ANALYSIS OF DYNAMIC QUARANTINE STRATEGIES USING MICROSIMULATION MODELS[1]

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Objectives and background of the model

In this report, we present additional simulation results for two pandemic containment strategies for the Santiago Metropolitan Region. This microsimulation model is based on that of Imperial College and estimates new infections by simulating, day by day, the mobility behavior of individuals in the region according to their social interactions (home, work, school, community), and how they change depending on the containment strategy used (see Figure 1). The model uses **detailed and objective information about the movement of people in the city.**

Scenarios analyzed: Intermittent quarantines with open or closed schools.

In the first report delivered to the Ministry for Science, three scenarios were analyzed:

Scenario 1: Social distancing + closure of schools and universities
Scenario 2: Total quarantine in the Metropolitan Region
Scenario 3: Intermittent quarantine

- Boroughs are grouped into six zones defined by Metropolitan Health Services with the aim of illustrating the use of the model. It is possible to analyze other zone groups.
- A threshold policy is used at zone level: quarantine is activated in a zone when the number of active cases of infection surpasses 5 for each 10,000 inhabitants. It is deactivated when the number falls below the same threshold.
- Without quarantine, a policy of social distancing and school closures remains in place (similar to Scenario 1).

In this report we focus on comparing **Scenario 3** with the following **Scenario 4**:

Scenario 4: Intermittent quarantines with open schools in periods without quarantine
- Similar to Scenario 3 to activate/deactivate quarantines by zone. During periods without quarantine, social distancing is in place, but schools are kept open.
- To define the rate of infection in a school, the parameter was calibrated using the value reported in the report by Imperial College (which is based on infection of seasonal flu).

The scenarios were simulated from April 1, so data reported after this date corresponds to simulations: what we analyze here is the prediction regarding how the situation would develop had quarantine continued. This differs from what happened and the results.

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[1] The model is updated and recalibrated each time data allows it. For that reason, predictions are dynamic.
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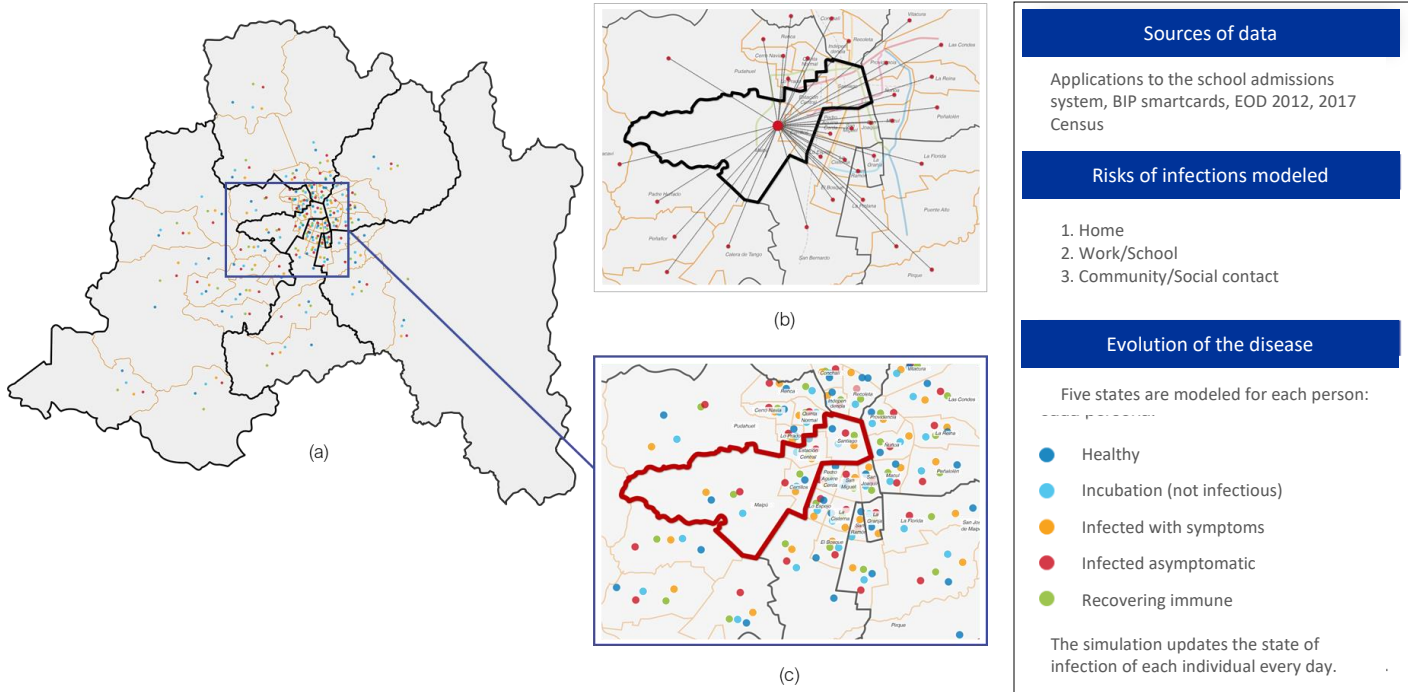
Figure 1: Panel (a) Modeling of agents in the Metropolitan Region. Panel (b): representation of movement on public transport from the center of Santiago. Panel (c): Metropolitan Health Service Santiago Centro – reduction of mobility in the simulation

