Policy Brief

October 2020

COVID-19 Modelling Consortium

Modelling the potential impact of various interventions on the COVID-19 epidemic in the Autonomous City of Buenos Aires, Argentina

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Acknowledgements

We would like to thank the team and all of the contributors and organisations who helped with the project: Ministry of Health of Argentina, Department of Strategic Information under the Ministry of Health of Argentina, as well as specific members of the COVID-19 Modelling Consortium (CoMo Consortium)

Disclaimer

The views expressed in this publication are those of the author/s and do not necessarily reflect those of Oxford Modelling Group for Global Health (OMGH), COVID19 Modelling Consortium (CoMo Consortium).

Executive Summary

Despite the set of measures introduced in Argentina in response to COVID-19, including lockdown and closure of borders, the epidemic has spread across the country with particular emphasis in the Autonomous City of Buenos Aires (CABA) and the Province of Buenos Aires. There is an urgent need for a tailored, evidence-based strategy to inform decisions on effective response measures to COVID-19 for Argentina. This brief presents preliminary findings of a mathematical model projecting the course of the COVID-19 epidemic in CABA given various interventions.

The simulation is based on the available local epidemiological data provided by the Argentinian Ministry of Health from the 6th of March till the 16th of June, 2020 and assumptions on current interventions, with appreciation of local social contexts, as well as existing global evidence, at the time of the modelling, regarding the nature of the disease and its spread. Despite rapidly emerging evidence, there remain **many uncertainties**; thus, results may change as we learn more about the nature of disease and the impact of interventions on the disease outcomes and receive more reliable data on intervention intensity and coverage.

Key assumptions

- Due to unavailability of direct values of the intervention coverage, adherence and efficacy, the related model assumptions were based on existing proxy data from other countries evidence base data, and information from Google Map analysis of the community mobility in countries (Google Map, 2020) and informed data from the Subsecretariat for Medicines and Strategic Information, Ministry of Health in Argentina.
- The currently accepted global evidence on the nature of disease, which is yet to be updated, was used for the disease parameters (CDC China, 2020; Korean Society of Infectious Diseases et al., 2020; Liu et al., 2020; Riou et al., 2020; WHO, 2020a).
- The demographics parameter values for the population age structure were based on data from the Subsecretariat for Medicines and Strategic Information, Ministry of Health in Argentina.
- The social contact matrices projection in 152 countries (Prem et al., 2017) was used to measure the contact patterns between different age groups in Argentina.

CAUTION: The model is sensitive to the input data, changes to which may significantly affect the model outputs.

Key findings

- Our model suggests two approaches be pursued simultaneously: prevention and health system preparedness. A high level of prevention activities may reduce the burden on the health system, but the health system needs to ensure sufficient capacity to accept and treat all patients.
- While cases averted increase when implementing stricter scenarios, deaths averted seem not to have the same positive effect– once the health system's saturation is avoided, deaths averted variation in between a Baseline and Mid scenario is expected to be 65%, while in between a Mid Scenario and a Strict scenario it is expected to be only 20%.
- Both the number of beds and ICU required are sufficient if either a Mid or a Strict scenario is implemented, theoretically questioning the usefulness of keeping strict measures in place.
- Paradoxically, if stricter measures are maintained for a longer period of time, the contagious factor (R0) takes longer to get below 1: while in the Mid Scenario this would be achieved in late September, the Strict Scenario would take until early December. This counter-intuitive finding might be caused by society's low complying with regulation, thus inefficiently pushing forward in time the pandemic peek.

Key conclusions

There is an urgent need in the country for tailored, evidence-based and emergent practices to inform the high-level decision regarding effective response measures to COVID-19.

Conclusion 1: Prevention is essential, rapidly screening and increasing hospital capacity to absorb both general and Covid-related patients' demand.

Conclusion 2: Keeping very strict measures until end of the year seems not to be considerably efficient in terms of deaths averted.

Conclusion 3: The model is a tool, under a set of assumptions, to help consider all the policy options given the UNCERTAINTY about the virus and its epidemiology

