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COVID-19: Traffic Restrictions Incidence on the Service Life of Pavements in La Plata City of Argentina

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ABSTRACT

The mandatory preventive social isolation imposed in Argentina due to the COVID-19 pandemic had many effects on the daily life of all the inhabitants. Behind the negative aspects caused by COVID-19, there are also beneficial effects for the population. One of them is the decrease in the movements of people to attend to their basic needs, which had been reflected in a lower volume of urban traffic in the cities. Such a decrease in demand would lead to an increase in the expected service life of pavements because they are structures calculated to support a certain number of load axes. Therefore, road maintenance policies to be carried out by the corresponding road departments could be deferred over time, without that representing a decrease in the expected bearing quality. The problem then lies in establishing which the maximum period feasible to defer these tasks is. One way to establish that value would be to link the decrease in vehicular traffic with the decrease in people's movement in terms of certain activities. This can be done with the data collected by Google of those activities, which are enabled to be used for the above analysis. The present paper is based on this analysis carried out for the city of La Plata, the capital of the Buenos Aires province in Argentina, where the LEMaC is located. This analysis structure can be reproduced in other urban areas or rural road networks with slight modifications and including the corresponding local data.

Keywords: Pavements; Service Life; Road Engineering; COVID-19.

1. INTRODUCTION

The pandemic caused by the SARS-COV2 virus which is identified as COVID-19 has a globally strong impact in a variety of issues such as whether economic, political, or financial and Argentina it is no exception. One of the most marked effects at the local level is the decrease of the movement of people, whose information has been collected by Google. From this data, it is possible to quantify various aspects that allow understanding the scope of the effect.

Previous reports indicated that reducing movement across the globe brought with it several positive changes, such as reducing environmental pollution on a global scale [1, 2]. In China and Italy, strong reductions in greenhouse gas emissions were achieved, such as a decline in carbon dioxide levels. Also, in Italy there was an impact on the level of pollution in the canals that run through the city of Venice in which, at least for a while, the transparency of the water could be appreciated [3]. NASA had reported an improvement in air quality that people breathe with a 30% reduction in nitrogen dioxide levels [4].

These consequences might be an effect of the COVID-19 pandemic and its control. In “normal times” congestion occurs with a negative impact on every sector of the lifestyle [5]; but in pandemic people that do not have essential work must stay at home and they are only allowed to circulate to attend to their basic needs. In this context, the daily transit of the population in capital cities of Argentine was strongly affected, with a considerable reduction in traffic volumes especially in the first months of quarantine with a zero-vehicle circulation [6].

The decrease of road accidents in this time also had a significant impact. According with ISEV (*Instituto de Seguridad Vial*), in the AMBA (*Área Metropolitana de Buenos Aires*) road accident severity was reduced by 35% in comparison to the data collected in previous years. On the other hand, there were also a decrease in an order of 40% in the mortality associated with vehicle accidents, taking the same period as a reference. These are some highlights the great impact that the reduction of traffic had in its multiple areas [7].

The interest for the purposes of a road structure indicates that the decrease in movement of people leads directly to a reduction in traffic, which must have a direct impact on the service life of the pavements [8]. This effect is important because, due to the negative economic effects generated by the pandemic, any defer in the maintenance of urban arteries allows that the resources can be used for other higher priority purposes.

The great unknown then is how to establish which would be the logical delay period of these road interventions, without that resulting in a decrease in the quality of the pavements below than what it was originally planned.

The study of this aspect was carried out in the city of La Plata, with possible application in other similar urban areas.

1.1 The area under study

La Plata is the capital city of the Buenos Aires province in Argentina and it is located around 56 kilometers from the Autonomous City of Buenos Aires. It is also called "the city of the diagonal avenues", due to the many arteries of this type that it has. The city was founded by Governor Dardo Rocha in 1882. Nowadays, its exponential growth makes it have more than 750´000 inhabitants according to the INDEC (*Instituto Nacional de Estadísticas y Censos*) [9] established in urban area and surroundings, known as the "Gran La Plata".

Most of the city's work and recreational activities are carried out around its founding axis; between 1st Avenue to 19th Avenue and its perpendiculars 44th Street to 54th Street [10].

