Interdisciplinary Task and Finish Group on the Role of Children in Transmission:

Modelling and behavioural science responses to scenarios for relaxing school closures

Paper summary

This paper presents the findings from a collaborative analysis conducted by SPI-M and SPI-B, to explore the modelling outcomes and behavioural science aspects of 7 school closure scenarios identified by the Department for Education (DfE), in comparison with schools either staying shut (Baseline 1), or remaining fully open (Baseline 2):

Table 1: Options for relaxing school closures provided by DfE

Scenarios	**High level policy description (provided by DfE)**	**Clarifications for modelling**
1. Stay shut BASELINE 1	As now, only children of key workers (as currently defined) and vulnerable children attend, with numbers being maintained.	4% of children in early years; 2% from year 1 upwards
2. More vulnerable children and key worker kids	Numbers of children expanded either by encouraging greater attendance from those already eligible or by expanding the numbers of children eligible.	11% of children (Sensitivity explored: heterogeneity – ie. variation in vulnerable/key worker children across schools, with extreme scenario being 11% of schools)
3. Transition years 5/6/10/12, this side of the summer holidays	Focus on bringing back children in key year groups as these pupils are at key education transition points. Assume all children would be in scope less those who have to self-isolate either because considered vulnerable or because they or a family member are ill. Assume that children/young people could largely comply with required social distancing measures.	Simplifying assumption of "normal" levels of capacity etc (Sensitivity explored: classrooms may not be at full capacity if pupils split using empty rooms from other years)
4. Early year settings	All EY settings including registered childminders would be able to resume caring for children.	
5. All primary	All primary schools	
6. All secondary	All secondary schools	

Scenarios	High level policy description (provided by DfE)	Clarifications for modelling
7. Half time A (Full class, 2 weeks on / 2 off – full attendance)	• Operates in all primary and secondary schools. • School cohorts split in two. Half of each school attend for two weeks and then spend two weeks at home, the other half of the school then attend for next two weeks. • Workforce also split in two and stick with the same 'half' of the school.	Simplifying assumption that this splits each class in two (and hence each year group). This includes households together where relevant to models (Sensitivities explored: - 1 week on, 1 week off ("7b") • Extreme scenario of all children present for 2 weeks, then all off)
8. Half time B – half days	• Operates in all primary and secondary schools. • School cohort split in two. Half cohort attends in morning and other half attend in afternoon. • Workforce split in two with half working in the morning and half working in afternoon.	As above
9. Fully reopen BASELINE 2	All primary and secondary schools reopen	

Susceptibility and infectivity

From the outset, it was recognised that the assumptions made about the relative susceptibility and infectivity of children, in comparison to adults, would have a central influence on the influence of schools openings on overall covid-19 transmission. An updated review (Annex A) suggests:

- Evidence remains inconclusive on both the susceptibility and infectivity of children, but the balance of evidence suggests that both may be lower than in adults.
- Serological studies are starting to be available on child infection history, with some suggesting low rates of infection. These must be interpreted with caution based on exposure history (e.g. school closure) in the area they are drawn from, and given also some suggestions that mild infections (as are more common on children) may be less likely to generate antibodies.

Insights from indicative modelling of scenarios

Given this uncertainty, the SPI-M BSI subgroup considered the impact on effective R or transmission rate from relaxing school closures across a range of assumptions for the infectivity of children, with the main findings presented considering equal probabilities, as this, if anything, will give an upper

end estimate of impact. At all levels of infectivity, some important insights can be drawn on the relative impact of the different approaches partial re-opening.

- The effect of school openings will not happen in isolation: although the choice of scenario for relaxing school closures is of importance, a more critical issue is adherence to existing measures in the broader community.

- Scenario 2 (increasing attendance of vulnerable and key worker children to 11%) has the smallest impact relative to Baseline 1 (the current measures), but this corresponds to the scenario with the fewest children returning to school

- The modelling consistently suggests that resuming early years provision has a smaller relative impact than primary school, which in turn has a smaller relative impact than resuming secondary schooling. However, this analysis does not incorporate potential for indirect impacts on contacts outside of school – which may differ by age of child.

- Scenario 7 (alternating one/two weeks on, one/two weeks off) may be a good way to stop extensive transmission chains in schools. When this effect in schools is embedded into the wider community, the impact is less strong, but still has some value in reducing overall R. The modelling of Scenario 7 is the least robust of the scenarios, and further exploration is needed.

Behavioural Factors

- The behavioural science assessment of the options for the easing of school closures recognises that scenarios 2-9 will increase interactions from the current baseline, though the dynamics will differ depending on the intervention. Adaptations to routines and environments may mitigate the extent of the increase, and pupil age and other characteristics will impact the effectiveness of interventions.

- Messaging to teachers, parents, and students will play an important role in each scenario. Additional work is required to identify perceptions of risk and information needs across these groups. Most importantly, each of these groups must perceive that the risk of infection is low before they will be willing to attend or send their children to school.

- The scenarios for relaxing school closures must be understood in the context of interactions taking place beyond the school. For example, social distancing guidance beyond the school will inform the infection rate in schools.

- Wider contextual issues must be taken into account when assessing the impact of the options for relaxing school closures (e.g. impact on the susceptibility of BAME and adolescent young adults; the role of testing in schools; employers allowing flexibility to enable parental engagement with school returns involving rota systems

- Scenario 7 is likely to be the most effective strategy to make school attendance normative. If steps are taken to synchronise attendance for families with multiple children, this may be the most effective at enabling parents to return to work. Scenario 7b, where children alternate in and out of school on a weekly basis, was perceived to be potentially preferable – both developmentally and practically – for young children and working parents.

