf{i} \otimes \mathbf{s})\right) \tag{1}$$

131 We simplified **s** and **i** such that adult age-groups (18+) were 1.0 and child age groups were

132 equal, *s* and *i* . We inferred *s* and *r,* keeping *i* at 1.0*,* by fitting our estimates using maximum

133 likelihood estimation to those calculated using the EpiNow2 package [21]. We assumed

134 gamma distributed uncertainty in the time-varying estimates which we parameterised using

135 the mean μ_{rt} and standard deviation σ_{rt} of these estimates over each survey period used to

136 calculate CoMix derived eigenvalues.

$$R \sim\ Gamma(\mu_{R_t},\ \sigma_{R_t}) \tag{2}$$

137 To show the likelihood surface of relative susceptibility and infectiousness, we calculated the

138 likelihood of a range of combinations of *i* and *s* while fitting *r*.

139 We fitted over 2 periods of time. Firstly, between 27th July and 10th October to most clearly

140 capture the impact of schools returning in the summer whilst minimising issues related to

141 gradual acquisition of natural immunity. Second, We fitted over a longer period of time

142 incorporating data from 10th June.

143 We omitted data at the end of August in both fits due to a short spike in reproduction number

144 estimates, which we believe resulted from large numbers of imported cases from

145 recreational travel. We further omitted two weeks in July when contacts were not recorded

146 for children. We assessed sensitivity to the fitted period, by using a range of fitting options

147 (Figure S4).

Evaluating the impact of reopening schools on Reproduction Number

149 We created contact matrices using CoMix data collected during the second lockdown, (5th

150 November to 2nd December 2020) to represent contacts during a lockdown with schools

151 open. We used data from 5th to 18th of January 2021 for contacts during a lockdown with

152 schools closed (Supplementary Figures, Figure S1). We constructed further synthetic

153 contact matrices representing opening primary or secondary schools by replacing the

154 contacts of 5-10 year-olds (primary) and 11-17 year-olds (secondary) in the 'schools open'

155 contact matrix (second lockdown), with those from the 'schools closed' contact matrix (third

156 lockdown) (Supplementary Figures, Figure S2).

157 Since the basic reproduction number scales linearly with the dominant eigenvalue of a matrix

158 of effective contact [22], the ratio of the eigenvalues of two effective contact matrices

159 provides a relative change in reproduction number between the three scenarios considered.

160 In the case where infectiousness and susceptibility are equal in all age groups, the effective

161 contact matrix is proportional to the contact matrix itself. Under the scenarios where we

162 assumed infectiousness and susceptibility vary with age, we converted measured contact

163 matrices to effective contact matrices by taking the outer product of the estimated age

164 stratified infectiousness profile and susceptibility profile vectors and calculating the

165 eigenvalues of the Hadamard product of the resulting matrix and the contact matrices.

166 To demonstrate the potential impact of reopening schools, we estimated the relative increase

167 (k) in reproduction number (R) by calculating the ratio of dominant eigenvalues of the

168 effective contact matrix associated with the respective reopening scenario and from the

169 current lockdown period.

$$k = \frac{Eig(\mathbf{C}_{Scenario} \circ (\mathbf{i} \otimes \mathbf{s}))}{Eig(\mathbf{C}_{LD3} \circ (\mathbf{i} \otimes \mathbf{s}))} \tag{3}$$

9

170   We also calculated how *R* varies from baseline values between 0.7 and 1.0, from official UK

171   estimates of the reproduction number from [23].

172 **Results**

173 **Descriptive analysis**

174 Adults' contacts were similar when comparing both periods of national lockdown, this is

175 consistent across all settings and regions. Although children's contacts at home were similar

176 between the two periods, contacts at school and other locations were consistently higher in

177 lockdown 2 than lockdown 3. Contacts were very similar between lockdowns in all age-group

178 combinations other than those between children (Figure 1). For participants under 18

179 years-old, the mean number of contacts that were also under 18 years-old was between 6.3

180 (3.9 - 9.0, 90% CI) and 16.7 (13.1 - 20.4, 90% CI) across the regions of England during the

181 November Lockdown. Such contacts were highest in South East, South West and Yorkshire

182 and Humber and lowest in London. The mean number of contacts between children reduced

183 to between 1.8 (1.3 - 2.5, 90% CI) and 2.6 (1.9 - 3.3, 90% CI) during the January Lockdown.

184 **Estimating susceptibility in children relative to adults using CoMix data.**

185 Fitting the R estimates from CoMix data to time-varying R estimates over a period from 27th

186 July to 10th October we estimated susceptibility of 44% (43.5% - 0.45.4%, 95% CI) in

187 children relative to adults (Figure 2, A & C), consistent with profiles ii and iii. When we fitted

188 from the 10th June to 10th October, 2020, we estimated 31% (29.8% - 31.4%, 95% CI)

189 relative susceptibility in children compared to adults (Figure 2, B & D), near the lower range

190 of ONS and Davies et al estimates. We chose to apply the second estimate as the fifth

191 susceptibility profile (v) to represent this lower bound (Table 1) and present fits to other date

192 ranges in the supplementary material (Supplementary Figures, Figure S4).