Result of the simulation
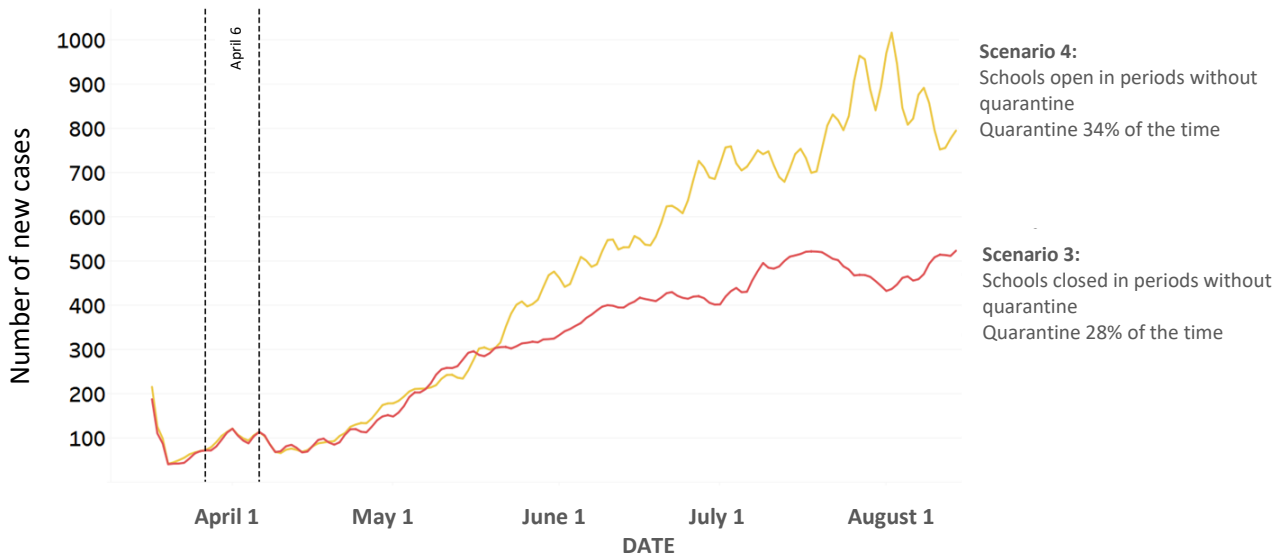
Figure 2: Average forecast (from various simulations) of new cases for the scenario of intermittent quarantine with and without school closures during periods without quarantine. The simulated intermittent quarantine strategies started on April 6. New cases are reported with a 3-day rolling average.

Scenario 3: Intermittent quarantine with **schools closed** in periods without quarantine.
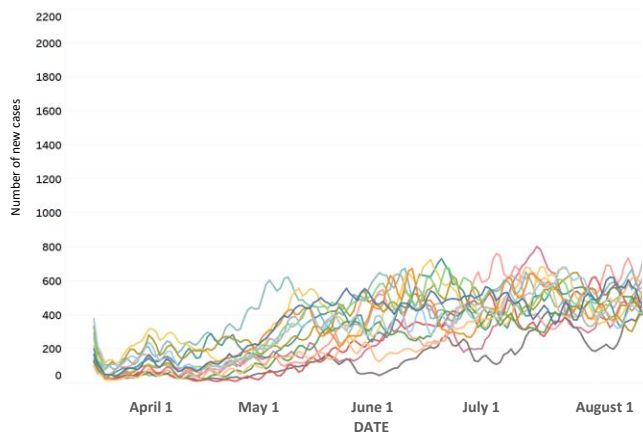
Scenario 4: Intermittent quarantine with **schools open** in periods without quarantine.

