Impact of gradual school reopening strategies using POLYMOD contact data

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Highlights

- Allowing more vulnerable children has the least impact, followed by early year and transition years. Note though that most reopening strategies still have significant impact.
- The results for primary and secondary schools are dependent on whether we use physical only contacts or all contacts, with secondary having slightly higher effect when using all contacts, but significantly less when considering physical only contacts.
- Results are highly dependent on the assumed infectiousness of children.
- R_0 only represents the initial reproduction rate and its link to the final attack rate is complex. This is especially true when relying on Polymod data, because there the early reproduction rate (in a fully susceptible population) is dominated by reproduction in school age children.

Methods

- Uncertainty was introduced by bootstrapping the polymod data and generating 1000 samples. Bootstrapping was done using the `socialmixr` package.
- In all scenarios contacts in the Polymod locations work, leisure, otherplace and transport were reduced to 20% of normal.
- Contacts at school between age groups were calculated according to $\kappa_{ij} = \min(a_i, a_j)c_{ij}$ where a_i is the attendance in age group i, c_{ij} is the number of contacts recorded in polymod and κ_{ij} is the adjusted number of contacts. We could also have assumed that all interactions are purely random by using $\kappa_{ij} = a_i a_j c_{ij}$, which would result in fewer actual interactions, but we make the assumption that most interactions are actually non random (e.g. with friends, teachers etc.).

Table 1: Scenarios under consideration.

Scenario	Description
Scenario 1	Stay Shut
Scenario 2	More vulnerable children and key worker kids
Scenario 3	Transition years 5/6/10/12, this side of summer holiday
Scenario 4	Early year settings
Scenario 5	All primary
Scenario 6	All secondary
Scenario 8	Half time B – Half class in AM/PM each day
Scenario 9	Fully reopen

Table 2: Attendance under the different scenarios by age group.

AgeGroup	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 8	Scenario 9
[0,6)	0.04	0.11	0.04	1.00	0.04	0.04	0.5	1
[6,10)	0.02	0.11	0.02	0.02	1.00	0.02	0.5	1
[10,12)	0.02	0.11	1.00	0.02	1.00	0.02	0.5	1
[12,15)	0.02	0.11	0.02	0.02	0.02	1.00	0.5	1
[15,16)	0.02	0.11	1.00	0.02	0.02	1.00	0.5	1
[16,17)	0.02	0.11	0.02	0.02	0.02	1.00	0.5	1
[17,18)	0.02	0.11	1.00	0.02	0.02	1.00	0.5	1
[18,19)	0.02	0.11	0.02	0.02	0.02	1.00	0.5	1
[19,25)	1.00	1.00	1.00	1.00	1.00	1.00	1.0	1
[25,45)	1.00	1.00	1.00	1.00	1.00	1.00	1.0	1
[45,65)	1.00	1.00	1.00	1.00	1.00	1.00	1.0	1
65+	1.00	1.00	1.00	1.00	1.00	1.00	1.0	1

Table 3: Relative increase in R under the different proposed scenarios. Results depend significantly on the type of contacts used, especially for the secondary school scenario. Infe is the relative infectiousness of children.

