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# COVID-19 in Brazil: The logic of failure

## COVID-19 no Brasil: A lógica do fracasso

## COVID-19 en Brasil: La lógica del fracaso

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**Abstract**
COVID-19 and its control constitute an example of a complex system, and most humans are poorly prepared to deal with complex systems. Here we show that government, some scientists and part of the news media did not recognize or ignored data that were freely available about the course of the epidemic in Brazil, and that this led to false conclusions and fatal decisions. The second wave of mortality did not originate in Manaus; Christmas and New Year celebrations that occurred long after the second wave started were not its primary cause; and social distancing accelerated rather than retarded the onset of the second wave. Had these facts been appreciated earlier, it would have been obvious that the only viable strategies were to reinforce the health system and obtain vaccines at any cost, and this might have saved between a quarter and half a million lives.
**Keywords:** COVID-19; Brazil; Second wave; Vaccines; Social distancing.

**Resumo**
A COVID-19 e seu controle constituem um exemplo de sistema complexo, e a maioria dos humanos está mal preparada para lidar com sistemas desse tipo. Nesse estudo mostramos que o governo, alguns cientistas e parte da mídia não reconheceram ou ignoraram os dados disponíveis gratuitamente sobre a direção da epidemia no Brasil, e que isso levou a conclusões falsas e decisões fatais. A segunda onda de mortalidade não se originou em Manaus; as celebrações de Natal e Ano Novo que ocorreram muito depois do início da segunda onda não foram sua causa principal; e o distanciamento social acelerou em vez de retardar o início da segunda onda. Se esses fatos tivessem sido apreciados anteriormente, seria óbvio que as únicas estratégias viáveis eram reforçar o sistema de saúde e obter vacinas a qualquer custo, e isso poderia ter salvado entre um quarto e meio milhão de vidas.
**Palavras-chave:** COVID-19; Brasil; Segunda onda; Vacinas; Distanciamento social.

**Resumen**
COVID-19 y su control constituyen un ejemplo de un sistema complejo, y la mayoría de los humanos están mal preparados para lidiar con sistemas complejos. Aquí mostramos que el gobierno, algunos científicos y parte de los medios de comunicación no reconocieron o ignoraron datos de libre acceso sobre el curso de la epidemia en Brasil, y eso llevó a conclusiones falsas y decisiones fatales. La segunda ola de mortalidad no se originó en Manaus; Las celebraciones de Navidad y Año Nuevo que ocurrieron mucho después de que comenzara la segunda ola no fueron su causa principal; y el distanciamiento social aceleró en lugar de retrasar el inicio de la segunda ola. Si estos hechos se hubieran apreciado antes, habría sido obvio que las únicas estrategias viables eran reforzar el sistema de salud y obtener vacunas a toda costa, y esto podría haber salvado entre un cuarto y medio millón de vidas.
**Palabras clave:** COVID-19; Brasil; Segunda ola; Vacunas; Distanciamiento social.

## 1. Introduction

The difficulties that humans have in dealing with complex systems were clearly outlined by Dörner (1996). The COVID-19 pandemic is an example of a complex system, which led to unprecedented integrated analyses of data throughout the world; a strategy that paid off in almost every country except Brazil. Here we show that the reason for the Brazilian failure to confront COVID-19 was that government, medical scientists, and the news media committed most of the errors that were listed by Dörner (1996). They held on to pet theories long after the data had refuted them, they were unable to see the collateral effects of decisions taken, and they could not deal with a situation that changed over time.

The Brazilian President, and many other people in the world, believed that COVID-19 would prove to be less dangerous to human health than influenza. That may well prove to be correct in the long term, but ignores the fact that influenza regularly causes >25% mortality in immunologically naïve populations (Walker, et al., 2015). Data on mortality soon showed that Sars-CoV-2 in the immunologically naïve (= World) human population caused unacceptably high mortality and could overwhelm health systems (Tangcharoensathien, et al., 2021). Nonetheless, the Brazilian President, following the example of the then President of the United States of America continued to say that the problem would just go away. This is an example of Dörner´s "ballistic decisions" or following a predetermined trajectory independent of the consequences.