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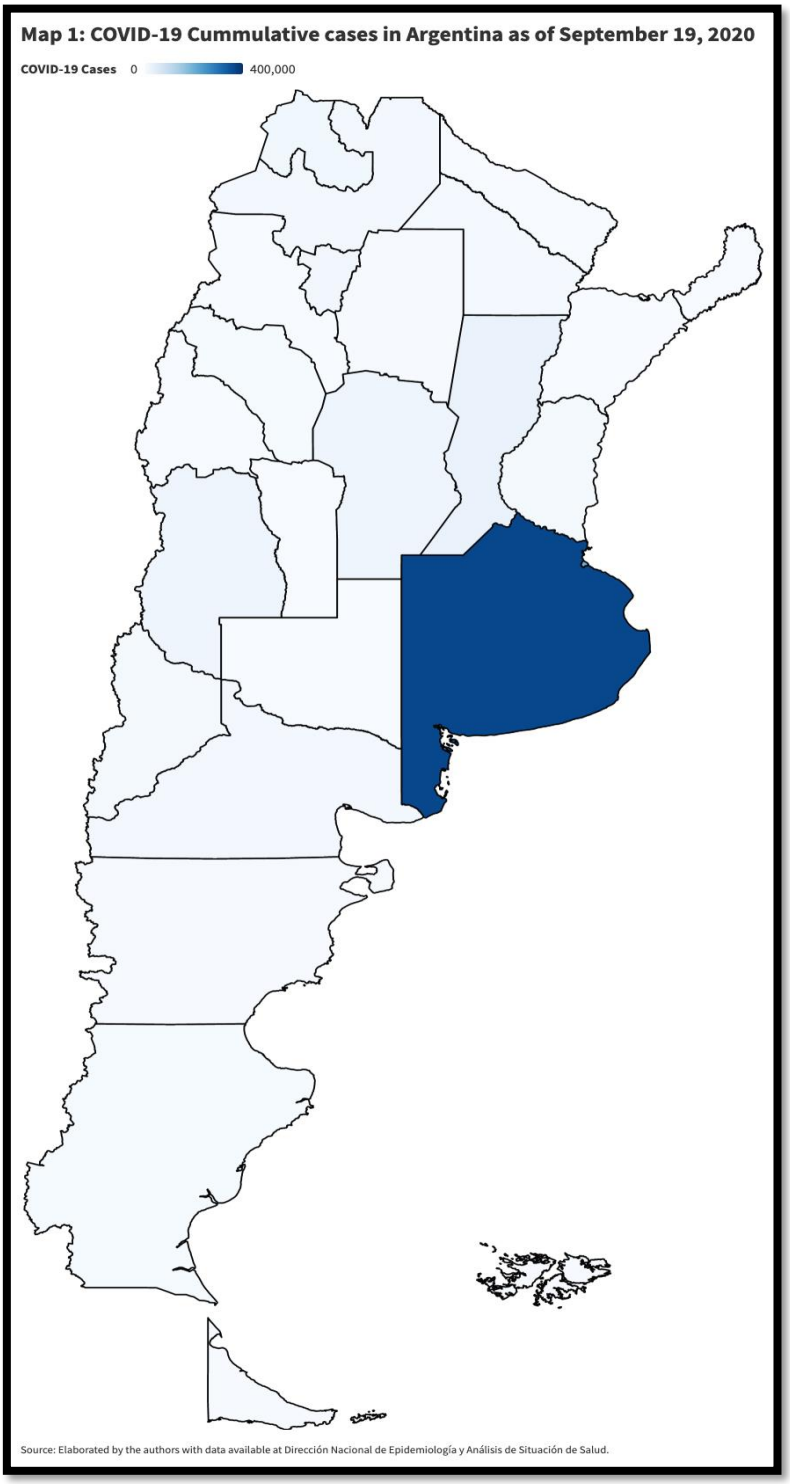
Situation

The first case was confirmed on March 3rd, involving a 43-year-old man who returned home from a two-week trip from Milan, Italy. By May, cases had reached 100 (MoH).

As of September 19th (Map 1), the majority of cases are concentrated in the Province of Buenos Aires (364,635), the Autonomous City of Buenos Aires (198,580), the Province of Santa Fe (25,518), the Province of Córdoba (18,589) and the Province of Mendoza (18,454).