A number of caveats of importance were noted in the modelling and behavioural science:

- School closures do not constitute a solitary intervention. It is important to understand the other types of social distancing measures that staff, parents, and students are engaging in beyond the boundaries of the school.
- It is important to understand what is going on inside of the school (e.g. physical distancing, hygiene measures, and more). The potential effect of such actions is not incorporated into the modelling
- Interventions must be eased in in a logical manner. Failure to do so will influence the number of parents who are willing to send their children to school. It will be vital to explain why and how school reopening is safe, and ensure that changing restrictions is not a signal that the risk from coronavirus is over and that it is safe to resume other activities or to abandon social distancing.
- Messaging to teachers, parents, and students must be robust to enhance confidence and willingness to return. This is especially important in respect to 'susceptibility'.
- The role of testing in maintaining the health of school systems, and the health of the nation, will need to be considered.

Conclusions and next steps

This time limited analysis brought together different disciplinary perspectives to assess different approaches to the re-opening of schools. Although there are many inherent uncertainties in the model predictions, the epidemiological analyses provides indicative insights into the extent to which different approaches to increasing school attendance may proportionally increase R. There is substantial uncertainty, with the relative contribution of school openings being driven also by the

relative susceptibility and infectivity of children of different ages compared to adults, as well as the extent to which social distancing is or is not sustained in the wider population.

The analysis highlights also the complexity of behavioural issues that will need to be considered about when implementing any of these potential policies, the future importance of clear, consistent, scientifically informed communication to children, teachers and parents; and the central importance of bringing together thinking on options to bring children back to school with wider discussions on options to release other aspects of the current lockdown. Although not initially one of the options proposed by DfE, options 7b (classes split in two, with children attending on alternate weeks) emerged from the joint discussions as having particular potential merit for further consideration.

This was a time limited activity, and at the last meeting the group agreed that there would be a merit to a continued joint working – potentially moving to a weekly forum. Next steps could consider, for example, the potential implications of the role out of testing on strategies for school opening. In doing this, however, it was noted that although this modelling can be further refined and expanded, there will be a limit to further modelling that would provide meaningful outputs (and be proportionate), given the current evidence base on children and expected behaviours.

As other countries start relaxing school closures and evidence starts to build, it will be important to use the collective insights gained to inform more detailed modelling and understanding of public responses to the proposed scenarios.

Modelling and behavioural science responses to scenarios for relaxing school closures

1. This report has been prepared for SAGE 30 (30th April 2020) by the Interdisciplinary Task and Finish Group on the Role of Children in Transmission (TFC). The TFC is composed of members from SPI-M, SPI-B, NERVTAG with additional members agreed though the SAGE and SPI-M secretariats.

2. It provides a summary of a collaboration between SPI-M and SPI-B to explore the modelling outcomes and behavioural science aspects of 7 school closure scenarios identified by the Department for Education (DfE) (See Table 1).

3. We have provided a relative assessment of scenarios for partial re-opening of schools, based on initial modelling and behavioural science considerations. This is indicative and should not be taken as a definitive answer on whether to pursue specific scenarios for partial re-opening.

4. Please note that there is a limit to further modelling that would provide meaningful outputs (and be proportionate) at this stage, given the current evidence base on children. Data on the role of children in transmission and their susceptibility and infectivity are still accruing.

5. As set out in the SPI-M consensus statement from 27 April 2020, bald calculations of a numerical relationship between relaxation of different measures and changes in R over-stretch the natural and behavioural science available to us now. This is a new infection, and we have a limited amount of information about how it spreads in which contexts. Some kinds of uncertainty will resolve over the next few months: how rapid and effective contact tracing is; the proportion of transmission that happens in asymptomatically infected people and those who are pre-symptomatic; the role of children in transmission; but others will always be hard to predict - and chief amongst those is how people will behave in the future in response to a threat they have never encountered before.

6. As a result, whilst individual modelling approaches can explore specific scenarios under specified assumptions, it is not possible to be sure that any specific set of policy changes will result in R remaining below 1. SPI-M cannot say with consensus, which combination of useful policy changes will result in R remaining below 1.

A. Proposed scenarios for relaxing school closures

7. The Department for Education (DfE) currently has seven policy options for partial reopening of the school system. This is considered against two baselines:
    - Baseline 1 (Scenario 1): current intervention of school closures
    - Baseline 2 (Scenario 9): fully opening schools
8. In all scenarios:
    - Children of key workers and vulnerable children may attend schools
    - Children with symptoms or living with someone who has symptoms continue to self-isolate
    - Children who are shielding (clinically extremely vulnerable) or living in a household with someone who is shielding continue to remain at home

Table 2: Options for relaxing school closures provided by DfE

Scenarios	High level policy description (provided by DfE)	Clarifications for modelling
1. Stay shut BASELINE 1	As now, only children of key workers (as currently defined) and vulnerable children attend, with numbers being maintained.	4% of children in early years; 2% from year 1 upwards
2. More vulnerable children and key worker kids	Numbers of children expanded either by encouraging greater attendance from those already eligible or by expanding the numbers of children eligible.	11% of children (Sensitivity explored: heterogeneity – ie. variation in vulnerable/key worker children across schools, with extreme scenario being 11% of schools)
3. Transition years 5/6/10/12, this side of the summer holidays	Focus on bringing back children in key year groups as these pupils are at key education transition points. Assume all children would be in scope less those who have to self-isolate either because considered vulnerable or because they or a family member are ill. Assume that children/young people could largely comply with required social distancing measures.	Simplifying assumption of "normal" levels of capacity etc (Sensitivity explored: classrooms may not be at full capacity if pupils split using empty rooms from other years)
4. Early year settings	All EY settings including registered childminders would be able to resume caring for children.	
5. All primary	All primary schools	
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Scenarios	High level policy description (provided by DfE)	Clarifications for modelling
7. Half time A (Full class, 2 weeks on / 2 off – full attendance)	• Operates in all primary and secondary schools. • School cohorts split in two. Half of each school attend for two weeks and then spend two weeks at home, the other half of the school then attend for next two weeks. • Workforce also split in two and stick with the same 'half' of the school.	Simplifying assumption that this splits each class in two (and hence each year group). This includes households together where relevant to models (Sensitivities explored: - 1 week on, 1 week off ("7b") • Extreme scenario of all children present for 2 weeks, then all off)
8. Half time B – half days	• Operates in all primary and secondary schools. • School cohort split in two. Half cohort attends in morning and other half attend in afternoon. • Workforce split in two with half working in the morning and half working in afternoon.	As above
9. Fully reopen BASELINE 2	All primary and secondary schools reopen	

B. Modelling scenarios for relaxing school closures

9. The SPI-M BSI subgroup has considered the impact on effective R or transmission rate arising from scenarios 2 – 9 for relaxing school closures, relative to the baseline (scenario 1).