193 **Evaluation of the impact of reopening schools**

194 Incorporating estimates of differential susceptibility and infectiousness of children compared

195 with adults (profiles ii - v), full school reopening increased R by a factor of between 1.3 and

196 1.9 times the baseline value across the four profiles used (including 90% CI range) (Figure

11

197 3, Table 2). This would result in an increase of *R* from 0.8 to above 1.0 for these four profiles.

198 Partial school reopening resulted in smaller increases in *R* from 0.8 to between 0.9 and 1.2.

199 **Table 2** Expected resultant *R* if schools were reopened for different baseline values of *R*

200 reported as median (90% CI)

Susceptibility/ Infectiousness	Attendance	Baseline *R*			
		0.7	0.8	0.9	1.0 (Scale factor)
1. Equal	Both	1.6 (1.5 - 1.6)	1.8 (1.7 - 1.9)	2.0 (1.9 - 2.1)	2.2 (2.1 - 2.3)
	Primary	1.1 (1.0 - 1.1)	1.2 (1.2 - 1.3)	1.4 (1.3 - 1.5)	1.5 (1.4 - 1.6)
	Secondary	1.1 (1.0 - 1.2)	1.3 (1.2 - 1.3)	1.4 (1.3 - 1.5)	1.6 (1.5 - 1.7)
2. Davies et al	Both	1.1 (1.0 - 1.1)	1.2 (1.1 - 1.3)	1.4 (1.3 - 1.4)	1.5 (1.4 - 1.6)
	Primary	0.9 (0.8 - 0.9)	1.0 (0.9 - 1.0)	1.1 (1.1 - 1.2)	1.2 (1.2 - 1.3)
	Secondary	0.9 (0.8 - 0.9)	1.0 (1.0 - 1.1)	1.1 (1.1 - 1.2)	1.3 (1.2 - 1.3)
3. ONS	Both	1.1 (1.1 - 1.2)	1.3 (1.2 - 1.3)	1.4 (1.4 - 1.5)	1.6 (1.5 - 1.7)
	Primary	0.9 (0.8 - 0.9)	1.0 (1.0 - 1.1)	1.1 (1.1 - 1.2)	1.3 (1.2 - 1.3)
	Secondary	0.9 (0.9 - 1.0)	1.0 (1.0 - 1.1)	1.2 (1.1 - 1.2)	1.3 (1.3 - 1.4)
4. Viner et al	Both	1.3 (1.2 - 1.3)	1.4 (1.4 - 1.5)	1.6 (1.5 - 1.7)	1.8 (1.7 - 1.9)
	Primary	0.9 (0.9 - 1.0)	1.1 (1.0 - 1.1)	1.2 (1.1 - 1.3)	1.3 (1.3 - 1.4)
	Secondary	1.0 (0.9 - 1.0)	1.1 (1.1 - 1.2)	1.2 (1.2 - 1.3)	1.4 (1.3 - 1.4)
5. CoMix fit	Both	0.9 (0.9 - 1.0)	1.1 (1.0 - 1.1)	1.2 (1.2 - 1.3)	1.4 (1.3 - 1.4)
	Primary	0.8 (0.8 - 0.9)	0.9 (0.9 - 1.0)	1.1 (1.0 - 1.1)	1.2 (1.1 - 1.2)
	Secondary	0.8 (0.8 - 0.9)	1.0 (0.9 - 1.0)	1.1 (1.0 - 1.1)	1.2 (1.2 - 1.3)

201 When we assumed equal infectiousness and susceptibility between all age groups (profile i),

202 reopening schools resulted in more substantial relative changes in *R*. Full school reopening

203 increased *R* by a factor of between 2.1 and 2.3 (Figure 3, Table 2), resulting in an increase

204 of *R* to roughly 1.7-1.9 from a baseline of 0.8 (Table 2). Partial re-opening increased *R* from

205 0.8 to 1.2-1.3 (Figure 3). We included these estimates for completeness but stress that

206 assuming that children are equally infectious and susceptible as adults is not compatible

207 with results from previous studies or our own estimates (Figure 2).

Discussion

209 The potential impact of reopening schools on transmission of SARS-CoV-2 is uncertain.

210 Although there have been many attempts to quantify the relative susceptibility and

211 infectiousness of children and adults, these estimates need to be assessed alongside rates

212 of contact to give an indication of the overall risk of transmission in any given setting. We

213 combined social contact data from a large-scale survey in England during two periods of

214 national lockdown, one with schools open and the other with schools closed, with estimates

215 of relative susceptibility of children and adults. We used these data to quantify the potential

216 impact of reopening schools on reproduction number.

217 Whereas adults' contacts were generally similar between the two periods of lockdown, there

218 was markedly higher contact between children during the November lockdown, when

219 schools were open. We observed the change in contacts at school but also in other contacts

220 outside of the home. Increased contact outside of school and home settings includes

221 contacts in wrap around care, which would be expected to rise, however it could also

222 indicate reduced overall adherence amongst children when attending schools physically.