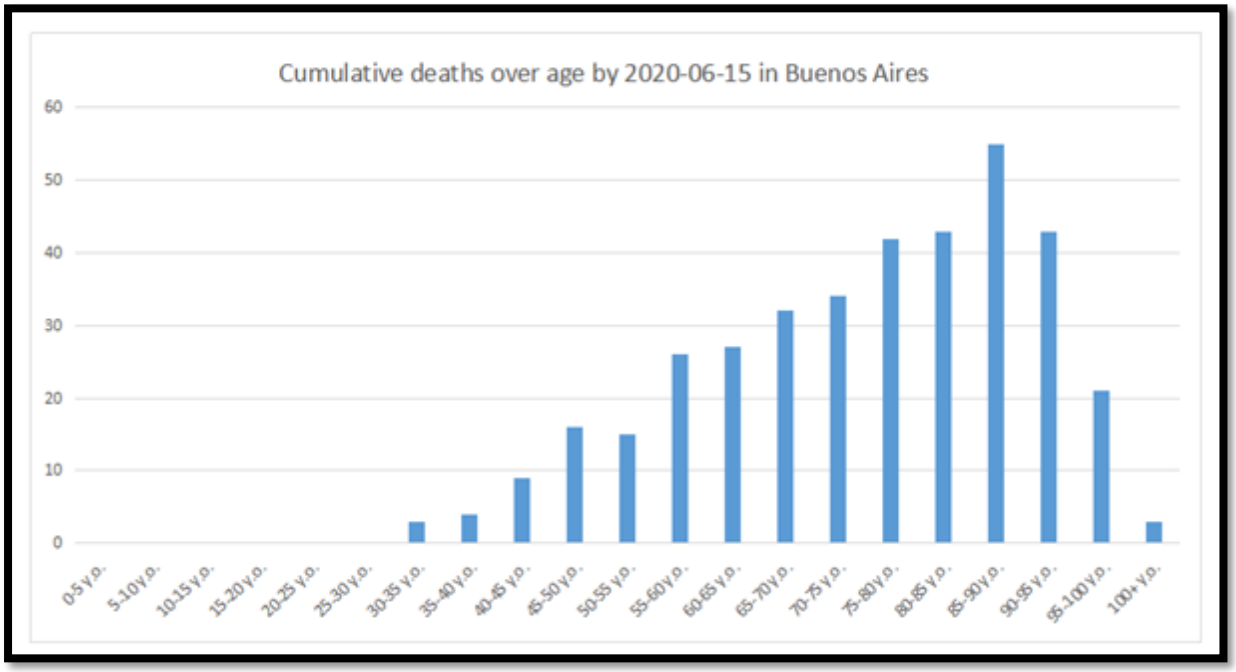


As of the 1st of October, the Ministry of Health (MSAL) has reported a total of 751,000 cases, and 16,937 deaths, mainly among elderly people over the age of 85 and those with pre-existing health conditions. The

majority of cases occur amongst those aged 20-40 years old (mean 38 years), while among those aged over 60 years old, cases only account for 30 percent. Regarding cases, 0.2% are international imported cases, 66.2% cases are community transition, 50.8% in males and 5.4% of the cases are amongst healthcare workers.

According to the World Health Organization (WHO), different countries exhibit variations in the rates of disease severity, mortality and hospital admissions. In China about 15-20% of cases required hospitalization, of whom 15% had severe symptoms and 5% required ventilation and other intensive care manipulations. In Italy and Spain about 40-55% of positive cases were admitted to hospitals, 7-12% of which needed intensive care (WHO, 2020b). This variation may be driven by factors such as population structure, efficiency of prevention and control measures and preparedness and capacity of health systems.

Graph 1: COVID-19 cumulative deaths over age, period from March till 15th of June in CABA.



The Ministry of Health of Argentina has developed a plan on preparation of hospital capacities and reorganized existing hospitals to treat COVID-19 patients. In total, over 21885 hospital beds, including 3819 in intensive care units were set up by June with a stock of respiratory ventilators of 3819 (MSAL).

Public Health Measures

A week after the first case was confirmed, the government introduced the first emergency measures.

On March 11th protocols for quarantining passengers on flights arriving from countries with COVID-19 were established, and the same day, four districts decided to cancel public events[1]. On March 15th, national authorities announced the closing of the country's borders as well as all businesses except essential ones[2], kindergartens, primary and secondary schools for a period of 15 days. On March 17th the Sanitary Emergency was declared[3], and three days later a nation-wide lockdown was implemented later extended to April 12, April 26, May 10.

[1] City of Buenos Aires and the provinces of Buenos Aires, Catamarca and Río Negro.
[2] Among non-essential ones, it was mandatory to close theatres, gyms, salons, spas, recreation centres, museums, casinos, discos, shopping malls, sporting and concert venues, restaurants, bars and liquor stores. Gas stations, supermarkets and grocery stores were allowed to remain open with some changes in operating hours and following strict sanitary measures.
[3] National Decree No. 287/2020.