10. Alongside inputs from SPI-B (in section D), this paper brings together modelling outputs from four groups, three of which are based on analysis of contact matrices from:

    a. (PHE) POLYMOD

    b. (LSHTM/Cambridge) BBC Pandemic Study

    c. (Bristol/Exeter) Social Contact Survey

    In essence, the impact of scenarios 1-6 and 8-9 is explored through modifying each set of contact matrices to remove, or reinstate, school-based contacts by age group. A further modification to combine the age structured matrices from POLYMOD and the BBC Pandemic Study with temporal transitions allows estimation of the relative impact of scenario 7 (Cambridge).

11. The fourth approach simulates scenarios 1 - 9 to September 2020 in the:

d. Warwick dynamic model

This is a SEIR-style age-structured model, matched to the early UK age-distribution of cases and then fitted to the temporal dynamics across 11 regions. Schools are assumed to operate between May and July 2020.

12. The four models take different approaches, and we are keen to present diversity of thought and results here. In addition to the use of both spectral and dynamic analyses, the three approaches using contact matrices use different datasets for mixing.

13. Further detail on the modelling approaches and outputs for each of these analyses is provided in Annexes B - F.

14. Please note that modelling outputs are indicative, and should not be taken as a definitive answer on whether to pursue specific scenarios for partial re-opening. As set out in section C, data on the role of children in transmission and their susceptibility and infectivity are still accruing. There are currently different views in SPI-M on the impacts of reopening schools on Rt.

Relative assessment of modelled scenarios

15. Table 3 provides a relative assessment of scenarios 2-9 (all scenarios for relaxation, plus baseline 2) under our four modelling approaches. The estimated impact on effective R or transmission rate for each scenario is expressed relative to the baseline of scenario 1.

Discussion and main insights from initial modelling

16. As illustrated in Figure 1, analysis of the Social Contact Survey from Bristol/Exeter suggests that the variation in impact across the nine school scenarios may be less significant than the level of adherence to other behavioural and social interventions.

Table 3: Relative assessment of modelled scenarios 1 to 9

		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9
		Stay Shut	More vulnerable children and key worker kids	Transition years 5/6/10/12, this side of summer holiday	Early year settings	All primary	All secondary	Half time A (Full class, 2 weeks on/two off – full attendance)	Half time B – Half class in AM/PM each day	Fully reopen
	Some likely sensitivities to assumptions. For most, we have assumed that other contacts beyond school are unchanged (Warwick's is the exception: more household contacts if not in school).	N/A	Models are taking simplification that this 11% is uniform. Heterogeneity in distribution across schools will increase risk of local outbreaks.	Models are assuming normal class sizes: could be better than this if classes can be split to make use of partially empty school	N/A	N/A	N/A	Assuming half in each staggered group. Result below for pessimistic assumption that total contacts remain the same.	Assuming half in each group.	N/A
LSHTM/Cambridge Using BBC all contacts data (Cambridge results for scenario 7)	infectiousness = 1	1	1.007	1.04	1.011	1.083	1.096	1.092	1.1	1.257
	infectiousness = 0.75	1	1.004	1.02	1.007	1.035	1.042	1.073	1.077	1.179
	infectiousness = 0.5	1	1.002	1.009	1.004	1.013	1.016	1.06	1.062	1.132
	infectiousness = 0.25	1	1.001	1.003	1.002	1.004	1.005	1.051	1.052	1.106
	Proportion at school	0.024	0.11	0.251	0.21	0.426	0.412	0.5	0.5	1
PHE Using POLYMOD all contact data (Cambridge results for scenario 7)	infectiousness = 1	1	1.036	1.169	1.041	1.432	1.524	1.214	1.259	1.684
	infectiousness = 0.75	1	1.024	1.094	1.03	1.27	1.32	1.147	1.17	1.468
	infectiousness = 0.5	1	1.013	1.042	1.019	1.121	1.135	1.082	1.089	1.244
	infectiousness = 0.25	1	1.005	1.013	1.008	1.032	1.034	1.03	1.03	1.075
	Proportion at school	0.024	0.11	0.251	0.21	0.426	0.412	0.5	0.5	1