With the objective of stopping the spread of the lethal SARS-Cov-2 virus the Obligatory Social and Preventing Isolation (*Aislamiento Social y Preventivo Obligatorio,* ASPO) was established throughout the Argentine territory on March 19th through the Decree N297/2020. La Plata city had to close its main entrances to the city. That made that the circulation of the population within the town during quarantine was lower than usual activity, being only essential personal allowed to circulate. This percent of population had to have the corresponding permits given by the Government. This made possible the initial containment of the virus, the main objective of the proposed measure.

1.2 The service life of the pavements

In the structural design of pavements, the greatest impact against the service life of the pavements are the loads due to the passage of vehicle traffic. The greatest damage is caused by heavy traffic, leaving a minimal incidence to the light traffic. While there are other factors which also threaten the service life of the pavement, such as climate conditions, special attention should be paid to this item because undervalued traffic can induce premature deterioration of the pavement compared to what was planned [11].

Within the framework of policies of maintenance pavements that each city must possess, it is vitally important to schedule periodic paving and overlay tasks, dependent on the degree of importance of the road under study. Tackling due corrections in time leads to strong savings, not only of economic resources but also of the other resources involved in the construction of the corresponding roads [12].

As shown in Figure 1, once the pavement reaches a certain level of deterioration the cost to be faced to achieve an initial level of service to the transit is approximately 10 times higher, compared to when the problem is addressed at an appropriate time.

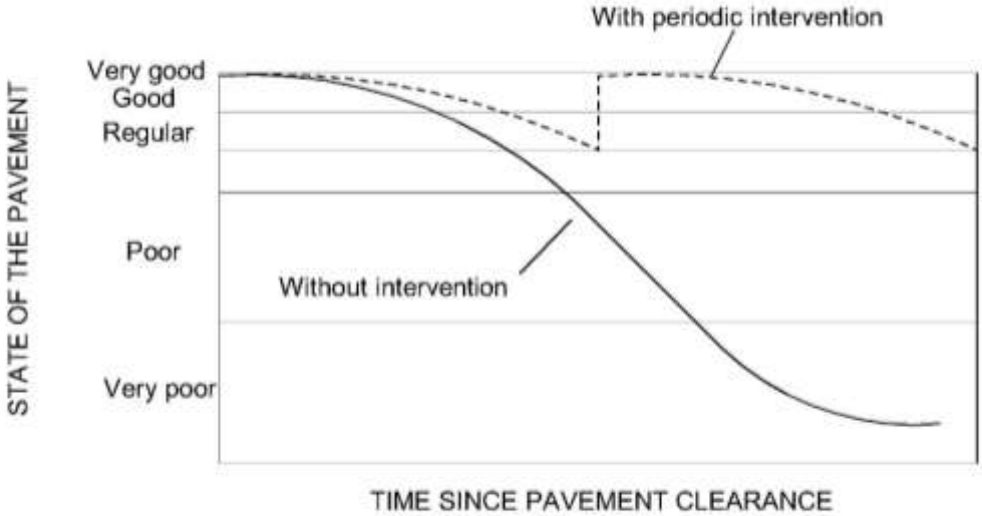

Figure 1. Relationship between pavement state and time since pavement clearance

2. MATERIALS

Since April 3rd, the company Google makes public the statistical data of the reduction of the movement in the population on a global scale. Anyone who has an Android operating system device, and has geolocation enabled, helps to collect this data, that Google makes it anonymous. In this way, one more tool is provided for any government or country that will need to cope with the COVID-19 pandemic [13]. Currently, several works have already been presented where it is possible to observe the use of the data provided by Google [14, 15] as well as by the Apple Company, which conducted a similar study. This paper uses data from Google because it has a better geographical accuracy than the one offered by Apple [16, 17].

As a measure for the protection of privacy, the data are only displayed in the form of percentages (positive or negative) with respect to a "reference value" (initial value for the purposes of this work). This value is not specified but it is stated that corresponds to the average between January 3rd and February 6th. In these dates Argentina was outside of any kind of restriction. It should be noted that this specific period has a strong seasonal impact, but that is contempt by the analysis carried out later, since the effects are analyzed in a relative and non-nominal way, as can be ratified further in this paper.

The data provided by Google is divided into:

- Shops and leisure
- Supermarkets and pharmacies
- Parks
- Transport stations

- Workplaces
- Residential areas

From this data, the scatter plot in Figure 2 is generated.