As the lockdown affects people's wellbeing and socio-economic challenges grow, the 10th of May new policies were implemented in the country following a 5 stages strategy to release lockdown following the case duplication time ***(table 1).***

Table 1: a 5-stage release strategy in Argentina

	Lockdown Stage 1	Managed isolation stage Stage 2	Geographic segmentation Stage 3	Gradual reopening Stage 4	New normality Stage 5
Authorized	Only the essential services	New permits	Provincial exceptions	Provincial exceptions	Wash Measures
Movement allowed	<10%	<25%	<50%	<75%	>75%
Case duplication time	<5d	5-15 days	15-25 days	>25 days	
Geographic area	Nationwide	Nationwide	Geographical segmentation by epidemiological criteria	Territorial restrictions	

On May 24, recreational walks through parks, squares and playgrounds were authorised in cities with up to 500,000 inhabitants. Also, all provinces except the capital city and the larger metropolitan area (AMBA) moved into stage 4 of the pandemic release strategies (allowing more than 75% of the population in such areas to move) according to the following guidelines:

A) Urban areas <500,000 inhabitants may be exempted as long as meet the following conditions:

1. The time of duplication of cases cannot be less than 15 days.
2. HS must be able to meet the potential demand.
3. Positive evaluation of population density and vulnerability situation of the area.
4. % of the population involved in the activities to be enabled cannot exceed 50%.
5. The area cannot have community transmission.

B) Urban agglomerates >500,000 people are still isolated

Capital city and larger metropolitan area (AMBA region) to continue under phase 3 of lockdown. Measures allowed 50% of the population to move within the geographic area and with social isolation in the houses continuing. Only recreational outings for the entire population include up to 1 hour within a radius of up to 500 m from home and children had to be accompanied by an adult. The lockdown release strategies were later cancelled in some provinces due to the increase in COVID-19 cases and lockdown measures were extended to the 7th of June, 28th and the 17th of July. Despite having in place, the world's largest lockdown, and a very strict policy scheme according to the *Oxford COVID-19 Government Response Stringency Index*[4], COVID-19 cases continue to rise in Argentina. There is an urgent need for clear evidence to inform the country's next steps to tackle the pandemic while acknowledging the wider health, social and economic consequences. More evidence is needed to determine the effectiveness of various interventions in the context of Argentina. It is possible that the increased detection of cases may be due to improved diagnostic capacity and availability of the testing resources.

[4] The *Oxford Covid-19 Government Response Stringency Index* is a composite measure based on response indicators including school closures, workplace closures and travel bans in a scale ranging from 0 to 100 (100 = strictest). As of September 20, Argentina scores 91.67.

Modelling the epidemic: alternative interventions/ scenarios

In response to the current situation, an Argentinian team of researchers and experts, in cooperation with the COVID-19 International Modelling Consortium (CoMo Consortium) under the leadership of Lisa J. White (Professor of Epidemiology and Mathematical Modelling, University of Oxford, UK) projected a possible course of the pandemic in the country through modelling several scenarios with varying interventions. The team has applied the mathematical modelling framework developed by the Oxford Modelling Group for Global Health (OMGH) in collaboration with CoMo Consortium. The model estimates the impact of potential intervention strategies on the course of the COVID-19 epidemics in individual countries and informs policy decisions. We included 3 scenarios with varied interventions and timelines, addressing the following questions:

- *What could be the scale of the epidemic if lockdown is lifted on the 18th July 2020 and not followed by any interventions?*
- *What could be the impact of 'medium disruption interventions' with varying intervention intensity after the end of lockdown on the 18th July 2020?*
- *What could be the impact of 'high disruptive interventions' with medium/high level of intervention intensity after the end of lockdown on 18th July 2020?*

Table 2. *Level of disruption of intervention scenarios on social life and the economy*

Level of disruption	Scenarios	Interventions
Current measures	Baseline	Lifting lockdown on the 18th July 2020 without any intervention thereafter (except Self-isolation if symptomatic, and test positive; voluntary quarantine if contacted with positive cases)
Medium	Scenario 2	Gradually lifting lockdown on the 18th July 2020 (gradual decrease in the coverage of social distancing and working from home. Self-isolation if symptomatic, and test positive; voluntary quarantine if contacted with positive cases)
High	Scenario 3	Extended lockdown till the 1st of September with a stricter lifting of the lockdown (increase in coverage of social distancing and working from home)

- **Baseline:** Lifting lockdown on the 18th July 2020 without any intervention thereafter. *Please refer to table 3 for more details.*

Table 3. *Current lockdown measures/parameters included in the model (period 6th March till 18th July)*

Intervention	Intense	Start date
Self-isolation if symptomatic (not including those hospitalised) *Coverage* *Adherence*	 50% 50%	 06/03/2020
Social Distancing *Coverage* *Adherence*	 20% 40% 85% 80% 75% 100%	 12/03/2020 17/03/2020 21/03/2020 06/05/2020 07/06/2020
Household isolation *Coverage* *Days in isolation* *Days to implement maximum quarantine coverage* *Decrease of external contacts* *Increase of home contacts*	 40% 14 days 2 days 10% 100%	 06/03/2020
Travel ban Coverage	 85%	 25/03/2020

