Projections of COVID-19 Cases and Deaths Following Schools Reopening

Summary

- We applied models that predicted the pattern of the first peak of COVID-19 cases in late July 2020 but did not predict the second peak in November 2020.
- The peak in November 2020 can be explained by now adding to the model: a) data that has become available on negative test numbers; b) an increase in reproductive number (i.e. R(t)) in October/November, which may be related to relaxation of restrictions and increased movement; and c) wider spread of COVID-19 into rural Kenya than in the first wave.
- We consider the most plausible effect of schools reopening on 4th January to be that the transmission rate in Kenya will increase the time-varying reproductive number (R(t)) by +25%, and, increase mixing between social clusters that were not in contact whilst schools were closed.
- Under the most plausible scenario, we project that the rate of COVID-19 case and death incidence will peak in mid-March 2021.
- Under the most plausible scenario, we project 13.7 thousand (10.6k-16.8k) new determined COVID-19 cases and 116 (58-289) new COVID-19 attributed deaths by June 1st 2021 (Fig. 1).
- The estimated +25% R(t) increase is conditional on other restrictions that reduce transmission remaining in place, and measures being in place to reduce transmission in the schools setting.
- A worst-case scenario would be an increase in R(t) by 50% and resulting in an epidemic of similar magnitude to the second outbreak in the country. We think this is unlikely.
- This model needs updating with the latest data on negative test numbers, and to add information on the age distribution on cases and deaths in Kenya. These improvements are also required for medium-term forecasts of vaccine effectiveness in Kenya. This stage of model improvements is expected to be completed by early February.
- The impact of other events such as new variants could increase the R(t) by more than +25%, and case numbers and deaths would then exceed our predictions.
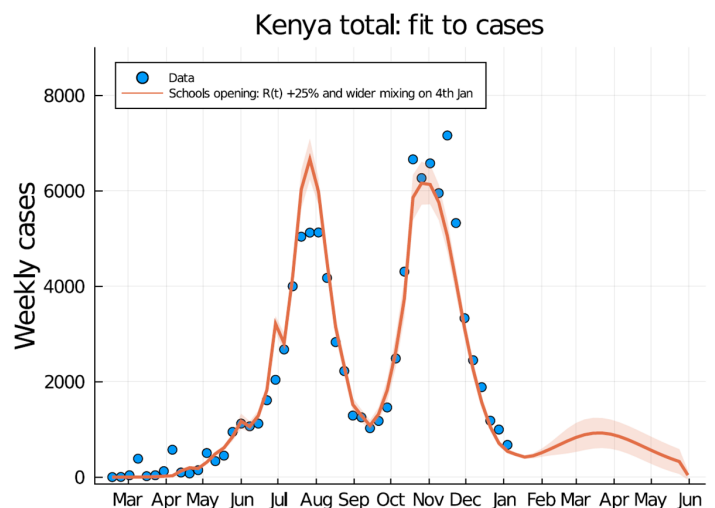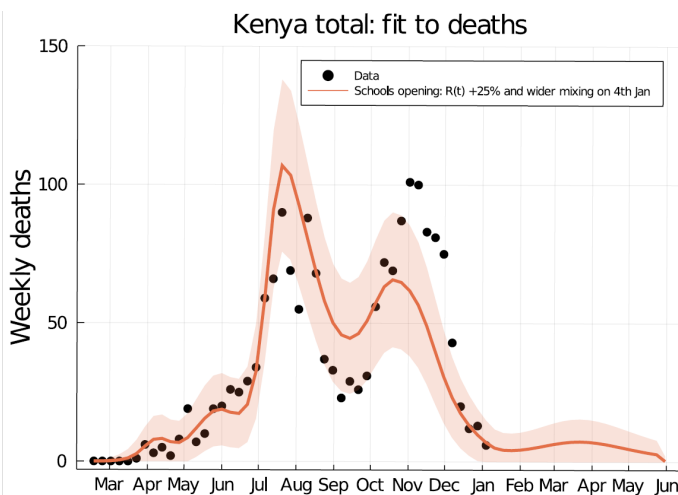

Fig. 1: Kenya-wide inference of deaths (left) and cases (right) with forecast under most plausible scenario. The modelling is based on an extended analysis from our published work (Ojal et al, 2020) using national seroprevalence and PCR line list data. The projection, i.e. the red line extending beyond the data points (blue dots), assumes an increase in the R(t) by 25% on January 4th.

Our previous predictions had been for a single peak. Models with the assumptions of a consistent R(t) over time and a single mixing population predict a single peak. Based on the second peak, we have added further parameters to the model. These include an increasing R(t) in October/November and a parameter to reflect limited mixing in the population (i.e. that there are some social clusters with limited contact between them).

This modified model is consistent with the second peak without the need to include waning immunity or new variants of SARS-CoV-2. It is possible that school openings will further increase R(t) and population mixing, and so we have examined predictions for this impact.

Scientific evidence for impact of schools reopening on transmission dynamics of COVID-19

The scientific consensus is that reopening schools increases the transmission rate of COVID-19. However, there is no broad consensus on the quantitative effect of schools reopening on current R(t); this is likely to be highly specific to the country considering schools reopening. The scenario presented here is based on the following evidence from the literature and our analysis of the Kenyan population structure.