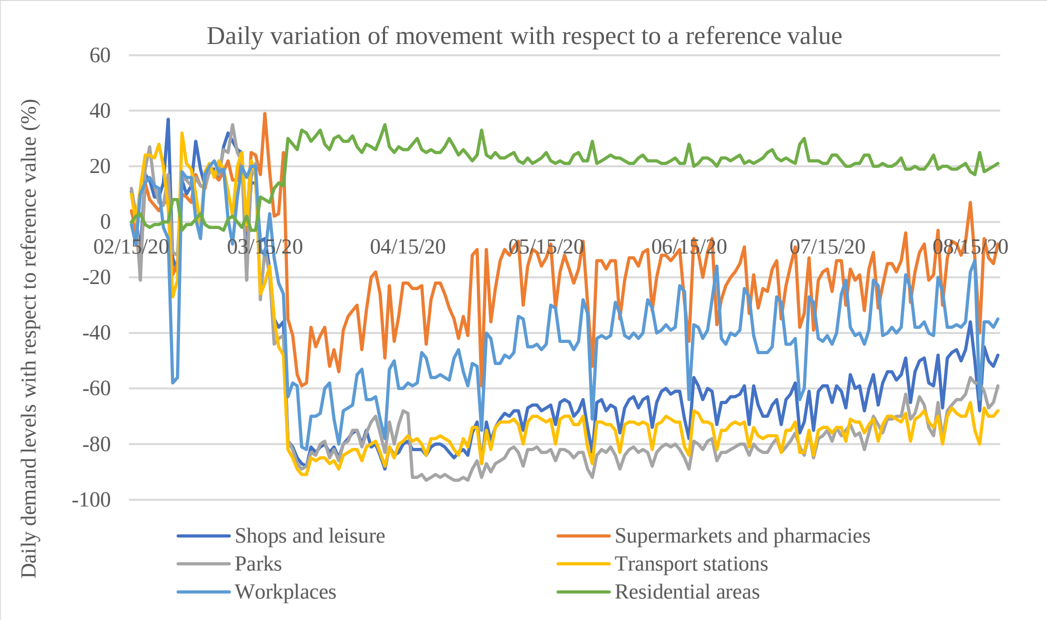

Figure 2. Activity-discriminated Google data 02/15/2020 – 08/21/2020 (compared to 100% reference value)

3. METHODS

In a first instance, it is decided to work only with the data in Figure 2 belonging to "Workplaces", since these data are estimated to have a greater correlation with the reduction of vehicle movements themselves [18]. In the rest of the data, such as in "Residential areas", would be related to movements of people connected to a low use (or non-use) of the motor vehicles (the movement increases observed in these terms, precisely due to "cell movements" in areas close to the housing, for sourcing and other reasons).

Since this data is collected from daily records, to take the average daily demand at the weekly level was considered, as a way to reduce the degree of dispersion of the data, collected in Table 1 and shown in Figure 3.