		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9
		Stay Shut	More vulnerable children and key worker kids	Transition years 5/6/10/12, this side of summer holiday	Early year settings	All primary	All secondary	Half time A (Full class, 2 weeks on/two off – full attendance)	Half time B – Half class in AM/PM each day	Fully reopen
Bristol/Exeter Using the Warwick Social Contact Survey. Note currently R relative to adherence 0.9 scenario 1	adherence = 0.8, inf =1	1.000	1.028	1.155	1.040	1.170	1.343		1.172	1.508
	adherence = 0.8, inf =0.75	1.000	1.013	1.085	1.016	1.100	1.213		1.097	1.314
	adherence = 0.8, inf =0.5	1.000	1.010	1.047	1.012	1.047	1.116		1.058	1.158
	adherence = 0.8, inf =0.25	1.000	1.009	1.023	1.011	1.016	1.033		1.017	1.047
	adherence = 0.95, inf =1	1.000	1.031	1.164	1.034	1.186	1.391		1.179	1.583
	ad = 0.8, inf = 1 (relative to ad=0.95)	1.193	1.221	1.361	1.226	1.376	1.586		1.385	1.767
	ad = 0.3, inf = 1 (relative to ad=0.95)	2.130	2.170	2.321	2.169	2.330	2.545		2.339	2.744
	Proportion at school	0.02	0.11	0.27	0.15	0.52	0.48		0.5	1
Warwick Full SEIR model. Broadly comparable to 25% infectivity, see Annex F for details	Relative change in growth rate	1	1.005	1.016	1.012	1.012	1.021	1.016	1.047	1.094
	Relative change in growth rate in children	1	1.026	1.084	1.062	1.066	1.11	1.076	1.131	1.258
	Relative change in cases	1	1.006	1.021	1.011	1.014	1.028	1.019	1.046	1.111
	Proportion at school	0.02	0.13	0.18	0.2	0.42	0.38	0.5	0.5	1

Table 3: Relative assessment of modelling outputs: sensitivity analysis for scenario 7

		Scenario 1	Scenario 7a 2 weeks Optimistic	Scenario 7a 2 weeks Pessimistic	Scenario 7b 1 week Optimistic	Scenario 7b 1 week Pessimistic	Scenario 9
		Stay Shut	Half time A (Full class, 2 weeks on/two off – full attendance)	Half time A (Full class, 2 weeks on/two off – full attendance)	Half time A (Full class, 1 week on/two off – full attendance)	Half time A (Full class, 1 week on/two off – full attendance)	Fully reopen
LSHTM/Cambridge Using BBC all contacts data (Cambridge results for scenario 7)	infectiousness = 1	1	1.043	1.092	1.041	1.085	1.257
	infectiousness = 0.75	1	1.035	1.073	1.034	1.07	1.179
	infectiousness = 0.5	1	1.029	1.06	1.029	1.058	1.132
	infectiousness = 0.25	1	1.025	1.051	1.025	1.05	1.106
	Proportion at school	0.024	0.5	0.5	0.5	0.5	1
PHE Using POLYMOD all contact data (Cambridge results for scenario 7)	infectiousness = 1	1	1.096	1.214	1.089	1.192	1.684
	infectiousness = 0.75	1	1.065	1.147	1.06	1.131	1.468
	infectiousness = 0.5	1	1.036	1.082	1.033	1.073	1.244
	infectiousness = 0.25	1	1.013	1.03	1.012	1.027	1.075
	Proportion at school	0.024	0.5	0.5	0.5	0.5	1
Warwick Full SEIR model. Broadly comparable to 25% infectivity, see Annex F for details	Relative change in growth rate	1	1.009	1.016	1.008	1.016	1.094
	Relative change in growth rate in children	1	1.023	1.076	1.025	1.075	1.258
	Relative change in cases	1	1.008	1.019	1.008	1.019	1.111
	Proportion at school	0.02	0.5	0.5	0.5	0.5	1

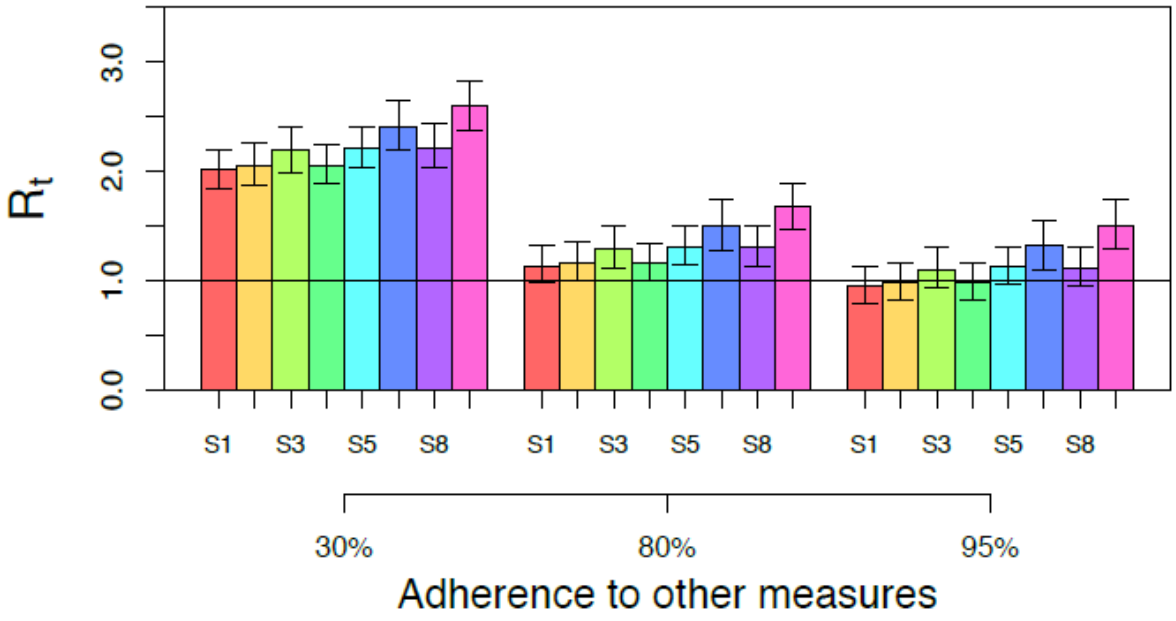
17. **In other words, although the choice of scenario for relaxing school closures is of importance, a more critical issue is adherence to existing measures elsewhere in the community** – with an impact on R_t an order of magnitude higher. If relaxing school closures results in falling adherence to existing social distancing and other measures (for example, through increasing adult work contacts), then this will reduce the scope for its implementation.

