









# The potential spread of Covid-19 and government decision-making: a retrospective analysis in Florianópolis, Brazil

## *O potencial de propagação da COVID-19 e a tomada de decisão governamental: uma análise retrospectiva em Florianópolis, Brasil*

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**ABSTRACT:** *Objective:* To analyze the association between the transmission potential of SARS-CoV-2 and the decisions made by the municipal government of Florianópolis (Brazil) regarding social distancing. *Methods:* We analyzed new cases of COVID-19 identified in Florianópolis residents between February 1 and July 14, 2020, using a nowcasting approach. Decrees related to COVID-19 published in the Official Gazette of the Municipality between February 1 and July 14, 2020 were also analyzed. Based on the actions proposed in the decrees, whether they loosened social distancing measures, or increased or maintained existing restrictions, was analyzed, thus creating a Social Distancing Index. Time-dependent reproduction numbers ( $R_t$ ) for a period of 14 days prior to each decree were calculated. A matrix was constructed associating the classification of each decree and the  $R_t$  values, analyzing the consonance or dissonance between the potential dissemination of SARS-CoV-2 and the actions of the decrees. *Results:* A total of 5,374 cases of COVID-19 and 26 decrees were analyzed. Nine decrees increased social distancing measures, nine maintained them, and eight loosened them. Of the 26 actions, 9 were consonant and 17 dissonant with the tendency indicated by the  $R_t$ . Dissonance was observed in all of the decrees that maintained the distance measures or loosened them. The fastest expansion in the number of new cases and the greatest amount of dissonant decrees was found in the last two months analyzed. *Conclusion:* There was an important divergence between municipal measures of social distancing with epidemiological indicators at the time of each political decision.

**Keywords:** Coronavirus infections. Epidemiology. Decision making. Government.

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**RESUMO:** *Objetivo:* Analisar a relação entre o potencial de propagação do SARS-CoV-2 e as tomadas de decisão do governo municipal de Florianópolis, Brasil, quanto ao distanciamento social. *Métodos:* Foram analisados casos novos de COVID-19 com tratamento de *nowcasting* identificados em residentes de Florianópolis entre 1º de fevereiro e 14 de julho de 2020. Também foram examinados os decretos relacionados à COVID-19 publicados no Diário Oficial do Município entre 1º de fevereiro e 14 de julho de 2020. Com base nas ações dispostas nos decretos, analisou-se se elas promoviam o relaxamento, o aumento ou a manutenção das restrições vigentes, criando-se o Índice de Distanciamento Social. Para o período de 14 dias anteriores a cada decreto, calcularam-se os números de reprodução dependente do tempo ( $R_t$ ). Construiu-se uma matriz entre a classificação de cada decreto e os valores de  $R_t$ , verificando-se a consonância ou a dissonância entre o potencial de disseminação do SARS-CoV-2 e as ações dos decretos. *Resultados:* Foram analisados 5.374 casos de COVID-19 e 26 decretos. Nove decretos aumentaram as medidas de distanciamento social, nove as mantiveram e oito as flexibilizaram. Das 26 ações, nove eram consonantes e 17 dissonantes com a tendência indicada pelos  $R_t$ . Dissonâncias foram observadas com todos os decretos que mantiveram as medidas de distanciamento e os que as flexibilizaram. No segundo bimestre da análise houve a mais rápida expansão do número de casos novos e a maior quantidade de dissonâncias dos decretos. *Conclusão:* Observou-se importante divergência entre as medidas de distanciamento social com indicadores epidemiológicos no momento da decisão política.

*Palavras-chave:* Infecções por coronavírus. Epidemiologia. Tomada de decisões. Governo.

## INTRODUCTION

SARS-CoV-2 is a new pathogen that was identified in December 2019 in Wuhan, China. It has spread rapidly around the world. As of August 2, there were more than 17 million cases and 680,000 deaths in 216 countries. At that time, Brazil had the second highest number of cases and deaths in the world<sup>1</sup>.