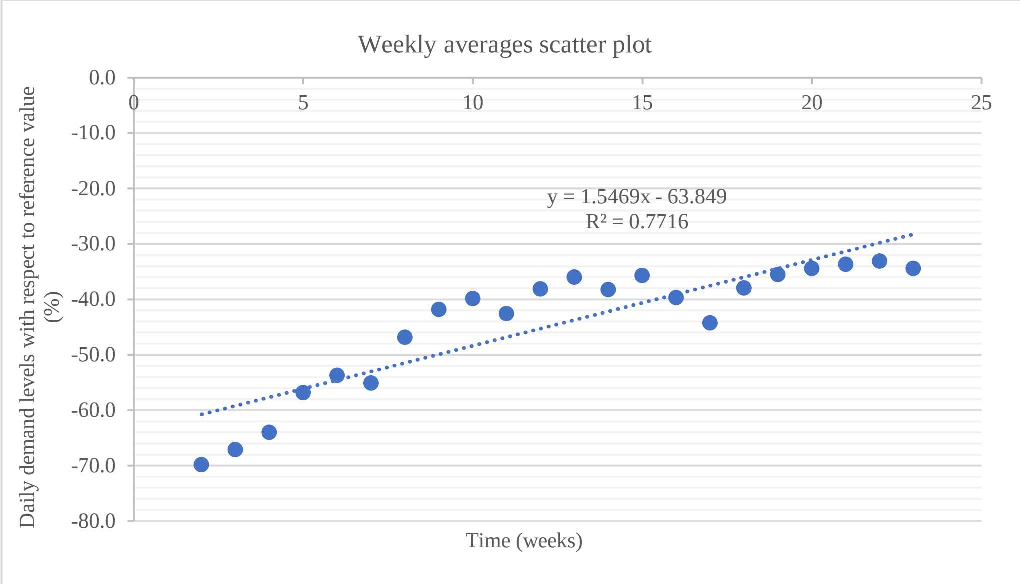

Figure 3. Trend analysis in daily demand at the weekly level

Table 1. Weekly averages of transit variation

Week	Average demand (%)
3/21 to 3/27	-69,9
3/28 to 4/3	-67,1
4/4 to 4/10	-64,0
4/11 to 4/17	-56,9
4/18 to 4/24	-53,7
4/25 to 5/1	-55,1
5/2 to 5/8	-46,9
5/9 to 5/15	-41,9
5/16 to 5/22	-39,9
5/23 to 5/29	-42,6
5/30 to 6/5	-38,1
6/6 to 6/12	-36,0
6/13 to 6/19	-38,3
6/20 to 6/26	-35,7
6/27 to 7/3	-39,7
7/4 to 7/10	-44,3
7/11 to 7/17	-38,0
7/18 to 7/24	-35,6
7/25 to 7/31	-34,4
8/1 to 8/7	-33,7
8/8 to 8/14	-33,1
8/15 to 8/21	-34,4

On the other hand, there are records that the last week corresponding to a usual movement is between Saturday 7th and Friday 13th March. The graph in Figure 3 shows the weekly averages between Saturday 21st March (the first date showing a sharp drop in daily movement and marks the start of strict restrictions) and Friday 21st August. The new "reference value" for the work (i.e. new record of 100% of demand) is therefore taken out of that graph and is calculated as an average of the levels between the weeks of February 29th and March 13th. It can be commented, only at a complementary level, that this new reference value is approximately 12% higher than the baseline estimated by Google.

As the records considered are directly affected by movement restrictions, it is not appropriate under these circumstances to apply seasonality corrections, which would have their logic app in periods of "normality". However, to clear up any doubts in this regard, the seasonality applicable to these roads are available and established by previous studies [19], which are presented in Table 2.

This analysis is directed to roads of the type "urban", "commercial" (non-tourist) and they do not have any type of toll collection; so, they have a reduced degree of seasonality, which would allow approximately (especially in studies such as this one) to dismiss the corresponding applicable corrections, as can be seen in Table 2.

Table 2. Applicable seasonality in central area of Argentina. Source: Rivera (2007)

URB	Use	Toll	Monthly coefficient											
			Jan	Feb	Mar	Apr	May	Jun	Jul	Ago	Sep	Oct	Nov	Dec
Rural	*Tourist*	*Without*	*no applicable*											
Rural	*Tourist*	*With*	0.650	0.798	0.922	1.021	1.092	1.134	1.146	1.125	1.071	0.982	0.855	0.690
Rural	*Comerc*	*Without*	0.991	0.987	0.990	0.997	1.006	1.018	1.029	1.038	1.044	1.045	1.039	1.025
Rural	*Comerc*	*With*	0.995	0.993	0.997	1.003	1.011	1.019	1.025	1.028	1.026	1.017	1.000	0.974
Urban	*Tourist*	*Without*	0.699	0.836	0.949	1.037	1.098	1.130	1.131	1.101	1.037	0.937	0.801	0.627
Urban	*Tourist*	*With*	0.578	0.769	0.935	1.074	1.184	1.264	1.313	1.327	1.307	1.250	1.154	1.019
Urban	*Comerc*	*Without*	1.044	1.032	1.024	1.020	1.018	1.016	1.012	1.005	0.994	0.976	0.950	0.914
Urban	*Comerc*	*With*	0.997	0.998	1.002	1.009	1.015	1.021	1.023	1.020	1.012	0.995	0.969	0.933

Therefore, it is justified to work with the "raw" data that is counted and, from the data presented in Figure 3, to find the trend curve corresponding to a simple linear regression. With this calibrated function, which has a value of 0.77 of determination coefficient R^2 (which meets the empirical limit of at least 0.70 for an analysis such as the present) [20], the data can be extrapolated in the future; and in this way it is possible find when, at least statistically, the level of demand considered as the basis for the analysis would be reached again.