18. This is echoed by the Warwick analysis (Annex F), which considers impacts under the current level of social distancing, reduced lockdown and minimal lockdown (2/3 and 1/3 of current adherence respectively). It similarly concludes that "the impact of opening schools is a lot less than any changes to the population-wide policy of lockdowns".[1]

Figure 1: Analysis of the Social Contact Survey: the effective reduction number after re-instating school-aged contacts for scenarios 1-6 and 8-9

This assumes that children are as infectious as adults. Baseline R0 = 3.1

This is figure 2 from the paper "The impact of opening schools on the effective reproduction number: Analysis of the Social Contact Survey" in Annex E



19. Although we acknowledge the value of "logical" easing of interventions with regard to public perception (as discussed by SPI-B in section D), any assumption that school and work measures are relaxed close together needs to be explored cautiously – the impact of both on transmission is greater than their individual effects.

[1] The Warwick results in Table 2 are for the baseline assumptions of current measures

20. Although the four modelling approaches differ in the magnitude of impact on effective R or transmission rate relative to baseline, there is broad consistency in the relative ranking of the seven scenarios for relaxing school closures.

21. Part of the difference in magnitude will be explained by the different contact matrices used in analyses. In particular, POLYMOD reports a high number of child contacts relative to the BBC pandemic study (for those aged 13+) and the Social Contact Survey. This may be due to changes over time[2] and the fact that POLYMOD contacts are based on parental reporting. In contrast, the dedicated school survey element of the Social Contact Survey considers self-reported contacts by children – so a child may report five specific contacts, rather than the entire class (25-30).

22. **Scenario 2 (increasing attendance of vulnerable and key worker children to 11%) has the smallest impact relative to the baseline**, scaling baseline R0 by approximately 1.036 in the worst case from the four sets of results.

23. There is a consistent message that **resuming early years provision has a smaller relative impact than primary school, which in turn has a smaller relative impact than resuming secondary schooling** (Early years < Primary < Secondary; or scenarios 3<4<5), even proportionately. However, as set out in paragraph 29, this does not yet incorporate the indirect impact on contacts outside of school – which may differ by age of child.

24. This ordering is, unsurprisingly, partly driven by the proportion of school-aged children captured by each scenario for relaxing school closures – with fewer children attending in scenarios 2 and 3 relative to 4 and 5. Although there are relatively similar numbers of children attending in primary and secondary school, there is consensus that re-opening secondary schools has a greater impact than primary; this is partly due to the higher number of (all) contacts reported by this age group.

25. **Scenarios 7a and 7b (alternating 2 weeks on/off, and 1 week on/off respectively) are good ways to stop extensive transmission chains in schools. When this effect in schools is embedded into the wider community, the impact is less strong, but still has some value in reducing overall R.** The modelling of scenarios 7a and 7b is the least robust of the scenarios, and further exploration is needed.

[2] POLYMOD was conducted in 2005-06, the Social Contact Survey in 2010 and the BBC Pandemic Study in 2017-18.

26. Scenario 7 is predicated on the fortnight/week off creating a break in transmission. This is reliant on children in the different phases not mixing (eg. those attending in weeks 1 and 2 not mixing with those attending in weeks 3 and 4), and on classmates not mixing outside of school and in the time off from school. It will also be affected by household dynamics. Further evidence is needed to understand the household dynamics and how children's contact patterns / networks might change in this scenario.

27. Although the initial modelling outputs show limited difference between scenarios 7a and 7b, additional research is needed to refine this. This is also heavily dependent on an assumed mean generation time of 5 to 6 days (and the distribution of generation times). The time off from school needs to be long enough to cover the latent period – that is, so that if a child is infected on the last day of school, any onset of symptoms is apparent before they return to school in the next cycle. Scenario 7b (week on/off) currently has 9 days between the last day of school and first day in the following cycle (due to weekend). Any shorter than this would not be recommended.

Caveats to modelling

28. **This is a relative comparison of options for school relaxation, not an absolute assessment of their impact**. Any assessment of absolute impacts would be dependent on: the proposed timing of interventions (background incidence of COVID-19), other behavioural and social interventions in place and adherence to these measures – among other issues.

29. **This is an initial approximation only, and for the most part does not model the impact on other contacts beyond those in school** (eg. adult contacts at school gate/travelling to school, indirect impacts on parents' work contacts). The main exception is the Warwick model, which considers the impact on within household contacts. This may affect some scenarios more than others – for example: increasing attendance of younger children may allow more parents to return to work relative to increasing attendance of older children.

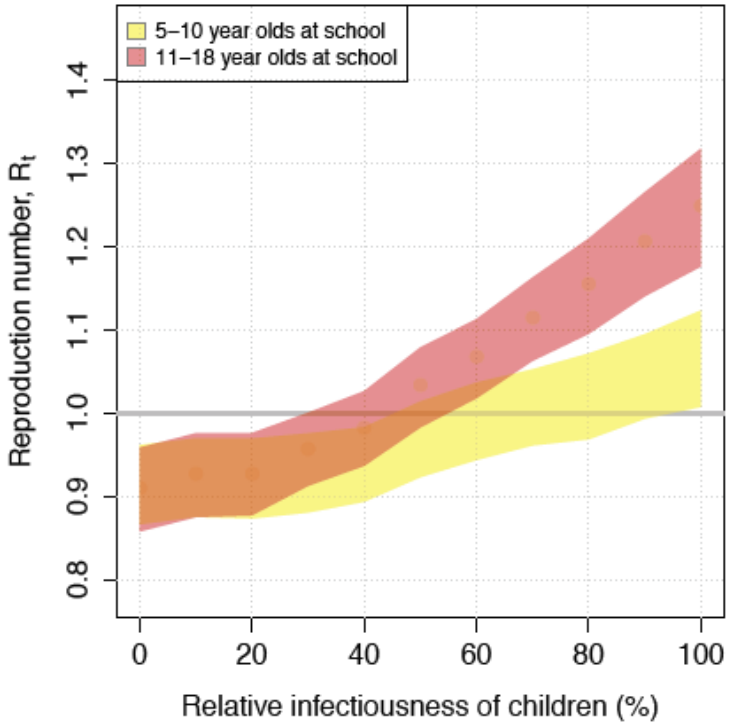
30. **Similarly, the potential for fomite transmission between groups in scenarios 7 and 8 has not been modelled** (this would be another free parameter). This implicitly assumes that schools are able to fully clean and disinfect school settings between the AM and PM classes in scenario 8 for example – which may not be feasible.