Efficacy	50%	
School closure *Coverage* *Efficacy* *Home contact inflation*	 100% 85% 10%	 15/03/2020
Working from home *Coverage* *Efficacy* *Home contact inflation*	 20% 60% 80% 70% 60% 50% 70% 85% 10%	 13/03/2020 18/03/2020 21/03/2020 12/04/2020 02/05/2020 23/05/2020
Cocooning the elderly *Coverage* *Adherence* *Age limit*	 70% 40% 60 years old	 15/03/2020

***Note**: Due to unavailability of direct values of intervention coverage, adherence and efficacy, the model assumptions on intervention parameters were based on other existing proxy data and information, such as the findings of Google Map analysis, and reports of the Sub secretariat for Medicines and Strategic Information, Ministry of Health in Argentina*

Scenario 2 and 3 described below were compared to the baseline (lockdown lifted as planned in July 18th)

- **Scenario 2 (Medium social disruption):** Lifting lockdown on the 18th July 2020 with a decrease in the coverage of social distancing and working from home and NO changes in adherence and efficacy of measures). *Please refer to table 4 for more details.*
  - ➔ Self-isolation of symptomatic cases & screening until the end of the year without change
  - ➔ Social distancing with gradual decrease of coverage to 60% until the 1st of September and then 50% till end of the year
  - ➔ School closure until the 1st of September without change and then open 50% till end of the year
  - ➔ Working from home with gradual decrease of coverage to 40% until the 1st of September and then 25% till end of the year
  - ➔ Travel ban until the end of the year without change
  - ➔ Cocooning elderly until 1st of September without change and then coverage reduced from 70% to 40% till end of the year

- **Scenario 3 (High social disruption):** Extending the lockdown till the 1st of September with an increase in coverage of social distancing and working from home, and there after reducing gradually coverage. *Please refer to table 4 for more details.*
  - ➔ Self-isolation of symptomatic cases & screening extended until the end of the year without change
  - ➔ Social distancing increase of coverage to 85% until the 1st of September and then 70% till end of the year
  - ➔ School closure extended till 31/12/2020
  - ➔ Working from home increase of coverage to 80% until the 1st of September and then 50% till end of the year
  - ➔ Travel ban extended till 31/12/2020
  - ➔ Cocooning elderly extended till 31/12/2020

***Table 4.** Parameters for future intervention scenarios included in the model*

Interventions	Baseline (lockdown until 18th of July)	Scenario 2	Scenario 3
Self-isolation if symptomatic *Adherence*	50% until 17/07/2020	50% extended till 31/12/2020	50% extended till 31/12/2020

Social Distancing *Coverage*	12/03/2020 20% 17/03/2020 40% 21/03/2020 85% 06/05/2020 80% 07/06/2020 75% 18/07/2020	Decreased 19/07/2020 60% 02/09/2020 50% 31/12/2020	Increased 18/07/2020 85% 02/09/2020 70% 31/12/2020
Household isolation *Coverage*	40% Until 17/07/2020	40% extended till 31/12/2020	40% extended till 31/12/2020
Travel ban Coverage	85% Until 17/07/2020	85% extended till 31/12/2020	85% extended till 31/12/2020
School closure *Coverage*	100% Until 17/07/2020	100% extended till 01/09 and then coverage decreased to 50% until 31/12/2020	100% extended till 31/12/2020
Working from home *Coverage*	12/03/2020 20% 18/03/2020 60% 21/03/2020 80% 12/04/2020 70% 02/05/2020 60% 23/05/2020 50% 18/07/2020	Decreased 19/07/2020 40% 02/09/2020 25% 31/12/2020	Increased 19/07/2020 80% 02/09/2020 50% 31/12/2020
Cocooning the elderly *Coverage*	70% Until 17/07/2020	extended till 01/09 and then coverage decreased to 40% until 31/12/2020	70% extended till 31/12/2020

Projected model outcomes

CAUTION: These projections are only for COVID-19 and do not account for the interplay of other factors, diseases and unintended impact on vulnerable populations.

The model predicts comparatively higher rates of the new cases and deaths averted compared to a baseline scenario.