| Scenario	Infe	all	physical
Scenario 2	0.25	1.005 (1.004,1.006)	1.007 (1.006,1.009)
	0.50	1.013 (1.011,1.015)	1.017 (1.014,1.02)
	0.75	1.024 (1.02,1.028)	1.026 (1.022,1.031)
	1.00	1.036 (1.031,1.042)	1.034 (1.029,1.041)
Scenario 3	0.25	1.013 (1.009,1.018)	1.011 (1.007,1.016)
	0.50	1.042 (1.027,1.065)	1.029 (1.017,1.047)
	0.75	1.094 (1.058,1.18)	1.051 (1.028,1.108)
	1.00	1.169 (1.096,1.346)	1.076 (1.039,1.209)
Scenario 4	0.25	1.008 (1.006,1.011)	1.022 (1.015,1.033)
	0.50	1.019 (1.013,1.026)	1.046 (1.03,1.071)
	0.75	1.03 (1.02,1.044)	1.066 (1.042,1.107)
	1.00	1.041 (1.027,1.062)	1.083 (1.05,1.137)
Scenario 5	0.25	1.032 (1.023,1.043)	1.053 (1.035,1.079)
	0.50	1.121 (1.082,1.176)	1.157 (1.104,1.245)
	0.75	1.27 (1.174,1.394)	1.274 (1.175,1.426)
	1.00	1.432 (1.288,1.612)	1.379 (1.241,1.582)
Scenario 6	0.25	1.034 (1.025,1.046)	1.027 (1.018,1.039)
	0.50	1.135 (1.093,1.201)	1.086 (1.053,1.137)
	0.75	1.32 (1.218,1.478)	1.169 (1.099,1.287)
	1.00	1.524 (1.365,1.751)	1.258 (1.147,1.441)
Scenario 8	0.25	1.03 (1.025,1.036)	1.043 (1.035,1.054)
	0.50	1.089 (1.075,1.108)	1.106 (1.086,1.131)
	0.75	1.17 (1.142,1.208)	1.167 (1.136,1.205)
	1.00	1.259 (1.217,1.316)	1.22 (1.179,1.273)
Scenario 9	0.25	1.075 (1.061,1.091)	1.101 (1.08,1.129)
	0.50	1.244 (1.199,1.307)	1.256 (1.203,1.323)
	0.75	1.468 (1.384,1.584)	1.403 (1.321,1.515)
	1.00	1.684 (1.567,1.849)	1.526 (1.419,1.673)
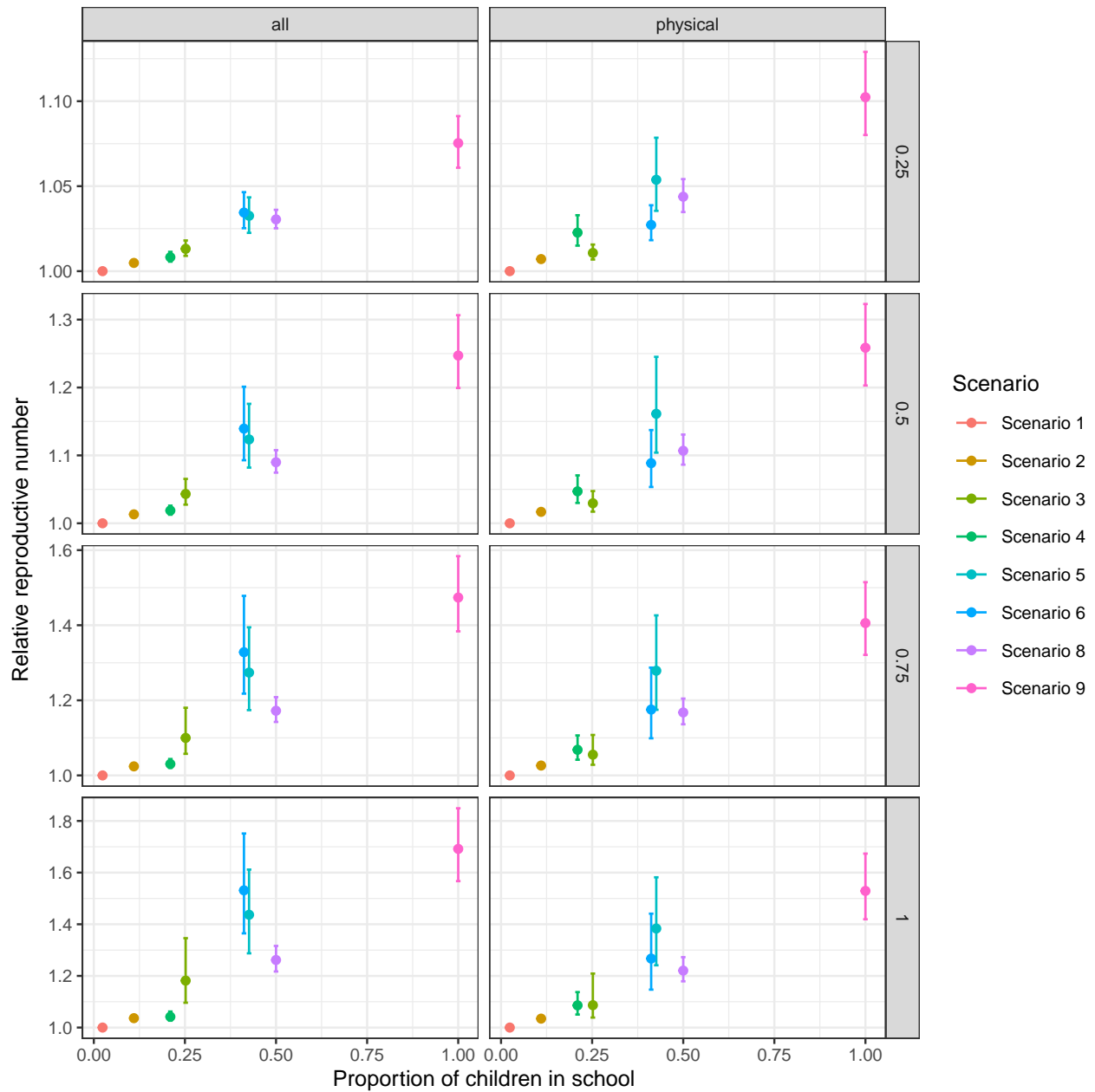
Figure 1: Relative R for the different scenarios, contact types and infectiousness of children by proportion of children going to school. The columns show all and physical only contacts, while the rows represent different assumptions of infectiousness.