31. As set out, outputs will be sensitive to assumptions and issues including but not limited to: the susceptibility and infectivity of children; proposed timing of interventions and

background incidence; other behavioural and social interventions in place; adherence to these measures; capacity and operational decisions around "delivery" in schools (eg. ability to social distance, ventilation in schools) etc. As before, these will affect the impact of each scenario differentially.

32. **In particular, we still do not have robust, high-quality evidence on the susceptibility, estimated asymptomatic fraction and relative infectivity of children** (see section C). This clearly has a significant bearing on the impact of relaxing school closure, as illustrated for infectiousness in Figure 2.

Figure 2: Analysis of the Social Contact Survey: the impact of infectiousness of children on the effective reproduction number when primary or secondary schools are open (scenarios 5 and 6)
This assumes a 90% reduction in all other contacts outside the home. Baseline R0 = 3.1
This is figure 4 from the paper "The impact of opening schools on the effective reproduction number: Analysis of the Social Contact Survey" in Annex E



33. **In general, we have made conservative assumptions** – for example: that children are as infectious as adults; that all eligible children attend schools in scenarios 3-9; or that class sizes are unchanged – with sensitivity analyses where feasible. These are clearly pessimistic assumptions in many cases – for instance, SPI-B have highlighted that not all parents will send their children to schools if the perceived risk is high, or if attendance is perceived as non-normative.

34. **Although some scenarios for relaxing school closures may have a small relative impact, this will need to be considered within the wider context** – that is, if the current reproduction number is only just below 1, then even a small change could lead to a return to exponential growth.

35. Although this modelling can be refined and expanded, please note that there is a limit to further modelling that would provide meaningful outputs (and be proportionate) at this stage, given the current evidence base on children. As other countries start relaxing school closures and evidence starts to build, we will have further information to inform more detailed modelling.

C. Update on Susceptibility and Transmission in Children

36. The SAGE document "SAGE Subgroup: The role of children in transmission SAGE 26: 16 April 2020" concluded that there was some evidence on that children had milder symptoms than adults, but that evidence on relative susceptibility and infectivity of children was as yet unclear. It recommended consideration of additional data gathering.

37. Evidence remains inconclusive on both the susceptibility and infectivity of children, but the balance of evidence suggests that both may be lower than in adults (Annex A).[3]

38. Serological studies are starting to be available on child infection history, with some suggesting low rates of infection. These must be interpreted with caution based on exposure history (e.g. school closure) in the area they are drawn from, and given some suggestions that mild infections (as are more common on children) may be less likely to generate antibodies.

D. SPI-B response to the 7 scenarios for relaxing school closures

39. The behavioural science considerations of the 7 scenarios for relaxing school closures can be found in Table 3. The population of this table was driven by the response to 6 practical questions, and 4 contextual questions, the summaries of which appear below.

40. **Q1: What networks or contacts between individuals does the scenario increase/limit vs. keeping the school shut as is the policy of today?** Scenarios 2-9 will increase interactions

[3] See Viner, Eggo (2020), *"Susceptibility and Transmission in Children – updates from the last few weeks"* – in the SAGE repository

from the current baseline, though the dynamics differ depending on the intervention. There are a number of scenario-specific considerations:

- Expanding the numbers of children by encouraging greater attendance from more vulnerable or key worker children (Scenario 2) has the potential to focus this increase among vulnerable SES students (among whom BAME and low SES individuals will be over-represented); among children of keyworkers (who are more likely to be exposed to infection); and between these groups.
- Bringing back children in transition years (Scenario 3) limits the increases to specific year groups, in contrast to bringing back all early years (Scenario 4), primary (Scenario 5), and secondary (Scenario 6), or fully reopening (Scenario 9) where the impacts will not be limited to specific year groups.
- Increases would be less if the year groups are split in half, with students remaining in their existing classes. Returning all primary and secondary schools to 2 weeks on/2 weeks off (Scenario 7), and to half time/half days (Scenario 8) will increase interactions among class members, and year groups from baseline.

41. **Q2: What role might extending/changing outdoor break time play in limiting transmission?**
Increasing the proportion of time outside could reduce transmission assuming it allowed more distancing across all scenarios. However, social distancing is more likely in secondary than primary or early year settings.

- Schools may prefer to simply reduce the total time in school and remove or reduce break times. This might not be an option for early years settings (Scenario 4) or in settings with more vulnerable children. At present schools are open for vulnerable children and the children of key workers – this would be expected to remain the case regardless of other re-opening change.
- Schools must consider alteration of the environment to disrupt transmission (e.g. interstitial spaces and activity areas) in Scenarios 7-9. Schools in Scenario 8 may not have this option if children are only attending for the morning or afternoon and therefore need to maximise contact time with teachers.
- Physical distancing between children, staff and children, and staff will be influenced by the physical design of the indoor and outdoor spaces and temporal management – to affect both flow of people and congregation inside and outside buildings. Additional work is required to develop plans for redesigning shared indoor and outdoor spaces to minimise COVID-19 transmission.

- The staff should move between classrooms, the students should not.