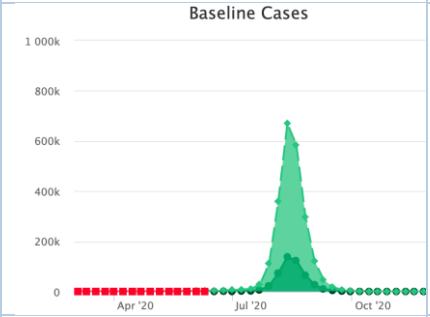
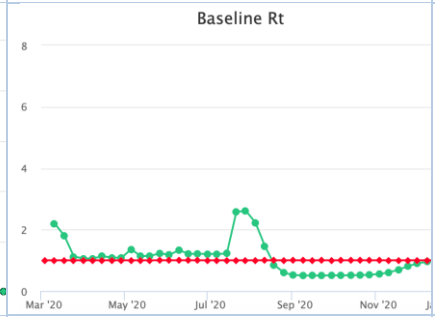
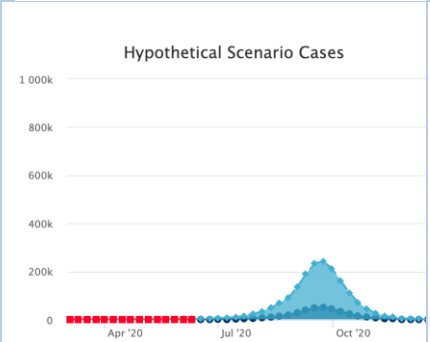
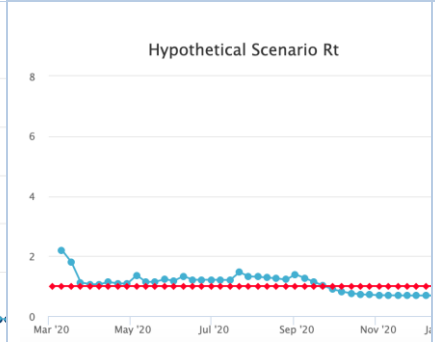
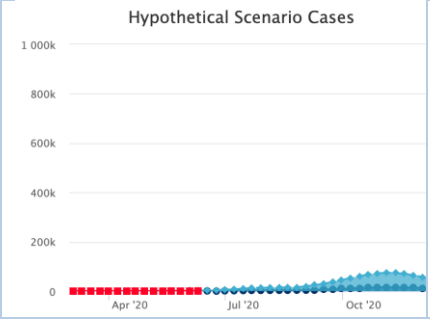
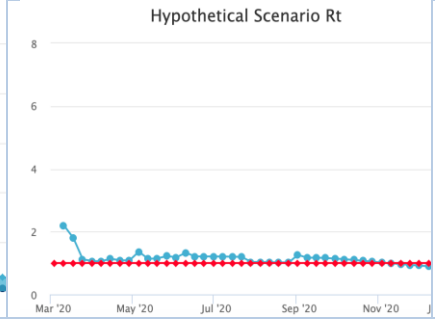
Three scenarios were included, together with the aforementioned baseline:

1. Baseline (worst case scenario) – release all restrictions on July 18th (i.e. no measures in place)
2. Intermediate scenario – maintain some restrictions until September and then ease them up
3. Strict scenario – maintain stringent lockdown until September, and ease restrictions slowly

The 'highly social disruptive scenario' (3) with lockdown extended has been predicted to have the highest percentage of averted new cases and deaths. However, this may result in adverse consequences for the social and economic life of the country and have unintended implications on the mental health of the people as well as long term economic consequences, exacerbation of inequities and deepening poverty.

Decisions on the strategy should be made with caution given the uncertainty around the COVID-19 (Graphs 1,2).

Graph 2. *Projected impact of intervention scenarios on COVID-19 cases*

	Incidence	Reproductive number (Rt)1	New cases averted
(Baseline)			Reference
Scenario 2 (Intermediate)			20.2 %
Scenario 3 (Strict-Lockdown)			50.3%

[1]***Note****: the reproductive number is an epidemiological value indicating the level of contagiousness of the infection, i.e. it is the expected number of cases generated by one infected person during the period of his disease. If Rt = 1, the epidemic is stabilised; Rt > 1 epidemic is increasing; If Rt < 1, the epidemic is decreasing.*