By October 2020, the mortality rate in Brazil was in drastic decline, and it appeared that immunity caused by natural infections might be fixing the problem without need for government intervention, but much of the reduction was due to the effects of social distancing, which can drastically impede the spread of the original Sars-CoV-2 strain (Candido, et al., 2020). There was only general recognition that the situation had changed in late January and February 2021 when mortality rates in Manaus (Amazonas State) exceeded those during the peak of the first wave in 2020, and the new Gamma variant (then known as P.1), was identified. It was generally assumed that Gamma originated in Manaus, but this confounds the intensity at the peak with the onset of the second wave, and variants should not be named after the location in which they were first detected (Karim, et al., 2021).

Viral variants compete for hosts (Rouzine & Rozhnova, 2018), probably because prior infection by one variant gives at least partial protection against the second. More contagious variants, such as Gamma, might not have a great selective advantage over other strains when there is little social distancing, but we can expect strong selective pressure for more contagious varieties when hosts are less accessible, such as when there are high levels of social distancing. Using simulation, Day and collaborators (2020) predicted that the strength of selection for higher transmission rate in SARS-CoV-2 should increase with the density of susceptible hosts. Therefore, we can expect mutations leading to more contagious varieties to be favored when there are more hosts available (less social distancing). Because this will lead to more cases, the opportunity for new mutations should also increase, thus increasing even further the chance that more transmissible variants will arise and increase in frequency.

However, Day and collaborators also noted that "some mutations may become more strongly selected in the presence of social distancing if they allow for viral transmission despite the intervention". The data on the trajectories of the epidemic in individual Brazilian states allow us to determine which of these mechanisms (number of mutations vs selection) is more important. If the first mechanism is dominant, there will be a positive relationship between social distancing in the state and time from the first death to the start of the second wave. If the second mechanism is dominant, there will be a negative relationship between social distancing and the time from the onset of the first wave to the onset of the second wave.

Here, we first estimated the onset of the second wave across Brazil as a whole, and then for each state separately, and for its relationship with social isolation.

## 2. Methodology

Data on daily new and cumulative deaths by COVID-19 for Brazil as whole and for Brazilian states, were obtained from the official COVID-19 website of the Brazilian Ministry of Health and from the State Secretaries of Health, respectively. These data have been used to investigate the COVID-19 propagation by a number of studies (Marson, 2020; Takemoto, et al., 2020; Marinho, et al., 2021; Marques, et al., 2021). For visualization of the long-term trend, we computed weekly averages of daily new deaths to minimize the influence of within-week variation in obituary reports. The time from first death to the onset of the second wave was computed in number of days.

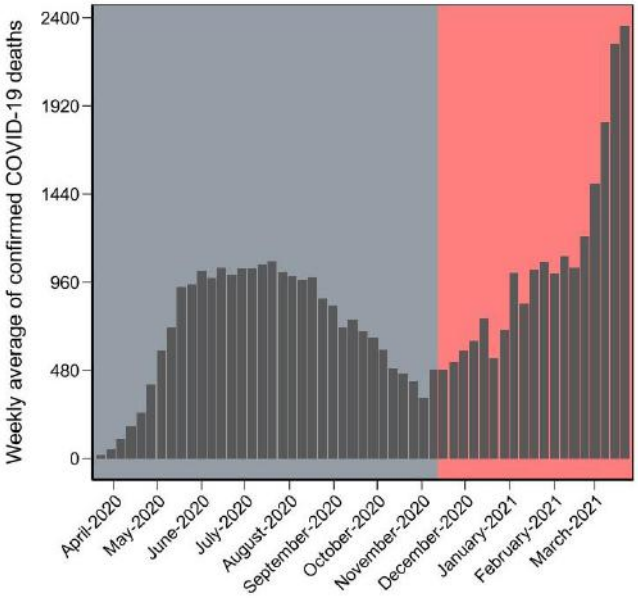
To estimate the transition between the first and second waves for Brazil as whole and for each Brazilian state, we assumed that the second wave necessarily began after the peak of the first wave. Accordingly, we looked for the inflection point (place where the derivative shifted from negative to positive in sigmoid curves) in the cumulative death curve from August 2020 onwards, using the Bisection Extremum Surface Estimator (Christopoulos, 2016).