42. **Q3: What messaging to pupils, parents or teachers should be prioritised in each scenario to reduce transmission – e.g. washing hands (hygiene) vs. reducing contact?** Messaging to teachers should include options to limiting interactions between year groups, limiting interactions between students in different classes or year groups, and stopping whole-school gatherings.
    - Differences exist between stages with younger children requiring more supervision, and older children being more likely to adhere to hand hygiene, face touching, and physical contact.
    - Messaging to vulnerable children and the children of key workers (Scenario 2) should not encourage distancing between vulnerable and key-worker children as this will be stigmatising and divisive.
    - For all scenarios, children with learning disabilities may require specific messaging and more behavioural direction about social distancing across all age-groups.
    - In all scenarios messaging to teachers should be the same and will be important:
        i. To ensure social distancing at front of class (more difficult with early years; easier with older children);
        ii. Routine handwashing for all students and teachers after each break period (i.e. each time leave class);
        iii. Cleaning classroom surfaces after school each day; teachers to wear basic protective measures (e.g. plastic disposable apron, etc., where supported by evidence).
    - Messaging should be developed for and in partnership with parents and students, too. The SAGE subgroup on the role of children in transmission (16th April 2020) highlighted the need for the development of a survey or portal capable of identifying concerns and issues from the bottom-up. They argued, 'We need to commission work to find out what the issues/challenges are for teachers, for parents, and for children' (p. 22).
    - Teachers, parents, and children must feel safe.

43. **Q4: How do pupil age and other characteristics impact the understanding of and compliance with social distancing measures?** The SAGE subgroup on the role of children in transmission (16th April 2020) argued that, 'We need to identify how age and type of setting

impact the understanding of, and compliance with, social distancing measures' (p. 22). For example, ounger children will require more support to adhere because of limited self-regulation. Older children might not adhere if they are not sufficiently informed, motivated, or enabled to do so. Adherence might be low where student needs and wants are not sufficiently considered or where students feel alienated by top-down regulation. Additionally, children with SEND might find expectations around social distancing very difficult to follow.

- Scenarios 2, 4, and 9 require additional planning as teachers may require more protective equipment for doing intimate care. ery young children (EYFS) often need assistance with intimate care (e.g. toileting; wiping noses). There is definitely potential for viral transmission in faeces. This will have major implications for teachers and social distancing, as well.
- Some SEND students can have similar issues, which has implications for all of the scenarios.

44. **Q5. Will parents send their children to schools if open? If not, why not? Will children and young people attend? What conditions need to be in place**? Parental willingness will be informed by a variety of factors. Most importantly, parents must perceive that the risk of infection is lower before they will be willing to send their children to school. This combines with other factors, such as the belief that their children need to attend school to prepare for the following academic year; whether or not school attendance is normative or non-normative; parental need to stay home with other age groups; and the impact of proposed school rota systems on parental ability to work. Additionally, older student's perceptions must be taken into account as they may vary (e.g. gender, SES, ethnicity) in their attitude to returning to prepare for public exams.
    - For all scenarios, parents understanding that children are at lower risk than adults will be key to encouraging them to send children to school. For example, if schools are reopened whilst the messaging is that it is not safe for adults to exit lockdown to work, parents are very likely to feel it is also unsafe for their children to attend school.
    - Scenarios 7 and 8: Parents of younger children may not be able to align their working time with the rota system or may be sceptical of the limited school offer. This might be particularly challenging where parents have different children with different rotas. Additionally, older students may decide not to attend if the rota

system is not perceived as a return to normal requiring their attendance or serving their needs.

- Parents of vulnerable children and those who are key workers have largely chosen not to send their children to schools that have stayed open to accommodate them.[4] A high degree of uncertainty exists over understanding the factors that drive parents to send their children to the schools that have remained open during COVID-19. It may be that parents perceived the risk of infection to be too high. Similarly, key workers may have complied with the strong guidance emphasising that this option was only for children who cannot be safely cared for at home. It is also possible that messaging about vulnerability had the potential to stigmatise and label the children attending the schools that remained open. This requires additional investigation.
- Looking ahead, data from a Cabinet Office YouGov poll of 1,532 UK adults (of which 418 had school-aged children) on 28th April found that 19% of those with school age children say that they would definitely send their children them back, and 26% said that they will probably send them back if schools reopen tomorrow. 18% of respondents reported that they probably would not send their child to school, and 15% definitely would not, and 12% were unsure, and 10% said that the decision did not apply to them. For those who would not send their children back to school (N=295), headlines show that 57% were concerned about safety at school/mixing with others, 54% expressed concern about spreading the virus to others, and 20% said that there was no point in the children returning at this point in the year (Cabinet Office 2020[5]).
- It is impossible to separate Questions 3 (messaging) and 5 (attendance at school). Messaging will inform the likelihood of attendance. Evidence-based risk communication will increase the likelihood of addressing concerns about safety at school, spreading the virus to others, and more.

45. **Q6. Is the implementation or likely impact on transmission of this model predicated on or potentially affecting other aspects of policy?** All discussions of Annex G highlight the importance of understand interactions taking place beyond the school. Very little is known about the levels of contact that children are having outside of the COVID-19 schools at this

[4] Department for Education (2020) – Coronavirus (COVID-19): attendance in education and early years settings
[5] These statistics are Official Sensitive.

point in time. Adherence to other social distancing measures will be important to understand, as well. In respect to the proposed scenarios:

- Scenario 2: There have been suggestions that vulnerable children should be compelled to attend schools. This would be unwise firstly because these are a diverse group only some of whom may be at increased risk of harm at home, and secondly because in all but a minority of cases the harms in terms of alienating parents and stigmatising children would outweigh any benefits. Additionally, SEND children could need intimate/close care from teachers/staff which makes social distancing difficult.
- Scenario 7 is more likely to be associated with increased attendance if employers give staff flexibility in shift working/home working so that this aids parents in returning to work. If it does not enable more parents to work then this may tip the balance so that they keep their children at home.
- Scenario 8: This option is more difficult to align with parental work patterns and so may have lower attendance.
- Following on from a point raised in the SAGE subgroup on the role of children in transmission (16th April 2020), issues around digital inequities must be addressed in order to enable everyone to be able to study equally offline in Scenarios 7 & 8.