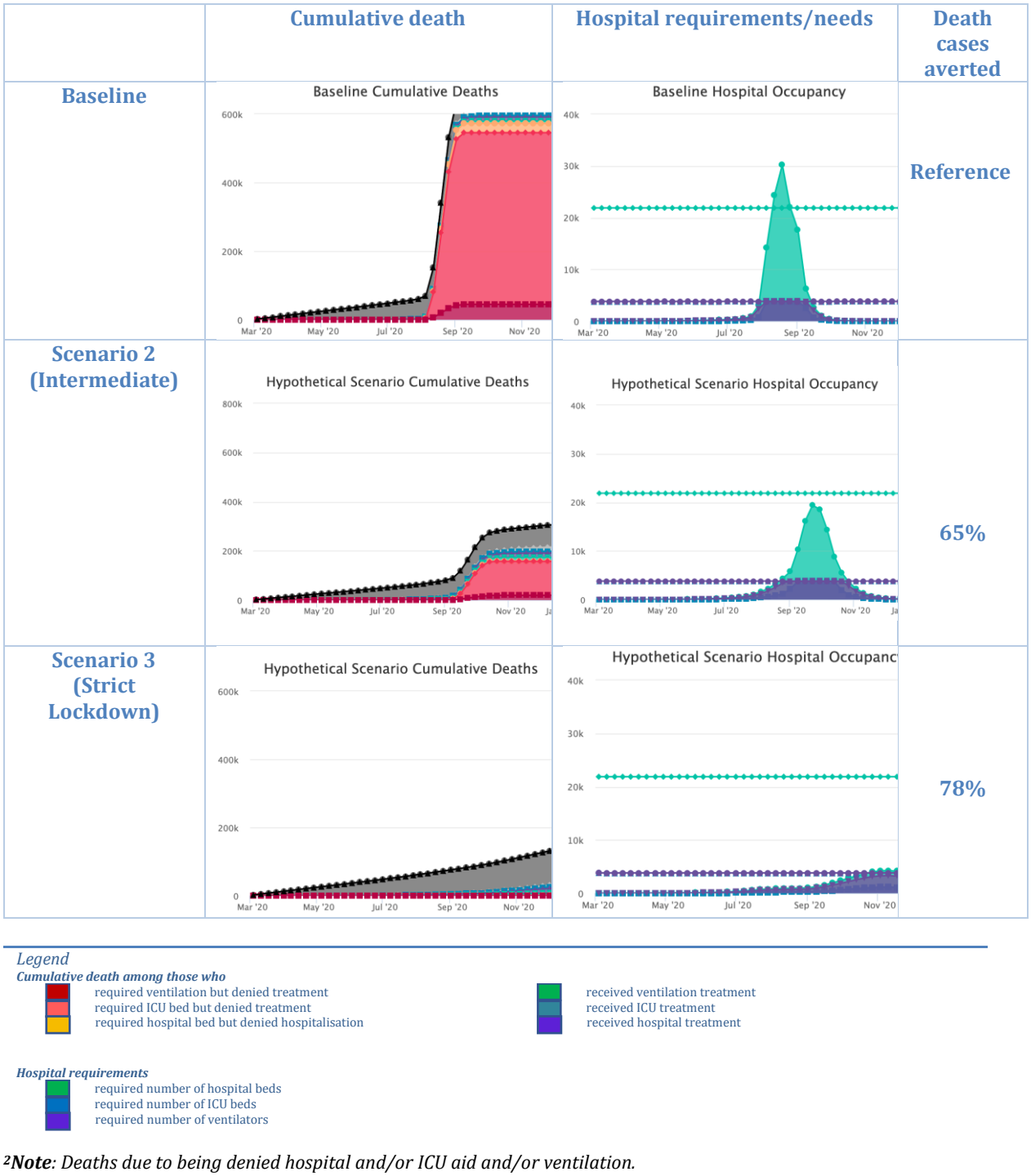
In **Baseline Scenario**, the simulation predicts that the wave of the epidemic would boost after removing all restrictions and lockdown, with 91.5% of the population may get infected in the ensuing months. It should be noted however, that the majority may experience only mild or no symptoms. Moreover, the reproductive number (R_t), currently balanced at the level of 1.4, would have increased to about 2.61 right after relaxing the lockdown and gradually decrease along with the saturation of the population with the virus transmission (i.e. achieving the herd immunity). Note that Scenario 1 is referred as a 'baseline scenario' against which the other scenarios will be compared.

In **Scenario 2**, the model predicts that compared to the baseline scenario, the overall cases would decrease and about 20.2% more of new cases are likely to be averted. In total, about 71.3% of the population may get infected during the course of the epidemic (majority with mild or no symptoms). Though the increase in the (R_t) value after relaxing the lockdown may still be observed, its trend may be slightly lower compared to the baseline scenario due to extended current interventions focused on those who have symptoms or are diagnosed positive and those who had contacts with positive cases.

In **Scenario 3,** the model predicts that compared to the baseline scenario only 41.2% of the population would get infected and the peek would be expected on November 17th. The main differences with the baseline, peek

on mid-August and 91.5% of the population getting infected, may be attributed to the maintenance of the strict measures in CABA, with high levels of adoption in the population.

Graph 3. *Projected Impact of Intervention Scenarios on cumulative deaths[2] and Projected requirements/need in hospital and ICU beds, ventilation*



[2]***Note****: Deaths due to being denied hospital and/or ICU aid and/or ventilation.*

In **Baseline Scenario**,, the simulation predicts that the health system would have been overwhelmed if all restrictions would have been eased, with approximately 595,000 deaths attributable to COVID-19 before end of the year. Most of those deaths would have been attributed to people untreated in ICU without access to a proper ventilator (500,000).