As of August 2, there was no treatment or vaccine for the new virus, and limited knowledge was available on its infectivity and clinical profile<sup>2</sup>. Thus, other ways to mitigate the spread of the virus, which occurs through the respiratory system, are needed. These measures, called non-pharmacological measures, seek to reduce the amount of infectious contact within the population. The World Health Organization (WHO) recommends several non-pharmacological measures to control the disease: quarantine, isolation of people with symptoms, and social distancing<sup>1</sup>. Additionally, the use of face masks and good hand hygiene are recommended<sup>1</sup>. There is evidence that non-pharmacological measures are effective in controlling the transmission of COVID-19<sup>3-7</sup>. They decrease the transmission of the disease and the number of serious cases, thereby reducing the impact of the disease on the health system and decreasing the number of people who die and the number of survivors with side effects. These measures also reduce the need for

hospitalization because of other conditions, which generate competition for beds between patients with SARS-CoV-2<sup>8</sup>.

The implementation of this set of measures requires quick action from the government and different social sectors. Actions are based on epidemiological analyzes and forecasts grounded in up to date, reliable and timely data. Thus, well-founded analyzes, based on accurate data, can contribute to improving patient care, saving lives and managing the economic crisis.

Mathematical and statistical models have been increasingly used to assist in decision making and planning interventions to control epidemics<sup>9-11</sup>, including the pandemic caused by SARS-CoV-2<sup>12-14</sup>. Recently, statistical estimators of the number of time-dependent reproductions ( $R_t$ ) have been proposed based on a set of assumptions regarding the dynamics of epidemics<sup>11,15,16</sup>. These estimators offer an important contribution to the monitoring of disease coping efforts<sup>17</sup>. In a technical document with recommendations on the monitoring and control of COVID-19, the WHO classifies  $R_t$  as a key criterion for defining - particularly in subnational studies - whether the epidemic is under control<sup>18,19</sup>.  $R_t$  represents the average number of secondary cases resulting from an infected primary case, at time  $t$ , if the conditions remain the same after time  $t$ <sup>15</sup>. This value changes with interventions and with the evolution of an epidemic. Outbreaks with  $R_t$  consistently below a value of one tend to disappear. According to the WHO, maintaining this value below one for at least two weeks is the best indication that the epidemic is under control<sup>18,19</sup>. If the  $R_t$  remains above one, the outbreak tends to continue<sup>11</sup>. For this reason, control interventions aim, in general, at maintaining  $R_t$  values below 1<sup>20</sup>.

In Brazil, the epidemiological scenario of COVID-19 is particularly worrying, as it is a country marked by social inequality, with millions of people who do not have access to basic sanitation or adequate housing, and who have a high prevalence of chronic diseases.<sup>21</sup> In different regions of the world, non-pharmacological measures to promote social distancing and reduce viral circulation have been adopted. However, to date, there are no analyses in Brazil on the relationship between implementing and loosening social distancing measures, and epidemiological indicators when political decisions are made. Thus, the present study aimed to analyze the association between the transmission potential of SARS-CoV-2 and the decision-making process of the municipal government of Florianópolis, Santa Catarina, Brazil, regarding social distancing.

## METHODS

### STUDY DESIGN

This was an ecological study, which used data from confirmed cases of COVID-19 whose symptoms started between February 1 and July 14, 2020 in Florianópolis (SC) and municipal decrees related to COVID-19 in the same period.

## DATA SOURCES AND VARIABLES

The municipal government of Florianópolis publishes a database of confirmed cases using nowcasting, a statistical technique used to treat artifacts produced by the time elapsed between the infection and the respective notification, and between the notification and collection of the exams<sup>22,23</sup>. Using this database, data on confirmed cases per day of onset of symptoms were extracted<sup>23</sup>.