46. SPI-B was also asked to consider some wider contextual issues:

47. Households with BAME & adolescent or young adult members may create greater susceptibility among children to the virus for different reasons. BAME individuals may be more susceptible because of the greater prevalence of frontline medical and care work. Adolescents may be more susceptible because they may not comply to regulations on social distancing and hygiene due to distrust of authority. Finally, young adult family members will be likely to be working in frontline logistics sectors such as warehousing and be exposed more in their workplaces to risky environments.

48. SPI-B already reflected upon the ways in which the school structure interplays with level of mixing in their response to Question 2.

49. In respect to teacher profiles, it may be possible to prioritise younger teachers' attendance as long as this was negotiated rather than imposed. Other staff could remain at home and

facilitate distance learning. However, SEND children will require a smaller population of skilled and experienced teachers to draw upon, which makes it challenging to prioritise a certain age profile of staff.

50. Testing can be maximized to enhance the effectiveness of interventions by drawing lessons from school-based health programmes. A successful testing programme will require strong intersectoral partnership, local champions and coordinators of testing, and clear school policies, as well as a credible test. This will inform the understanding of the severity of coronavirus events in school populations.

Caveats

51. **School closures do not constitute a solitary intervention. It is important to understand the other types of social distancing measures that staff, parents, and students are engaging in beyond the boundaries of the school.** This identification of behavioural science factors to consider the easing of school closures did not include interactions external to the school environment.

52. **It is also important to understand what is going on inside of the school (e.g. physical distancing, hygiene measures, and more).** This will enable us to move beyond understanding the frequency of contact, to understanding the type of contact occurring between students, teachers, and parents.

53. **Interventions must be eased in a logical manner. Failure to do so will influence the number of parents who are willing to send their children to school**. It will be vital to explain why and how school reopening is safe, and to ensure that changing restrictions is not a signal that the risk from coronavirus is over and that it is safe to resume other activities or to abandon social distancing. It is important to explain why resuming school attendance is safer to resume or must be resumed for other important reasons (such as to reduce harm to vulnerable children), compared with other activities, such as going to work. For example, it may be confusing if individuals were encouraged to return to school, but the number of times that they are allowed to leave the house each day remains the same. Similarly, it is likely to be difficult to convince parents that it is safe to send their children to school if offices are still shut**.** SPI-B's previous work on phased changes in activity restrictions and principles for the design of social and behavioural interventions have highlighted the need

for a credible order to changing restrictions (e.g. from least to more at risk) (SPI-B Theory and evidence base for initial SPI-B recommendations for phased changes in activity restrictions; SPI-B: Principles for the design of social and behavioural interventions (April, 2020).

54. **Messaging to teachers, parents, and students must be robust to enhance confidence and willingness to return**. This is especially important in respect to 'susceptibility'. Communications to all parties (teachers/ parents/ pupils) requires further work to enable the co-production of messages.

55. **We must consider the role of testing in maintaining the health of school systems, and the health of the nation.** It is important to work tracing into the models where possible.

56. **We need to understand the steps being taken by other countries.** What was their approach? How are they monitoring schools? What are their measures of success? What other interventions are in place alongside the easing of school closures?

Discussion and main insights from the SPI-B response to the 7 scenarios for relaxing school closures

57. **Scenarios 2-9 will increase interactions from the current baseline, though the dynamics differ depending on the intervention**. Changes may focus the increase on specific groups (e.g. BAME/low SES), year groups, or class groups.

58. **Adaptations to routines and environments may mitigate the extent of the increase.** For example, reducing the proportion of time outside and alterations to the school environment could limit transmission. The effectiveness of adaptations and alterations will be influenced by the physical design of the indoor and outdoor spaces, temporal management, and the care requirements of different age and SEND groups.

59. **Pupil age and other characteristics will impact the effectiveness of interventions.** For example, younger children and SEND students will require more support than older children to adhere with social distancing measures. Older children may be less likely to adhere if their wants and needs are not considered in the design of interventions.

60. **Messaging to teachers, parents, and students will play an important role in each scenario.** Additional work is required to identify perceptions of risk, understanding, and information needs across these groups. Most importantly, these groups must perceive that the risk of infection is low before they will be willing to attend or send their children to school.

61. **Messaging to teachers should include options to limiting interactions** between year groups, limiting interactions between students in different classes or year groups, and stopping whole-school gatherings.

62. **Messaging to parents and students should address a range of factors** including perceptions about the level of risk, need to attend school for the following academic year, whether or not school attendance is normative, parental ability and desire to keep children at home, and the impact of proposed school rota systems on the parental ability to work.

63. Messages should be developed in partnership with teachers, parents, and students.

64. **The scenarios for relaxing school closures must be understood in the context of interactions taking place beyond the school.** For example, very little is known about the levels of contact that children are having outside of the COVID-19 schools at this point in time. Social distancing guidance beyond the school will inform these interactions. Additionally, scenarios involving rota systems will be easier to engage with if employers give staff flexibility in shift working or home working. This, in turn, will aid parental return to work.

65. **Wider contextual issues must be taken into account when assessing the impact of the options for relaxing school closures**. First, households with BAME & adolescent or young adult members may create greater susceptibility among children to the virus for different reasons. Second, it may be possible to prioritise younger teachers' attendance in order to decrease the likelihood of infection for teachers in more vulnerable groups. This must be negotiated, rather than imposed. Finally, testing can be maximised through partnerships approaches to school-based health programmes. This will be needed to inform the understanding of the severity of coronavirus events in school populations.