223 The differences in contacts suggest that reopening all schools is highly likely to increase R

224 above 1.0, from an assumed current value 0.8. Reopening primary or secondary is likely to

225 increase R above 1.0. This would be expected to stop or reverse the fall in cases that has

226 been observed since January 2021 [24]. The risk of cases increasing following the reopening

227 of schools is highly dependent on the current value of R. Although cases of the current

228 dominant variant (B.1.1.7) appeared to be increasing whilst national lockdown was still in

229 place in November [10, 13], the latest national serology surveys suggest that immunity levels

230 have substantially increased across the UK [24], resultant from both infections and the

231 national COVID-19 vaccination program. These changes in overall immunity should be

232 reflected in the current estimates of $R,$ but these estimates are lagged due to delays in

233 reporting [25].

234 In November, when schools were open, there was substantial variation in contacts between

235 children by region. We have not presented regional estimates of the impact of reopening

236 schools on *R* due to low numbers of observations between the lower-level age-group

237 aggregation used in the construction of contact matrices, however the variation in mean

238 contacts points to potential geographical variation in the impact of reopening schools, which

239 may be lower in London than other parts of the country.

240 There are a number of important limitations to this work: Contacts in different settings likely

241 contribute differently to transmission, but we assumed all contacts make equal contributions

242 to transmission, as these differences are not well quantified in the context of control

243 measures. If contacts at school are lower risk than those outside of school the impact of

244 reopening schools would be lower. The age-stratified susceptibility profile is likely to change

245 over time as natural immunity is acquired in the population. The profiles we used each reflect

246 a single point in time. Changes in the relative immunity in children would alter the relative

247 impact of school contacts on overall transmission. We assume adult contacts revert to those

248 observed when all schools were open, which is conservative, in reality, particularly for partial

249 reopening scenarios, adult contacts may not fully return to the same levels. Furthermore,

250 there may also be differences in adherence to restrictions between the two lockdowns,

251 unrelated to school closure. However, the change in adults' contacts between the two

252 periods was relatively small. The proportion of children in school varied over time due to

253 exclusion-based control measures during the autumn, though the proportion attending

254 school remained high during the November lockdown (Supplementary Figures, Figure S3).

255 Contacts of children are reported by parents, which may impact their reliability, particularly in

256 school, where parents are unlikely to witness students' behaviour, it is unclear whether this

257 would lead to systematic bias in reporting either more or fewer contacts.

258 Our work evaluates the impact of reopening schools on the reproduction number in England,

259 which gives an indication of how transmission may be affected. However, there are other

260 factors that reopening schools may introduce, such as the potential for children's contact at

261 school to provide routes of transmission between households, facilitating long chains of

262 transmission that would be otherwise impossible[26]. We are not able to capture these

263 network effects in this analysis, however they may play an important role in the change in

264 epidemiology between school closure and reopening. Second, there is evidence for lower

265 prevalence in primary school than secondary schools [8]. Our framework has not captured

266 these differences suggesting there may be additional factors that reduce the impact of

267 reopening primary schools relative to secondary schools. Furthermore, additional

268 management strategies such as mass testing of school children, may serve to reduce the

269 risk that a contact in a school results in infection beyond those implemented last year.

270 Importantly, with the recent emergence of new variants, particularly B.1.1.7 [27], the baseline

271 R will depend on proportions of these variants as well as contact patterns. Furthermore,

272 these proportions are likely to change, potentially altering the implications of reopening

273 schools.

274 Our results suggest reopening schools is likely to increase R close to or above 1.0, which

275 would stop the decrease in cases observed in recent months. However, precise estimates

276 rely heavily on the baseline values of R and the profiles of susceptibility, generally assuming

277 lower susceptibility and no greater infectiousness in children relative to adults.

278 **List of abbreviations**

279 CI   Confidence Interval

280 ONS   Office for National Statistics

281 UK   United Kingdom

282 **Declarations**

283 **Ethics approval and consent to participate**

284 Participation in this opt-in study was voluntary, and all analyses were carried out on

285 anonymised data. The study and method of informed consent was approved by the ethics

286 committee of the London School of Hygiene & Tropical Medicine Reference number 21795.

287 **Consent to publish**

288 Not applicable

289 **Availability of data and materials**

290 Although it is not possible to share the contact survey data used to generate the contact

291 matrices used in this analysis. The analysis code and contact matrices used are available in

292 an online repository here: https://github.com/jdmunday/CoMix_schools_reopening

293 **Competing interests**

294 None

295 **Funding**

296 CoMix is funded by the EU Horizon 2020 Research and Innovations Programme - project

297 EpiPose (Epidemic Intelligence to Minimize COVID-19's Public Health, Societal and

298 Economical Impact, No 101003688) and by the Medical Research Council (Understanding

299 the dynamics and drivers of the COVID-2019 epidemic using real-time outbreak analytics

300 MC_PC 19065).

341   **Authors contributions**

342   JDM, CIJ, WJE conceived of and planned the analysis; JDM and CIJ performed the main

343   analysis with input from WEJ and SF; SF provided estimates of time-varying reproduction

344   number; CIJ, KvZ, and WEJ designed the CoMix contact survey, CIJ, AG, KW, and KvZ

345   cleaned and managed the contact survey data; All authors wrote and reviewed the

346   manuscript. The CMMID COVID-19 Working Group provided discussion and comments.