Data on social mobility was obtained from Google. Google measured "residential duration", or the average time spent home by an individual every day. Then, for each day, Google calculated the percent change in this variable relative to a baseline period (January 2020), and provided time series of these values for each Brazilian state. Accordingly, for each state, we computed the average of those percent changes, and used it to measure the tendency for social isolation over the study period. Hence, higher values indicate higher increases in time spent home (i.e. more social isolation) relative to the baseline (e.g. Kleinschroth & Kowarik 2020; Mena, et al., 2021) .

## 2. Results

The onset of the second wave of the COVID-19 pandemic in Brazil was estimated to have occurred on November 11, 2020 (Figure 1).

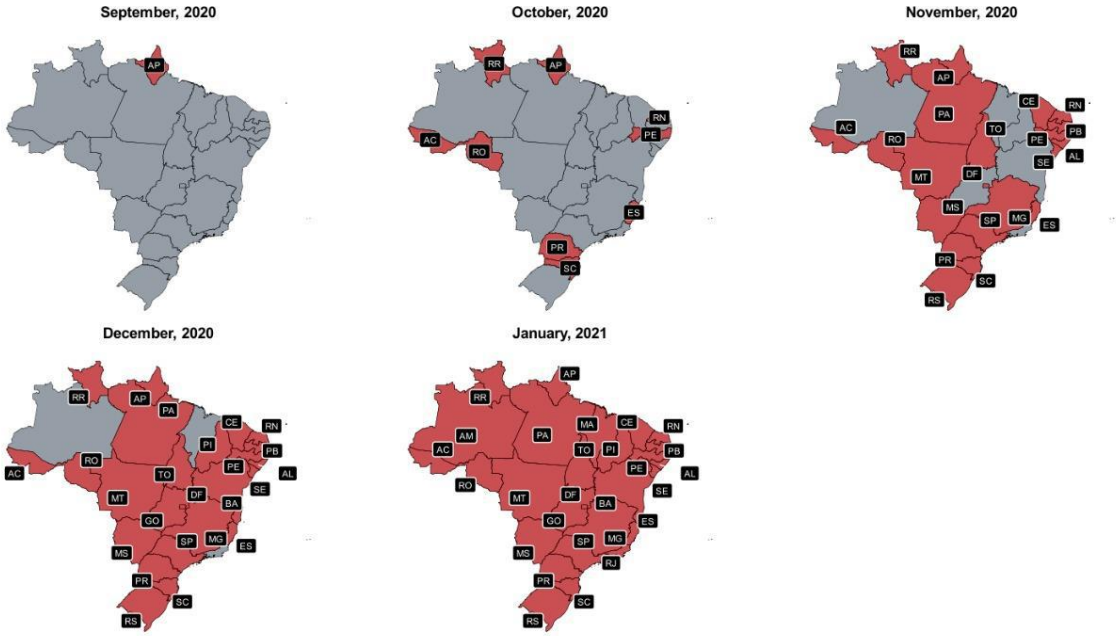
**Figure 1.** Weekly average of confirmed COVID-19 deaths in Brazil (black line) from the first recorded death (March 17, 2020) to March 25, 2021. Grey and red areas indicate the first and second waves, respectively. The transition point between waves was defined as the inflection point of the curve of daily cumulative deaths from August 2020 onwards estimated as 11 November 2020 using the Bisection Extremum Surface Estimator.




Source: Authors.

However, there was much heterogeneity across states. The state that first reached the second wave was Amapá (172 days after the first recorded death, Figure 2), whereas the state that took the longest to reach the second wave was Rio de Janeiro (322 days after the first recorded death, Figure 2).