- A published modelling study on reopening schools in the United Kingdom predicted that reopening schools, in conjunction with simultaneous widespread relaxation of other measures, would increase R(t) by +50% (Panovska-Griffiths et al, 2020). Attributing half of this increase to schools reopening gives +25%.
- A population age structured mixing analysis has found that schools opening has, by itself, small impact on post-measures R(t) (Lee et al, 2020).
- We undertook a similar age structured mixing analysis to Lee et al as part of earlier scientific guidance to the Kenyan Ministry of Health (Fig. 2). We found that, in the Kenyan setting, reopening schools would increase R(t) by +25%. We estimated that there would be a 50% reduction of within school infectious contacts compared to pre-pandemic social mixing in schools based on the additional measures introduced.
- Our analysis is that in late December the baseline R0 (not accounting for decreased population susceptibility) was 2.5-3.5 with variation between Kenyan counties. Therefore, the increase of 25% gives an overall R0 of 3.1–4.4. We consider this close to a "worst case" scenario given that these would be among the highest baseline R0 estimates in the world. This informs our view that an increase in the current R(t) of +50%, leading to a third wave of similar magnitude to the second wave, is unlikely.
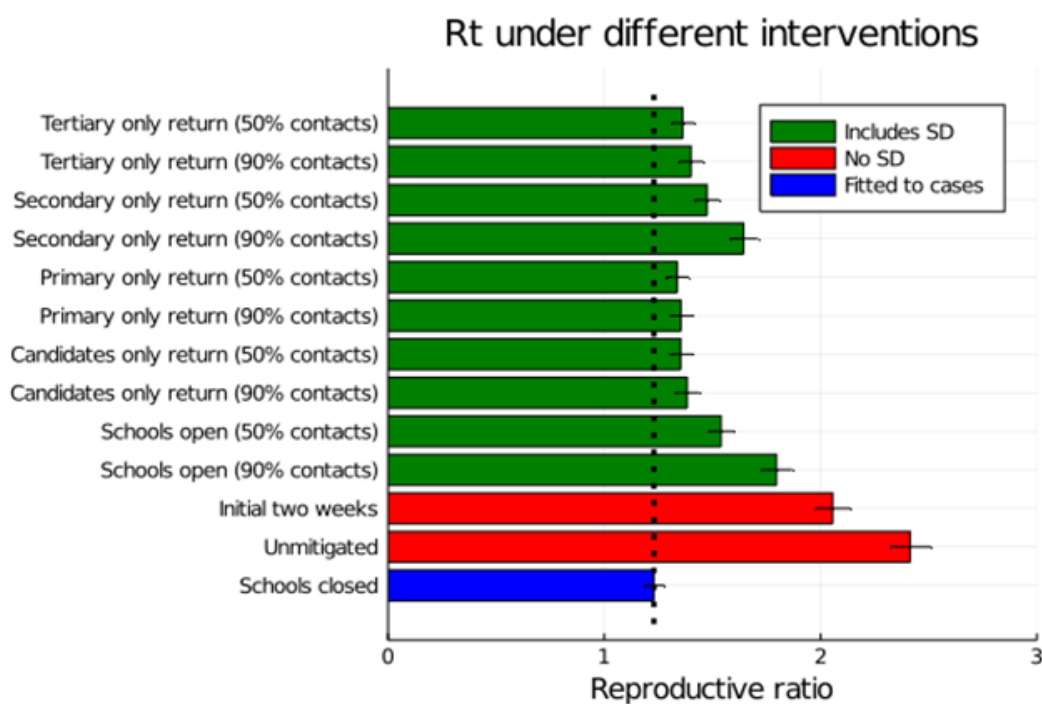

Fig. 2: Population age-structured mixing analysis of R(t) relative to R(t) = 1.2 (June, 2020).

We project the schools opening could lead to 13.7 thousand (10.6k-16.8k) new determined COVID-19 cases and 116 (58-289) new COVID-19 attributed deaths by June 1st 2021, on top of the 99k cases and 1,700 deaths reported to date. Underlying the observed epidemic we project that there will be 1.1 million (0.53m-1.7m) infections over this period, with the large majority of infections remaining undetected owing to the limitations on testing. We predict that by mid-February the impact of schools opening should be clear in terms of case numbers.

Recommendations

- Maintain public health messaging on preventive measures
- Enhance measures to reduce the risk of transmission in schools, such as physical distance and hand hygiene

Bibliography

B. Lee, J. P. Hanley, S. Nowak, J. H. T. Bates, L. Hébert-Dufresne, Modeling the impact of school reopening on SARS-CoV-2 transmission using contact structure data from Shanghai, 1–9 (2020).

J. Ojal et al., Revealing the extent of the COVID-19 pandemic in Kenya based on serological and PCR-test data. medrxiv.org. (2020).

Panovska-Griffiths, J. P. , et al. Determining the optimal strategy for reopening schools, the impact of test and trace interventions, and the risk of occurrence of a second COVID-19 epidemic wave in the UK: a modelling study. The Lancet child and Adolescent Health, 1–11 (2020).

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