It should be noted that in Brazil it is mandatory to provide notification of a suspected case of COVID-19 within 24 hours<sup>24</sup>. On April 14, 2020, Florianópolis adopted the same criteria recommended by the Ministry of Health for the purpose of reporting suspected cases of COVID-19: fever accompanied by cough, dyspnea, runny nose or a sore throat<sup>24</sup>. Suspected cases can be confirmed using real-time reverse polymerase chain reaction (RT-PCR) tests, serological tests, or clinical-epidemiological criteria.

The decrees from the City of Florianópolis are published in the Official Gazette of the Municipality (*Diário Oficial do Município* — DOM)<sup>25</sup>. All decrees published in the DOM between February 1st and July 14th, 2020 were analyzed and those that were related to dealing with COVID-19 were selected. For the purposes of this analysis, the actions proposed in each decree were studied.

## CALCULATION OF $R_t$

The  $R_t$  and its confidence interval were estimated for each day of the study, using a period of 30 days. The method proposed by Cori et al.<sup>26</sup> was used in this calculation because it is suitable for real-time estimates<sup>2,26</sup>. The method proposed by Parag and Donnelly<sup>27</sup> was used to estimate the best smoothing window in the 30-day periods. A gamma distribution with a mean of 4.8 and a standard deviation of 2.3 was used to express the serial range distribution, which is used in the estimate of  $R_t$ <sup>28</sup>.

In order to analyze the propagation potential of SARS-CoV-2, the  $R_t$  was estimated for the 14 days prior to the publication of each decree. This is the period, as indicated by the WHO<sup>18</sup>, during which the  $R_t$  must remain below one in order to be able to define the spread of the disease as “controlled”.

## SOCIAL DISTANCING INDEX OF THE DECREES

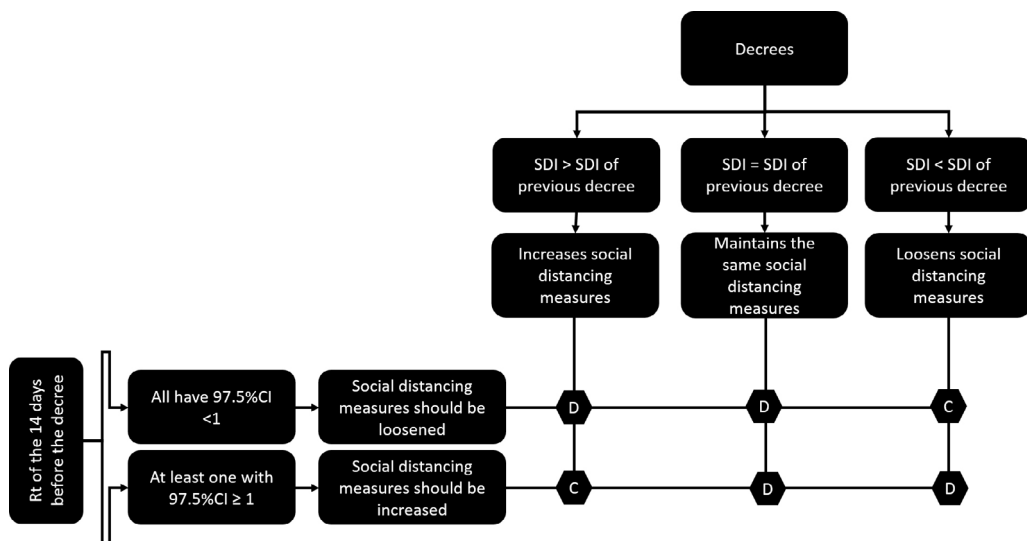
In order to perform an objective analysis of the decrees, restrictions on each activity (such as commerce, offices, public parks) were mapped and the locations were classified into three categories, according to the intended result: closed (for example, shopping centers should be closed); open (for example, shopping centers could remain open); and open with restrictions (for example, shopping centers could remain open as long as they followed

restrictive measures). The “closed” category was assigned a value of one, the “open” category was assigned a value of -1 and the “open with restrictions” category was assigned a value of 0. Thus, based on these actions, a Social Distancing Index (SDI) was developed. The SDI of a decree was calculated as the average of the values of all its actions for the activities mentioned in the decree. Thus, a decree with a higher SDI than the previous one received the classification of “increases social distancing measures”; one with a lower SDI was classified as “loosens social distancing measures”; and one with the same SDI, “maintains social distancing measures”.