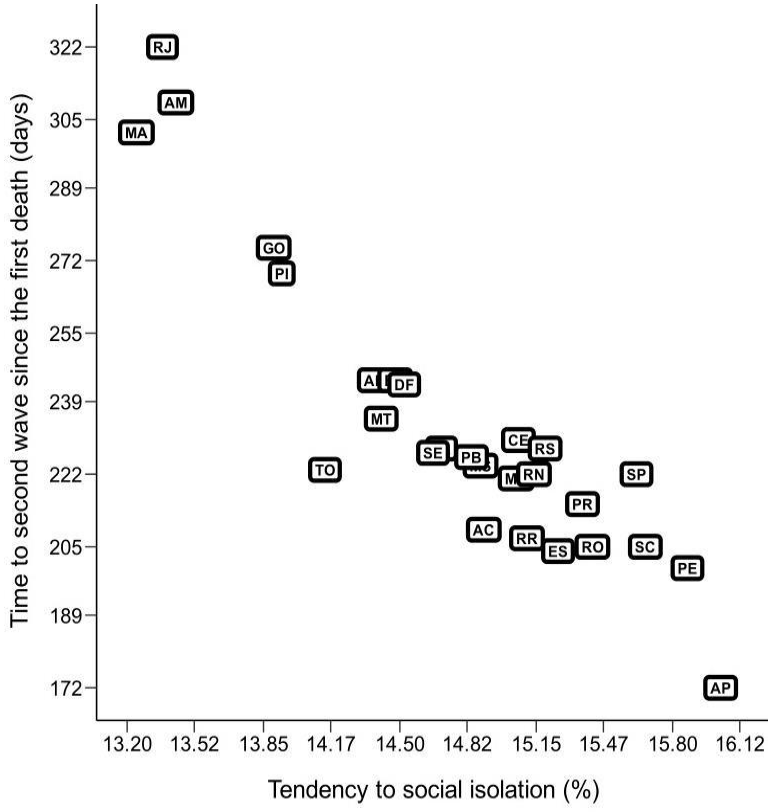
**Figure 2.** Monthly progression since the start of the second wave of deaths from COVID-19 across Brazilian states. Letters indicate official state codes. Grey and red states indicate before and after the arrival of the second wave, respectively. The transition point between waves for each state was defined as the inflection point of the curve of daily cumulative deaths from August 2020 onwards.




Source: Authors.

Further, time to second wave strongly decreased with tendency to social isolation ($r = -0.92$, $P < 0.001$, $n = 27$; Figure 3).

**Figure 3.** Relation between time to second wave of COVID-19 and tendency to social isolation across Brazilian states (r = -0.92, P < 0.001, n = 27) as provided by Google's mobility dataset. The tendency to social isolation measures the average increase in time spent home by people during the same period. Each point represents one state and letters inside the points indicate official state codes.




Source: Authors.

## 3. Discussion

In this study, we investigated the dynamics which may have led to an earlier onset of the second wave of the COVID-19 pandemic in Brazil relative to that acknowledged by the country's Government and media. The daily new deaths in Brazil clearly showed that mortality was increasing and that a second wave of infection had taken hold of the country by late November 2020 (red area in Figure 1), albeit with much variation across Brazilian states. Crucially, this variation was highly predictable from the tendency of states to engage in social isolation, with the second wave hitting states with more social isolation first. This should have sparked warning bells, but the government did not react (Vargas, 2020), and the scientific community hung onto the hypothesis that the same processes (slow spread, effective social distancing) operating at the beginning of 2020 would continue into 2021 (Almeida, et al., 2020), an example of Dörner's "methodism". The scientific community advised the news media that the problem was because of lack of social distancing during the Christmas and New Year periods (O Globo, 2020), and newscasters stood in front of graphs showing an undisputable increase in deaths starting in November 2020 (Figure 1) and attributed it to festivities that did not occur until late December (Jornal Nacional, 2020). Blaming someone else is an example of what Dörner (1996) called "conspiracy theories".