Additional Files

Supplementary Figures

19

Figure Captions

Figure 1. Contacts in the national lockdown periods in November (Lockdown 2) and January (Lockdown 3). *A) the distribution of the number of reported contacts in Home, Work, School and Other locations for Adult (> 17 years old) and Child (<= 17 years old) participants.* ***B)*** *Mean contacts reported between Children and Adults in each region of England. Error bars show the 90% CI (bootstrapped, 1000 samples).*
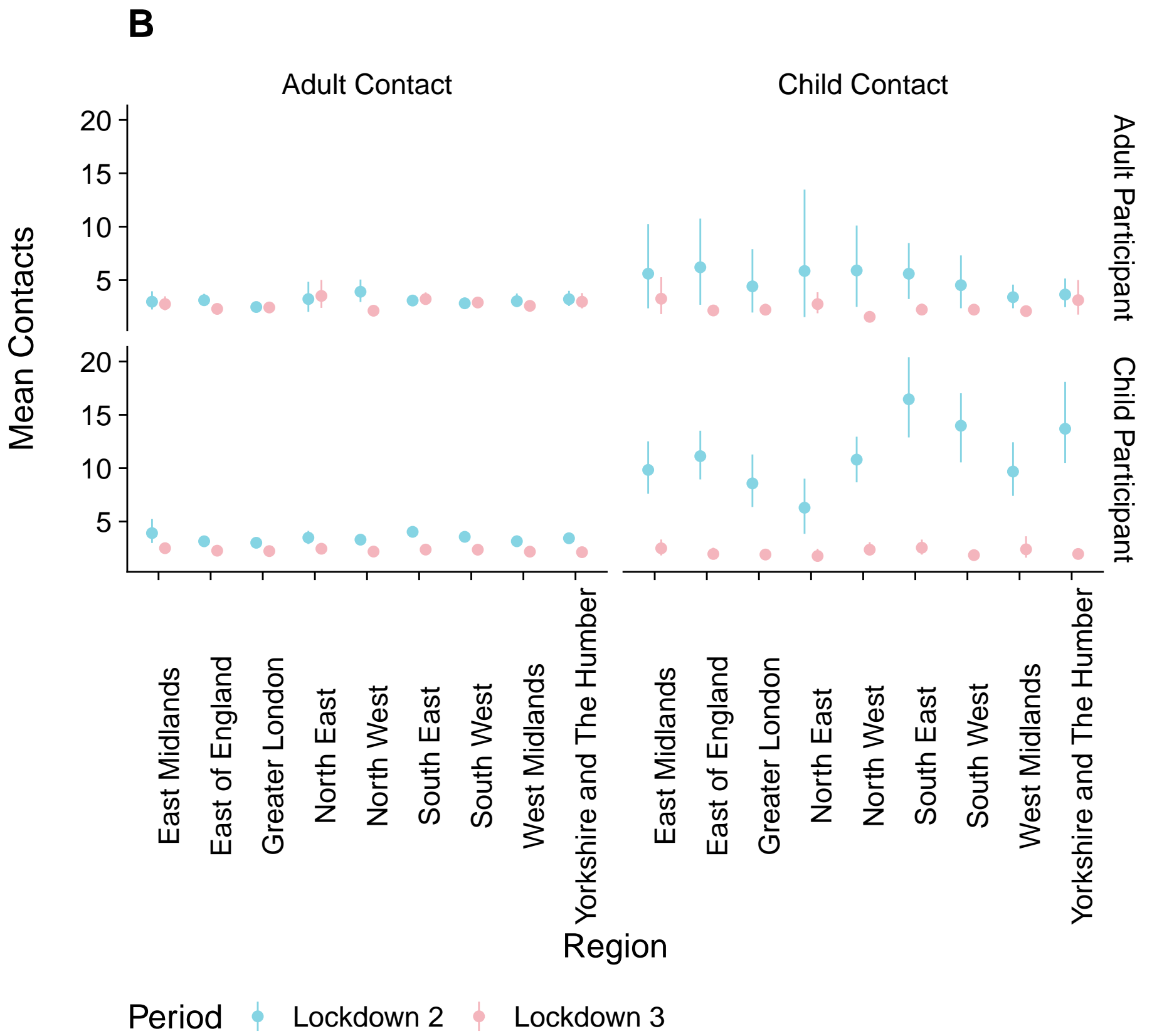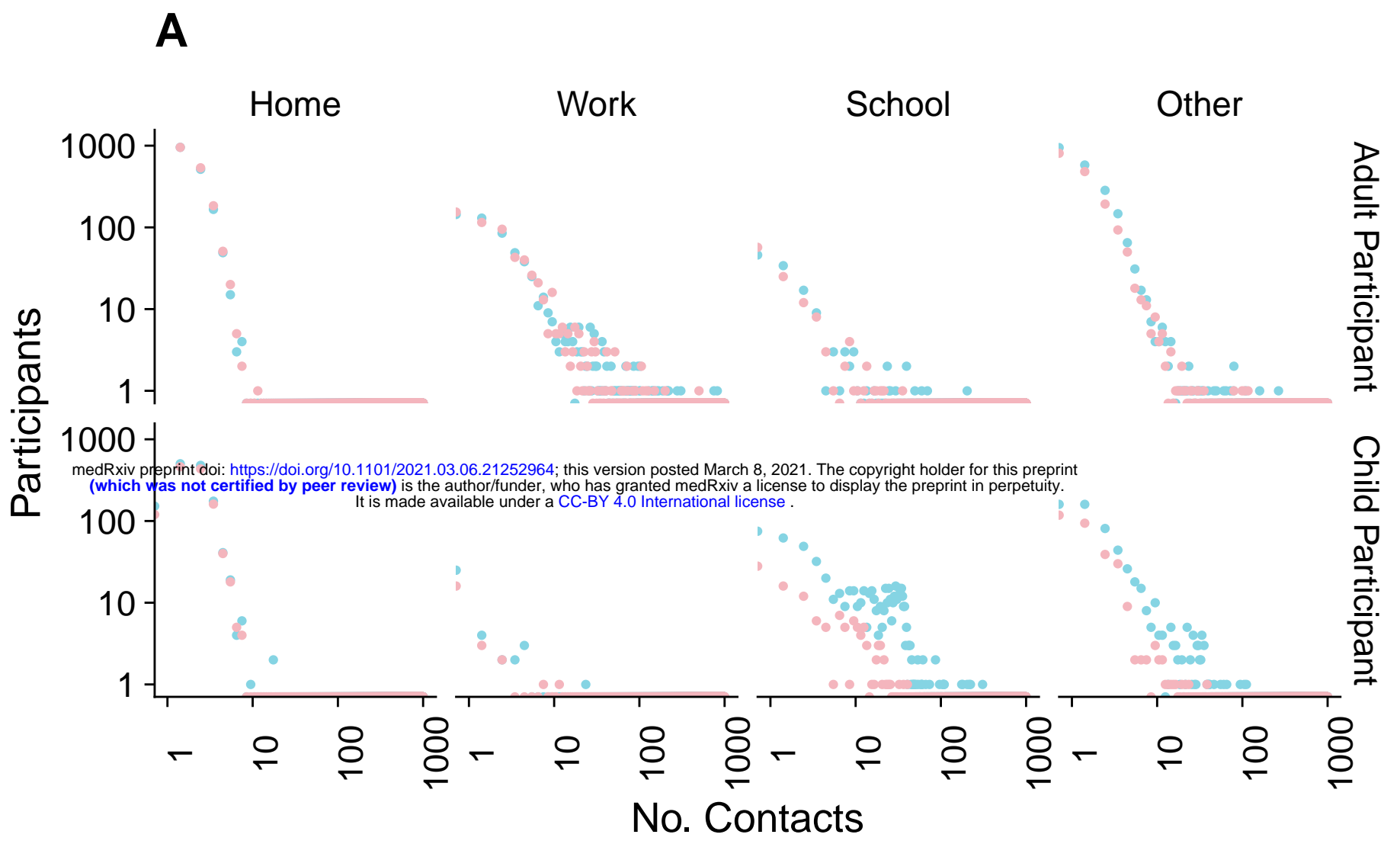
Figure 2: R estimates using CoMix data fit to time-varying reproduction number estimates based on the time series of cases *[21]. Transformed likelihood for different combinations of relative susceptibility and infectiousness based on data from* ***A)*** *August to October and* ***B)*** *June to October and the corresponding R estimates in* ***C)*** *and* ***D)*** *respectively. 90% CI of the estimates are shown by Grey rectangles for CoMix and the red ribbon for the time-varying reproduction number estimates from case data, red bars show their mean for the CoMix survey periods. Grey shaded areas indicate fitted periods.*