### ANALYSIS MATRIX

A matrix was constructed between the classification of each decree and the  $R_t$  of the 14 days preceding its publication (Figure 1). Based on the matrix, the consonance or dissonance between the potential for transmission of SARS-CoV-2 and the target situation was analyzed, that is, the tightening or loosening of social distancing measures.

Following the idea of suppression, if the credibility interval (95%CI) of  $R_t$  reached 1 or was greater than 1 in at least one of the 14 days, it was assumed that the decision making should include an increase in social distancing measures. If the 95%CI of  $R_t$  was less than 1 during all 14 days, decisions should be made in order to loosen social distancing measures. Thus, when the classification met what was required by



C: consonance; D: dissonance.

Figure 1. Analysis matrix of the relationship between the transmission potential of SARS-CoV-2 and government decision making regarding social distancing.

the expansion potential of the virus, the situation was classified as consonant. And if not, as dissonant.

To assess the relationship between the dynamics of the epidemic and the adopted restriction measures, we compared the incidence curve, which was smoothed by LOESS regression<sup>29</sup>, with the publication dates of each decree, classified as described above.

All analyzes were performed using R software version 3.6.3. Scripts and databases are available at: [https://github.com/lpgarcia18/propagacao\\_da\\_covid\\_19\\_e\\_decisao\\_governamental](https://github.com/lpgarcia18/propagacao_da_covid_19_e_decisao_governamental).

## ETHICAL CONSIDERATIONS

Only open, secondary and anonymized databases were used. Thus, this project was not submitted to a Research Ethics Committee.

## RESULTS

According to data with nowcasting, Florianópolis had, up until July 14, 2020, 5,374 cases of COVID-19. The municipality published 26 decrees containing social distancing measures associated with the disease. The first was enacted on March 13, 2020 and the last one to be included in this analysis, was enacted on July 10, 2020. The classification of these decrees and their actions are described in Table 1 of the Supplementary Material.

The SDI showed a progressive increase from March to the beginning of April 2020, and then it decreased until mid-May. It went up again until mid-June and finally dropped by the end of the study (Figure 2). Based on SDI, nine decrees increased the social distancing

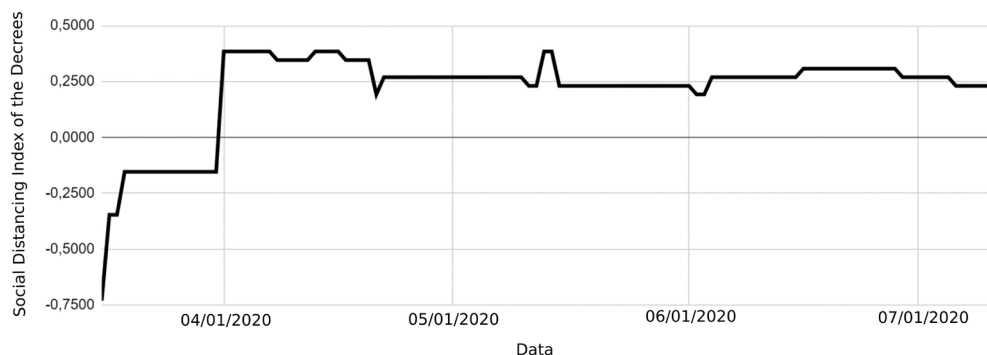
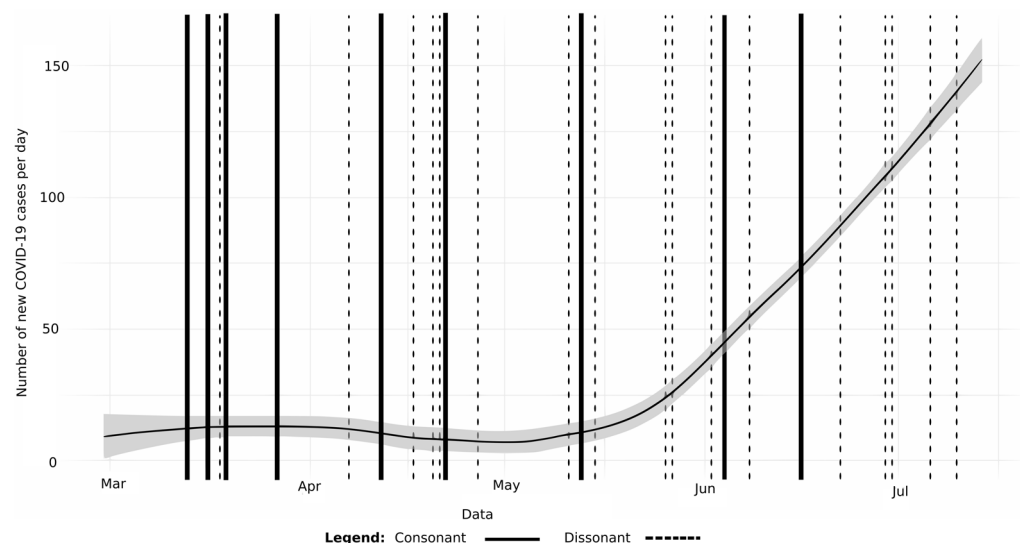