Our findings are consistent with the idea that more transmissible variants may be more strongly selected for under social distancing (Day, et al., 2020), thus accelerating the onset of the second wave (Figure 3). There may have been multiple causes of the second wave, but if the principal cause was the propagation of more contagious mutants including the Gamma variant, then it was most likely to have originated in Amapá or one of the southeastern states, and least likely to have

originated in Amazonas or Rio de Janeiro, the states hardest hit by the second wave in early 2021 (Figure 2). Social distancing was almost non-existent in Amazonas, whereas most other Brazilian states showed higher levels of social distancing (Almeida, et al., 2020), which apparently impeded transmission of Sars-CoV-2, but also made it more difficult to recognize the start of the second wave. It should be noted that no Brazilian state consistently maintained the levels of social distancing that the World Health Organization recommended to contain the epidemic. The relationships between social distancing and the probability of a new variant arising, the probability of a new variant fixing and the number of cases due to the new variant after it fixes are obviously complex, but if searches had been made when the second wave first became apparent in each state, Gamma and other variants may have been recognized much earlier.

The inflection points in the case and mortality curves that indicate that the second wave was in course must post-date the times that it started. Nevertheless, the inflection points predate the end-of-year parties in almost all states, and only Amazonas, Maranhão and Rio de Janeiro states had inflection points starting in January that might indicate an effect of reduction in social distancing due to end-of-year festivities. The second wave had started in many states before December 2020 (Figure 2). It has been suggested that the reduction in social distancing in most states since mid-year was the driver of increasing cases and deaths in November 2020 (Almeida, et al., 2020), but this ignores the variability in average social distancing across states and is clearly contradicted by the fact that states with higher average social distancing were hit by the second wave earlier (Figure 3). Therefore, neither lack of social distancing, nor the prevalence of parties, are good candidates to explain the second wave of COVID-19 cases and deaths in Brazil as a whole, even though both must logically affect transmission to some degree.

Independent evidence backs our claim that social distancing can select for more infectious (and more deadly) strains. Zimerman and collaborators (2021) showed that the proportion of Gamma in relation to other variants circulating in Manaus during a given week was proportional to the degree of social distancing the week before, with no detectable new variants following weeks in which the isolation index was less than 40%. There can be little doubt that social distancing is an important weapon in the war against COVID-19, but it also has indirect effects that can complicate the overall strategy. At best, it is a mechanism to buy time, and if we do not use that time wisely, it can backfire against us.

Propagation of COVID-19 is an example of a complex system, and those responsible for its control in Brazil made almost all the errors that Dörner (1996) identified in his book “The Logic of Failure”. However, perhaps the most important was in not recognizing that a second wave had started sometime before October 2020, even though this was obvious in the reported death rates by the end of November 2020 (Figure 1). Dörner (1996) explains that one of the most common reactions to information that indicates that a strategy is not working is to blame someone else; scientists and news media blamed end-of-year party makers. Government officials had no-one to blame but themselves.

The fact that the system underwent a game-change some time before early November 2020 should have raised alarm bells. Had government officials admitted that the problem would not go away by itself and scientists admitted that the same levels of social distancing would be much less effective in the second wave, the only options would have been to massively upgrade the health system and to obtain vaccines at any cost. Pfizer offered 70 million doses of its vaccine to Brazil in August 2020, with a delivery date in December 2020. The makers of Coronavac offered 160 million doses of their vaccine in July, August, October and December, but all the offers were ignored (Reuters, 2021). Massive vaccination campaigns in most countries (e.g. USA) made the second wave almost imperceptible by the end of February 2021, but mortality due to COVID-19 in Brazil continued to rise and daily mortality rates were more than triple those at similar periods after the initial outbreak in 2020.

## 4. Conclusion

The second wave of the COVID-19 pandemic clearly hit Brazil by November 2020, with states engaging in more social isolation arriving at the second wave even earlier. Nevertheless, the Brazilian Government and media did not acknowledge these observations, even though the data available at the time already indicated the need for immediate action. Dörner (1996) carried out his experiments in computers because it would be unethical to do so in real-life situations. The Brazilian experiment confirmed all his predictions about the causes of failure when dealing with complex systems in the real world. The result was the unnecessary deaths of between a quarter and half a million people.

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