Figure 3: The impact of reopening schools on the reproduction number. *A) the relative increase in R (the ratio of dominant eigenvalues between contact matrices for each reopening scenario and that for current contact patterns) under different estimates of the age profile of susceptibility and infectiousness.* ***B)*** *The estimated R after reopening schools (points, 90% CI bars) from baseline R of 0.7, 0.8, 0.9 and 1.0 (vertical line). Dashed vertical lines show R = 1.0.*

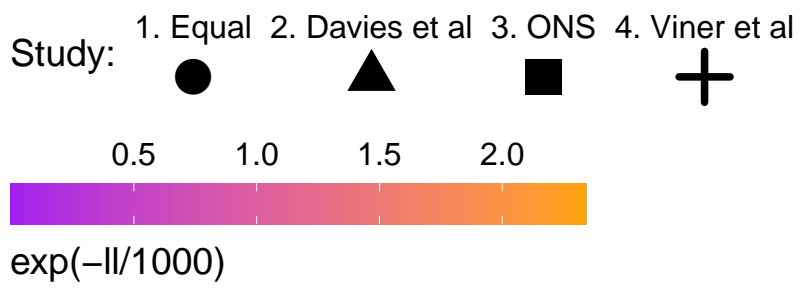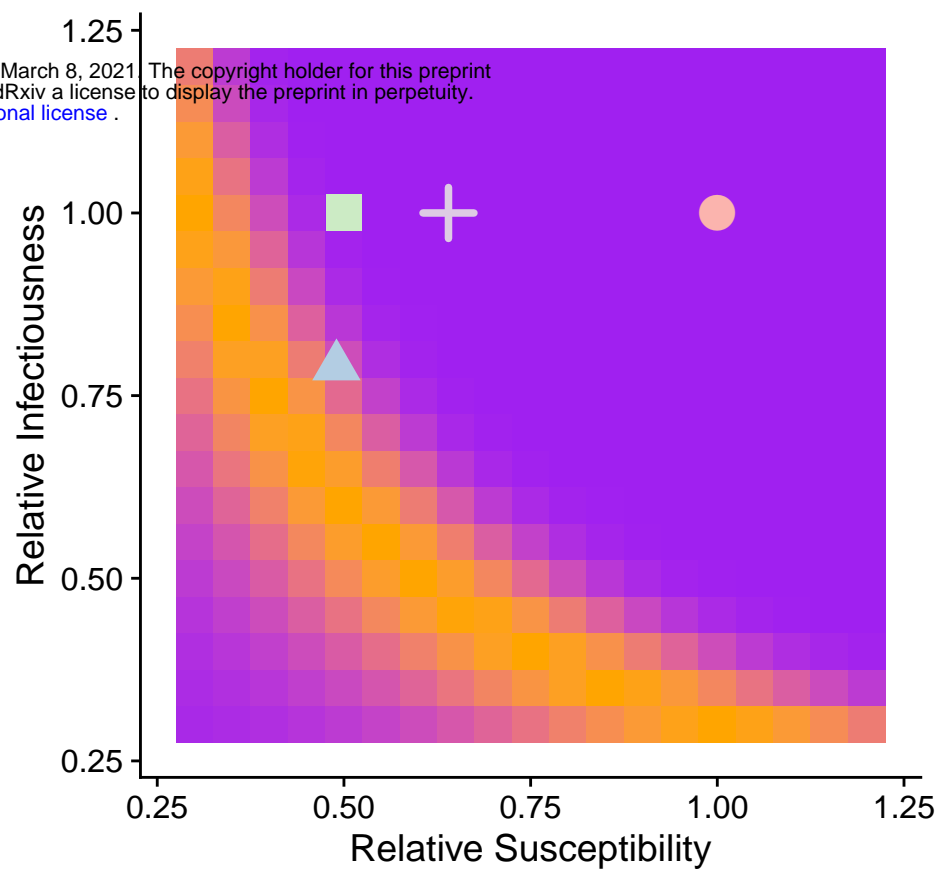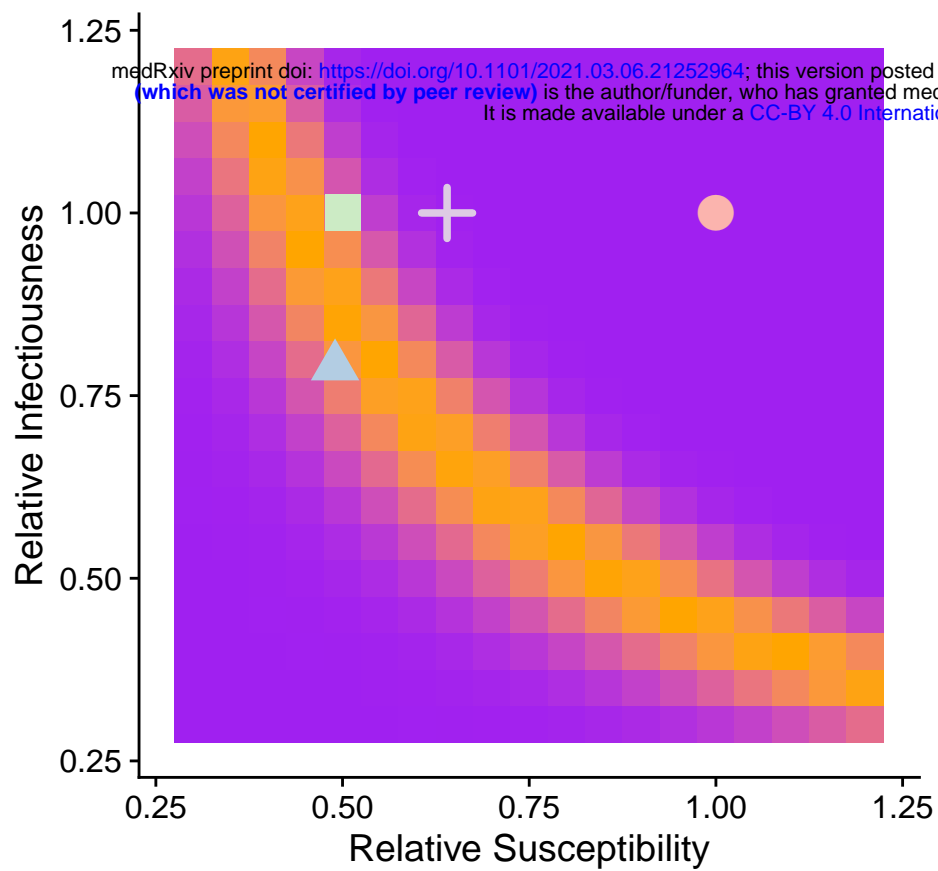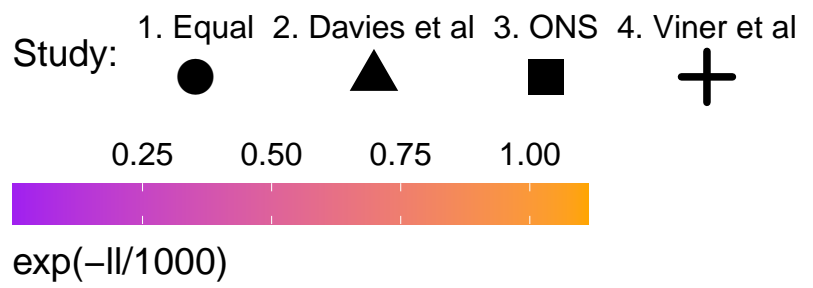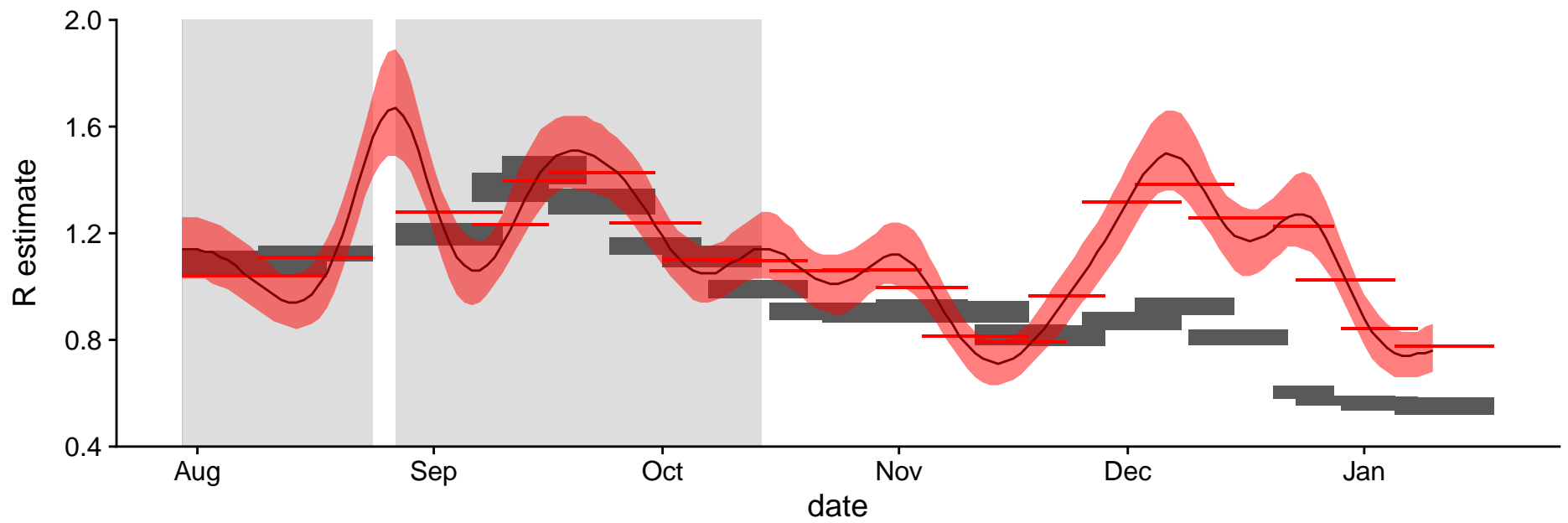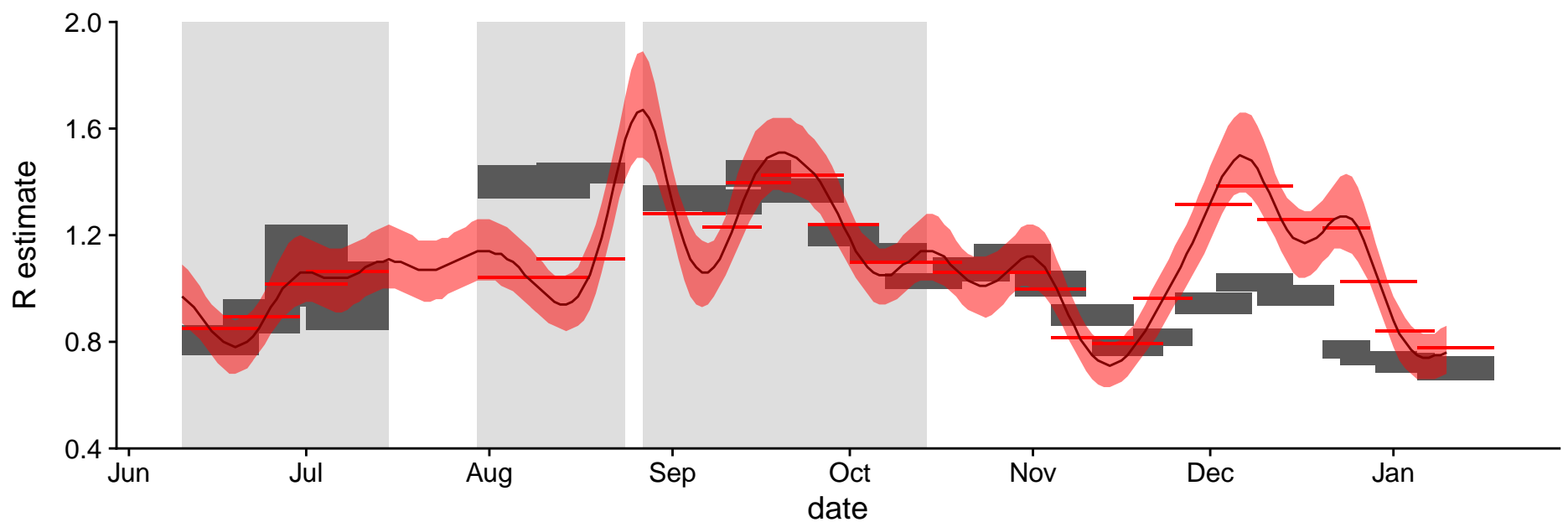## References