In **Scenario 2**, the model predicts that the health system would not be overwhelmed with the flow of patients during the peak time of the epidemic. However, during the second half of September, although hospitals bed offer (21,885) would be enough to serve the demand (19,414), the number of people who would need ICU or lung ventilation will be slightly above the capacity (3,819 ICU beds available, and 3,832 needed). The successful avoidance of CABA's health system overwhelming may be due to the decrease of patients as a result of continued interventions focused on limiting the spread of the infection from positive cases.

In **Scenario 3,** the model predicts that the health system will be less burdened compared to the other Scenarios. This can be seen from the chart "cumulative deaths", where the number of people in need for ventilators who have been denied relevant treatment is still high. Lower burden on the health system may be due to the decrease of patients as a result of continued lockdown and intensified interventions focused on limiting the spread of the infection from positive cases. As regards deaths, this strict scenario predicts that by the end of the year, 31,072 deaths will be attributable to COVID-19.

Limitations and Assumptions

- We need to consider limitations of this modelling analysis based on uncertainties about the virus and its epidemiology, as well as assumptions regarding current intervention coverage and efficacy affected by social, cultural and economic factors. The model outputs will change as we learn more about the disease and the impact of interventions on the nature of disease and receive more reliable data on intervention intensity and coverage.
- The current model did not include vaccination or use of dexamethasone, as a pharmaceutical intervention, nor the use of mass screening for the prevention of the COVID-19 infection, though the modelling tool has foreseen this option with the assumption of its availability in a later period.
- We have not included seasonality due to a lack of evidence on whether this epidemic will have a seasonal pattern, and if so, whether it will have the same pattern as flu.
- The current model did not include WASH practices, as an intervention for the prevention of the COVID-19 infection, as per requested by the Ministry of Health of Argentina.
- Another important limitation of this projection is that it did not include an analysis of the effect of high rates of the COVID-19 infection among healthcare workers on the health system's capacity to respond to the epidemic.
- The model is based on the epidemiological data as of the 16th of June, 2020 provided by the Ministry of Health of Argentina (MSAL). There is needing to continually update the simulation with new data/evidence.

Conclusions

Conclusion 1: Prevention is essential, rapidly screening and increasing hospital capacity to absorb both general and Covid-related patients' demand

A *phased transition approach* may be the most appropriate after lockdown, so as to combine the relaxation of general quarantine restrictions with key epidemiological prevention interventions — such as isolation for those who had contact with positive cases, self-isolation if symptomatic and screening (testing), as well as social distancing for reduction of the infection transmission.

Unquestionably, public health must drive the decision-making process while designing epidemiological prevention interventions. Leveraging on social and behavioural perspectives as tools for responsive engagement with populations, however, may be very useful. Massive-reach information campaigns already in place, for example, may be effective in early stages of a pandemic but they lead to severe misinformation in the context of a phased transition scheme. In this sense, it is suggested to adopt an audience segmentation approach in order to deliver tailored messages that take into consideration the federal design of the country and the epidemiological situation in Buenos Aires and the rest of the provinces.

Conclusion 2: Diminishing returns in keeping strict measures until end of the year, in terms of cases and deaths averted

The model predicts that there will be a point at which the level of benefits gained by implementing a strict lockdown will be less than the amount of energy, social efforts and budget invested. This finding needs to be particularly stressed out in the context of Argentina, that has in place one of the world's longest and strictest nationwide lockdowns.

The effectiveness of a strict lockdown, the commitment to social distancing and even self-isolation decrease over time. To maximize the benefits, social distancing and mass quarantine should be introduced aggressively and rapidly to allow sufficient time for health services to be ready. In this sense, two approaches should be pursued simultaneously: prevention and health system preparedness.

A high level of prevention activities may reduce the burden on the health system but the health system needs to ensure sufficient capacity to accept and treat all patients. Sufficient capacities of health system in responding to increased demand in COVID-19 testing, contact tracing, quarantine and treatment are crucial in saving lives and reducing risks. Substantial focus on infection prevention control (IPC) is critical to address increasing rates of infected healthcare workers.

Conclusion 3: Uncertainty and Updates

All results of the modelling shall be used with caution due to the limited evidence on the spread of COVID-19 and its epidemiology. The model and projections should constantly be updated, as more evidence becomes available. It is also important to be aware of the unintended consequences of the options chosen, as the model projections are only for COVID-19 and do not account for interplay of other factors, diseases and impact on general and vulnerable populations.

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