(a)
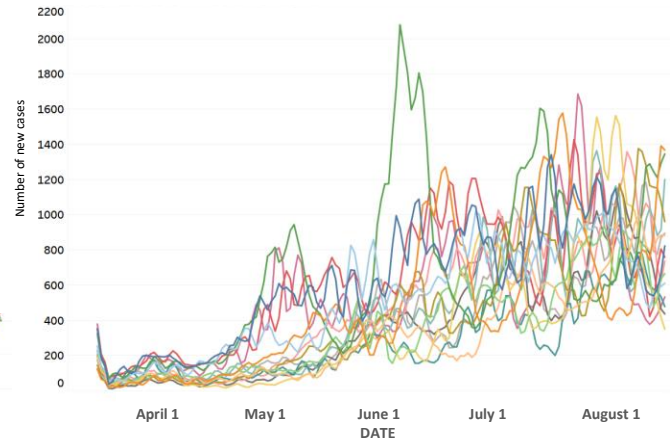
(b)

Figure 3: Evolution of new daily cases for multiple simulation runs.
Panel (a): in Scenario 3 with closed schools. Panel (b): Scenario 4 with schools open.

Conclusions

- Intermittent quarantines according to the threshold **defined here with closed schools and social distancing** (Scenario 3) would seem to be a viable alternative, since they would keep the number of new daily cases in the region relatively stable, ranging from a minimum of 300 to a worst case of 700 (Figures 2 and 3a). For this, asynchronous quarantines should be defined for around 30% of the time for each SS, with an average of 2.5 million people affected[3].

- Simulated intermittent quarantines **with open schools and social distancing** (Scenario 4) considerably increases the average number of new daily cases with respect to Scenario 3 (Figure 2) with 900 versus 500 new cases by the end of July. This, despite the simulation intermittently quarantining almost 2.5 million people. Furthermore, the scenario with open schools is more uncertain, showing more variability: in the simulations, the daily new cases oscillate between 400 and a worst case of 1,400 towards the end of July (Figure 3b). Quarantines result for 35%, with a maximum of 40% for SSMS.

Important considerations

- There is no consensus in the scientific community about the effect of schools on the infection rate[4]. In Chile, it is not possible to estimate the effect of school closings with aggregate contagion data: the closure occurred early when the number of cases reported prior to the intervention was low, making it impossible to measure the effect with sufficient statistical precision.

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[3] Durante abril, la cuarentena intermitente real afectó a cerca del 50% de lo que se obtenía en la simulación.
[4] School closure and management practices during coronavirus outbreaks including COVID-19. Viner, Russel, Croker, Packet, Ward, Stansfield, Mytton, Bonell, Booy. The Lancet, April 6, 2020.

- The simulation uses the parameters of the work developed by Imperial College, based on the patterns of infection of seasonal influenza. Given the low prevalence of symptomatic cases in children, it is not clear that COVID-19 transmission rates are comparable to influenza (at school). Additionally, it is assumed that it is possible to maintain social distancing in periods when schools are open. Given the high mobility that exists in the city of Santiago to go to school, it is not clear that social distancing can be sustained with schools running.

Annex: Time in intermittent quarantine by Health Service

Service	Population (M)	% time in quarantine	
		Closed schools	Open schools
Metropolitan Central	1378	26.2%	28.5%
Metropolitan North	1584	30.8%	45.4%
Metropolitan West	3730	30.0%	26.9%
Metropolitan East	1790	21.5%	36.2%
Metropolitan South	1634	27.7%	32.3%
Metropolitan South-East	1817	33.1%	40.0%
Weighted average		**28.5%**	**33.7%**

Table 1: Time in quarantine under the scheme of intermittent quarantines, with schools closed or open, separated by regional health service.