Figure 2. Social distancing index of decrees related to COVID-19, with actions that impacted social distancing. Florianópolis (SC), 2020.

measures. In nine, the measures were maintained and in eight, they were loosened. The  $R_t$  of the 14 days prior to the publication of each decree, with their respective confidence intervals, the classification of each decree and the analysis of the situations are described in Table 1 of the Supplementary Material.

Of the 26 actions analyzed, nine were consonant and 17 were dissonant with the trend indicated by the estimates of  $R_t$ . The 95%CI of  $R_t$  encompassed or was above 1 in at least one of the 14 days prior to the publication of all the decrees. Dissonance was observed with all the decrees that maintained the distancing measures, such as that of June 22, when they should have been increased; and with decrees that loosened them, such as that of June 29, when they should also have increased the distancing measures (Supplementary Material - Table 1).

Of the nine consonant situations in the municipality, seven occurred in the first two months of the fight against COVID-19, between March 13 and May 13. All of them increased measures of social distancing. The number of dissonant situations was also equal to seven in the same period. In the two months that followed, between May 14 and July 14, there were two consonant situations and 10 dissonant situations. During this period (according to the two-month period of analysis), there was also a faster increase in the number of new cases per day, when compared to the previous period (Figure 3).



Consonant: a situation in which the decree increases social distancing measures, when the  $R_t$  is greater than one in at least one of the 14 days prior to its enactment, or when the measures decrease when the  $R_t$  is less than one during all 14 days; dissonant: all other situations.

Figure 3. The relationship between consonant and dissonant situations and the number of new COVID-19 cases per day. Florianópolis (SC), 2020.

## DISCUSSION

When analyzing the relationship between the potential for spreading the SARS-CoV-2 virus, measured by the  $R_t$  in Florianópolis and the decisions of the municipal government regarding social distancing, more dissonance was observed in the most recent period, corresponding to the second two-month period of analysis. This dissonance occurred at a time when the number of cases in the municipality increased from 25 new ones per day to more than 150 new ones per day. The accelerated growth of cases in the period of loosening of social distancing measures may be an indication that a greater alignment between decision-making regarding measures and consideration of epidemiological situation is necessary, in order to control the epidemic.

There is robust evidence regarding the effectiveness of non-pharmacological measures, especially social distancing, in controlling the spread of SARS-CoV-2.<sup>3-7</sup> Suppression strategies have achieved good results, as seen in New Zealand<sup>30,31</sup>. This evidence, however, indicates the maximum potential impact of the actions if implemented in due time. Therefore, the epidemiological situation and governmental decision-making need to be aligned.