In this way there are two curves, one blue for a normal period without pandemic, with a constant level of demand (according to the caveats already explained); and the other in orange with pandemic data from weekly averages through August 21 and with data extrapolated by regression after this date. These curves can be seen in Figure 4.

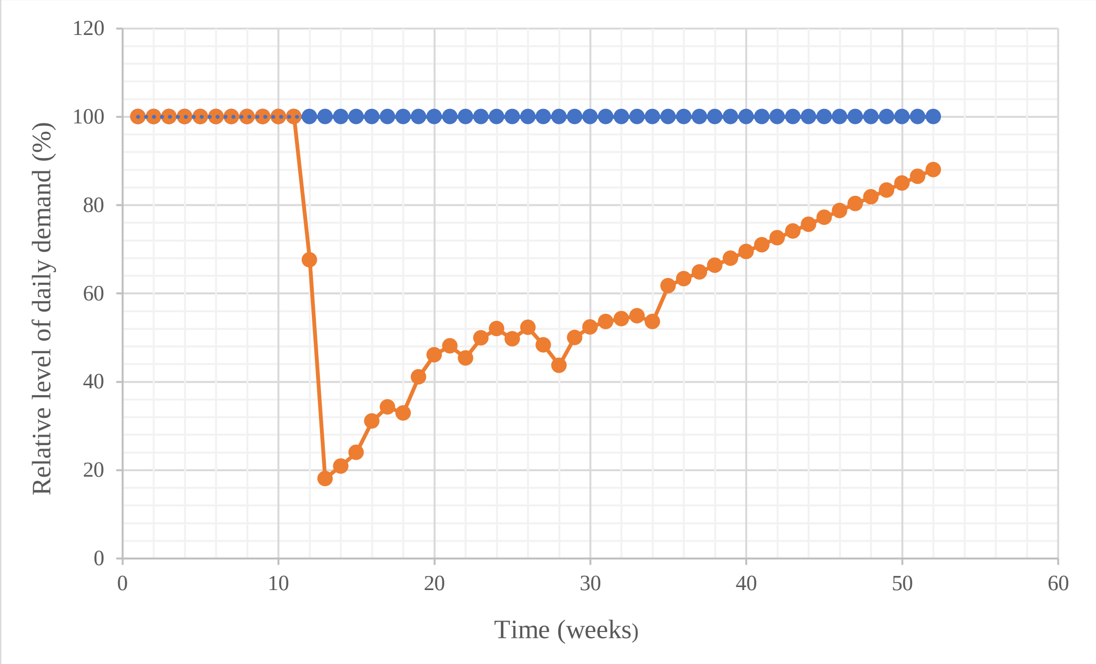

Figure 4. Demand curves "without pandemic" vs. "with pandemic"

Figure 4 shows the two curves proposed (with pandemic and without pandemic). From the regression found, it can be seen how the normal state of displacement of society around the work areas would not be reached this year, but would be only in the first months of 2021; which would coincide, at least for the time being, with other points of view, such as the availability of developing vaccines.

4. RESULTS AND DISCUSSIONS

Based on the data obtained, several scenarios of road interventions can be raised, according to the usual adoptable analysis periods.

With regards to intervention policies in the urban road network of the La Plata city, and in the vast majority of urban areas of the AMBA, it would be appropriate to think of a period between maintenance interventions (it has been decided for the estimation purposes of the analysis not to distinguish between conservation and rehabilitation policies) of 1 or 2 years. Similarly, in areas of very low demand (or without demand) for heavy vehicles, it is common to find in the city (and others in which the LEMaC has sometimes intervened) structural pavement packages consistent with service life of 5 years. Finally, on all other roads (except roads with exceptional characteristics) paving policies are consistent with structural packages of identifiable service life of 10 years [21]. The above would involve interventions including the period of movement restrictions related to the COVID-19 pandemic that could be discriminated against as of "maintenance" with a service life of 1 year and 2 years, "minor road paving" with a service life of 5 years, and "paving of other roads" with a service life of 10 years.