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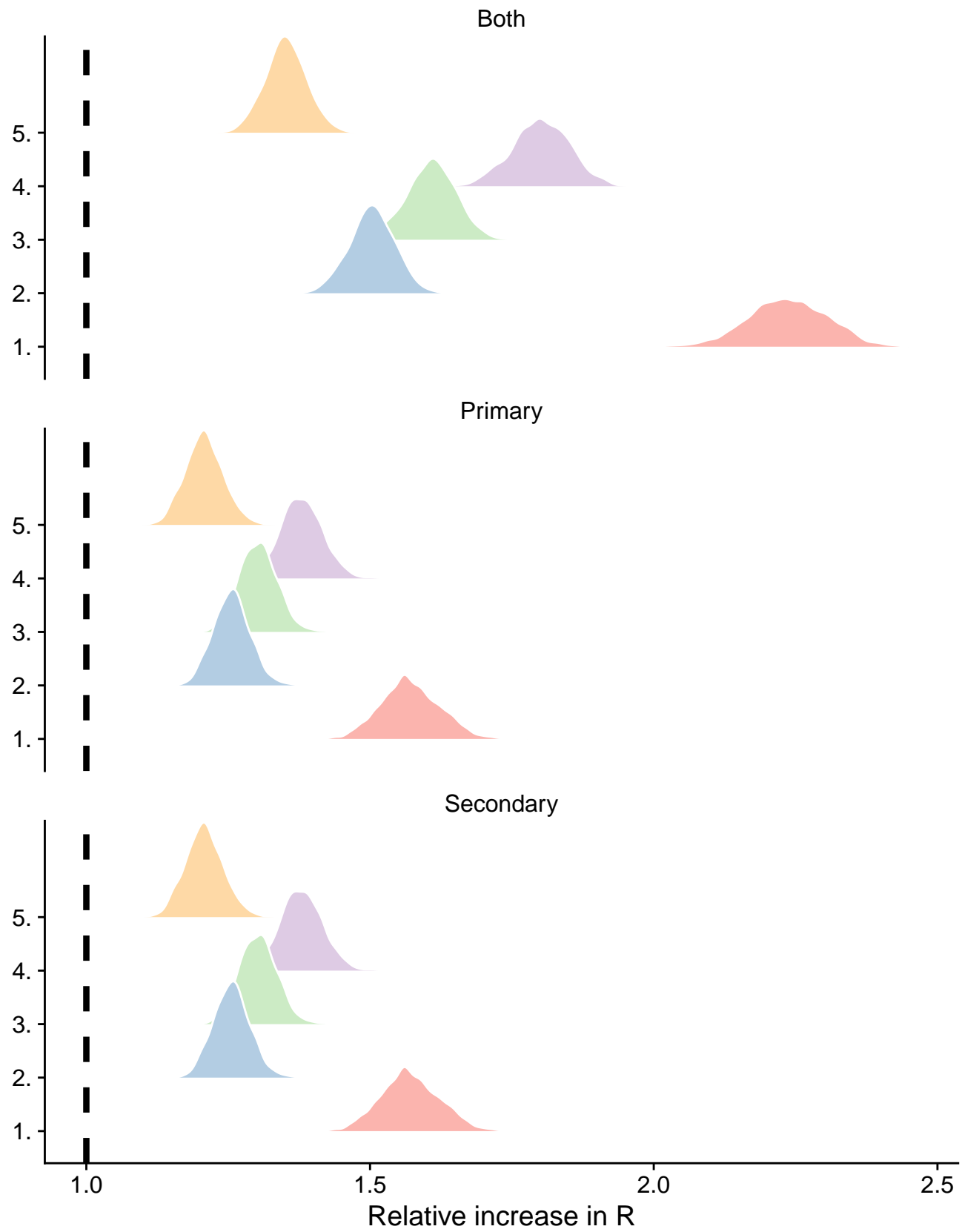469 -of-concern-20201201. Accessed 26 Jan 2021

A

Study: 1. Equal 2. Davies et al 3. ONS 4. Viner et al 5. CoMix fit

Both

Primary

Secondary

Relative increase in R

B

Baseline R = 0.7

Both
Secondary
Primary

Baseline R = 0.8

Both
Secondary
Primary

Baseline R = 0.9

Both
Secondary
Primary

Baseline R = 1

Both
Secondary
Primary

R