The Brazilian federal government's actions to deal with COVID-19 have faced strong international criticism, especially due to the lack of implementation of non-pharmacological measures<sup>32,33</sup>. States and municipalities had to go to the Supreme Federal Court of Brazil to have the assured right to implement them<sup>34</sup>. The municipal government of Florianópolis has launched a series of decrees with actions that complement this goal. The SDI calculated in this study shows a progression towards the implementation of actions aimed at strengthening social distancing in the municipality from mid-March to early April. After this period, the SDI decreased, indicating a loosening of the initial measures. In addition, the highest SDI value was 0.385, indicating that the restrictions never reached half of the activities contemplated in the set of decrees. As we consider below, activities have different weights in reducing contact spread. Even so, the government's set of actions shows that it identifies more activities that should continue to function than those that should have restrictions, contrary to what is expected in public policies of social distancing.

The analysis carried considering the epidemiological framework of the municipality and the decision making by the government at the municipal level demonstrates a mismatch at various times, especially in the last two months of analysis. While in 50% of the situations analyzed in the first two months there was consonance between the epidemiological situation and decision making, only 20% of the situations were consonant in the second two months. The increase in the SDI and the higher proportion of consonant decisions coincided temporarily with the stability in the number of new cases of COVID-19 in Florianópolis in the first two months of analysis. The reduction in the SDI and the higher proportion of dissonant situations, in turn, coincided with the increase in cases in the second two months. The study design, however, does not



allow for causal relationships between these phenomena, but suggests that they may be related.

By homogenizing the actions implemented by the decrees in order to calculate the SDI, this study takes a first step at getting closer to more answers. Calculating the SDI made it possible, for example, for the closure of one sector in one decree to be replaced by the closure of another sector in the next, with both maintaining the same SDI. The political manager, however, may have chosen to close a certain sector where social distancing was less important in the first decree, while choosing a certain sector where social distancing was more important in the second. Thus, a future refinement of our analysis should weigh the SDI with the impact of each action.

It must also be taken into account that this is a retrospective analysis, and it is possible that their estimates were not available for making a decision on the date of publication of the decrees. Even so, the temporal relations between the consonance of the policy, the epidemiological situation and the stability in the number of cases, in the first two months of analysis are worth noting as are the dissonance and the increase in the number of cases, in the second. These relations are an indication for future decisions to be made by the municipal executive power, which should be firmly guided by how the virus is spreading. The present study analyzed the epidemiological situation related to the monitoring of the pandemic. In addition to the analysis of the epidemic's growth potential, the only aspect included in this analysis, it is important to remember that other aspects, such as the capacity of the health system to adequately welcome and treat patients and health surveillance to identify and monitor suspicious and infectious cases, need to be taken into account by governmental leaders<sup>35</sup>.

The epidemic has mostly entered and spread throughout metropolitan regions. The fact that they are land, sea and air hubs and that they have greater population density allows for this to happen. There is a greater number of people per room in households. Not by chance, there are other risk factors in addition to inadequate housing conditions, such as the higher prevalence of chronic diseases that constitute comorbidities for COVID-19. On the other hand, these metropolises have better materials and institutional infrastructure, which more conducive to finding solutions. The lack of coordination between the national executive branch of government and the state level government provided for an enormous diversity institutional and individual responses to the pandemic. Thus, only by analyzing different local coping strategies will it be possible to compose a general picture of these responses and learn from them.

Altmann et al.<sup>36</sup> emphasize that, in the discussion of weighing economic costs and the spread of the disease, governmental leaders must have the best data available. But the COVID-19 pandemic reinforces the idea that the effectiveness of science-based policies depends on government initiatives to implement them<sup>37</sup>. It is challenging for public authorities to balance the different and profound consequences of COVID-19, but disease control is essential for the recovery of the economy, and it is important that decisions and communications are based on the best available evidence, and that they are transparent.<sup>38</sup>

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