Given these alternatives, and based on the calculations derived from the differences in areas below the curve according to Eq. (1) (based on the data collected extended to the established service life), it can be calculated using Eq. (2) that with pandemic there would be, respect to 100% of demand that would have been without pandemic, the rounded demand levels of:

- Maintenance (1 year): 69 %

- Maintenance (2 years): 84 %
- Minos road paving (5 years): 93 %
- Paving of other roads (10 years): 97 %

$$Total\ demand = \sum_{i=1}^{n} \frac{(Relative\ demand_i + Relative\ demand_{i+1})}{2} \quad (1)$$

$$Percentage\ of\ demand = \frac{Demand\ with\ pandemic}{Demand\ without\ pandemic} * 100 \quad (2)$$

The values are presented in Figure 5.

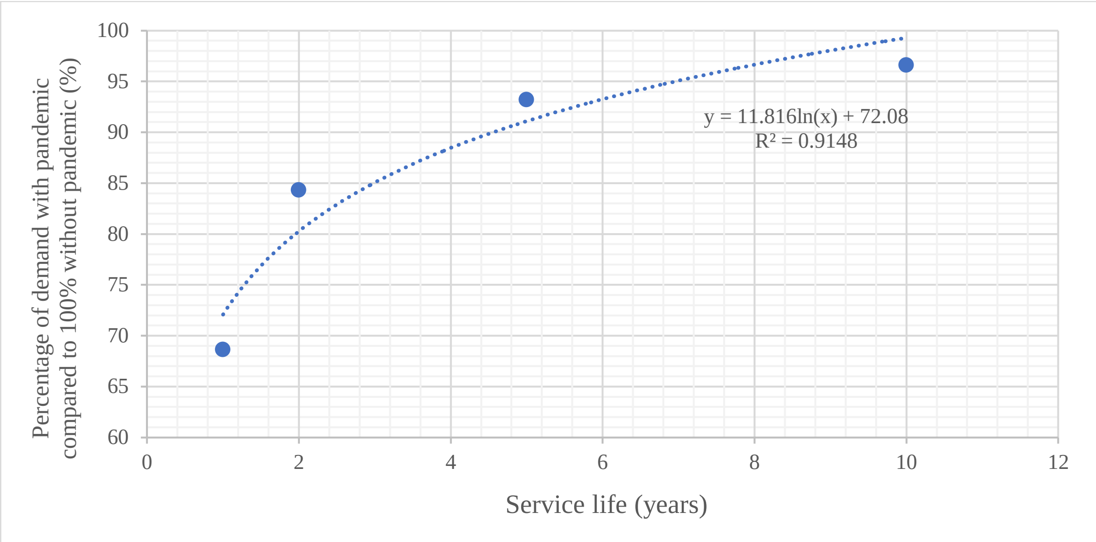

Figure 5. Demand levels in service life "with pandemic", relative to "without pandemic"

As can observed from the 1-year analysis, new interventions on the road could be deferred approximately 4 months (given the 69% level of demand for the total 12-month of the year).

Figure 5 has also added the logarithmic trend line of the results obtained, with a value of 0.92 for its determination coefficient R^2, which allows establishing the percentages of decrease in demand for other service lives of interventions, for cases where the corresponding analyses were desired from this parameter.

This analysis carried out for the city of La Plata is recommended to be carried out in other urban areas from the Google records available in those locations.

5. CONCLUSION

From the study carried out using the data provided by Google, given the decrease in traffic due to the pandemic generated by the coronavirus, the impact on the service life of the pavements of the city of La Plata could be established. This is done by considering the impact generated in the surroundings of the work zones as a valid indicator, which are the ones that experienced the greatest decrease in circulation in this pandemic.

The analysis makes it possible to estimate the extension of the pavement's service life due to the temporary absence of traffic in the months with some type of restrictions. This extension makes it possible to reprogram the periodic interventions that must be carried out, guaranteeing the level of service of the roads under study. This extension of deadlines makes it possible to allocate resources to other activities of higher priority, such as social services and health. In La Plata city, the logical maximum term to defer interventions would be of 4 months.

Future work to be done is to measure traffic levels on representative roads. In this way, the study can be validated or calibrated, which will give it greater reliability for its application in the new waves of restrictions expected for the pandemic.

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CONFLICT OF INTERESTS

The authors would like to confirm that there is no conflict of interests associated with this publication and there is no financial fund for this work that can affect the research outcomes.

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