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COVID-19 IN BRAZIL: ANALYSIS OF THE PANDEMIC SHORT-TERM SCENARIO IN RELATION TO OTHER COUNTRIES

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ABSTRACT

Objective: to compare the growing trend in the cases of patients with COVID-19 in Brazil in relation to other countries. Methods: the sequence of 20 days from the first notification and the date each country reached the accumulated incidence of 0.05 cases per 100 thousand inhabitants were analyzed. For the analysis of the trend, Joinpoint Regression was performed, and the comparison of the curves was done by the parallelism and coincidence analyses. Results: the growth trend registered in Brazil (37.6%), in the 20 days after first notification, was close to that observed in the Netherlands (34.5%), Iran (33.4%), Switzerland (35.5%) and Pakistan (31.9%) and higher than the rate by China (19.7%). The analysis the sequence of 20 days from the date each country reached the accumulated incidence rate showed a daily growth trend in all countries, with the average growth in Brazil being 23.5%. With the exception of the United Kingdom, all countries analyzed showed a daily growth curve different from that of Brazil. Conclusion: Brazil has a growth trend similar to that observed by the United Kingdom and lower than that of Italy, Spain, France, and the United States.

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INTRODUCTION

The Health Commission of the Hubei Province, China, notified that in December 2019, the city of Wuhan presented 27 cases of pneumonia of unknown etiology with a death record. In January 2020, it was found that it was the 2019-*novel coronavirus* (2019-nCoV), and in February 2020, the Coronavirus Study Group of the International Committee proposed the name of *severe acute respiratory syndrome coronavirus 2* (SARS-CoV– 2), and the World Health Organization (WHO) named Coronavirus Disease – 2019 (COVID-19) the disease caused by this new virus (Biscayart *et al*., 2020; Chan *et al*., 2020; Guo *et al*., 2020). Faced with the situation of the epidemic, on January 30th, the WHO declared a Public Health Emergency of International Concern, at a time when there were more than 7.000 cases in 18 countries and 170 deaths in China. The pandemic situation was decreed on March 11th, a situation in which 118.319 cases were registered in 113 countries and the number of deaths was over 4 thousand (WHO 2020a, b). In Brazil, on January 28th, the first Epidemiological Bulletin, an epidemiological surveillance guide and a National Contingency Plan for COVID-19 was published, which aimed to guide the National Surveillance System and the Unified Health System (SUS) service network to act in the identification of COVID-19, in order to mitigate the risks of sustained transmission and the appearance of serious cases and subsequent deaths (Croda *et al*., 2020). The first case of COVID-19 in the country was confirmed on February 26th, 2020, and until March 3rd, 488 suspected cases were reported, 2 were confirmed and 240 were discarded in Brazil, with no evidence of local transmission. The first two confirmed cases occurred in men living in the city of São Paulo, SP, who had returned from a trip to Italy (Croda and Garcia, 2020). Currently, the disease has shown a significant growth in the country, and until May 29th, 2020, there were 411.821 reported cases and 25.598 registered deaths, epidemiological situation that indicates that Brazil has become the current epicenter of the disease in the world (WHO, 2020c). The insufficient scientific knowledge about the new coronavirus, its high speed of dissemination and the capacity to cause deaths in vulnerable populations, generate uncertainties about which would be the best strategies to be used to face the epidemic in different parts of the world.

In Brazil, the challenges are even greater, as little is known about the transmission characteristics of COVID-19 in a context of great social inequality, with populations living in precarious housing and sanitation conditions, without systematic access to water and in a situation of agglomeration (Werneck and Carvalho, 2020). The spread of the virus took exponential proportions, putting all nations on alert to fight the virus and control the disease. Recognizing the dissemination process and the control measures adopted by the countries is a fundamental tool for the planning of control actions, especially for Brazil, which, given its territorial extension and population contingent, is more likely to face an explosion of the epidemic. Thus, the present study aims to compare the growing trend in the cases of patients with COVID-19 in Brazil in relation to other countries.

METHODS

An ecological study of time series analysis was conducted, based on the information reported by WHO in the Situation Reports issued daily. For the understanding of the scenario of expansion of the epidemic in the short-term, and with the purpose of analyzing the trends and understanding the population dynamics of the disease in the next segments of time, we considered the first 20 days after the registration of the first case of COVID- 19 in each country until March 18th, 2020. In order to carry out the trend analysis, in addition to Brazil, countries that had at least 30 records of the disease in the period were included, therefore, 22 countries were included. To analyze the expansion of the pandemic in Brazil and compare it with other countries, a time series analysis was carried out, based on the cumulative incidence of confirmed cases of COVID-19 until April 3rd, 2020.

The analysis included countries that had at least 100 confirmed cases of COVID-19 in the 30 days after the first case was registered, and that had at least 20 days of follow-up after reaching the cumulative incidence rate of0.05 cases per 100 thousand inhabitants, which for the purpose of standardizing the analysis, was considered D1. Based on these criteria, 20 countries were included to be compared to Brazil. An analysis of the COVID-19 time trends by country was carried out using Joinpoint Regression analysis, where the average daily percentage change was estimated, with a 95% confidence interval. The final model selected was the most adjusted model, with the Daily Percentage Change (DPC) based on the trend of each segment, estimating whether those values were statistically significant ($p<0.05$). To quantify the trend in the cohort of the days analyzed, the Average Daily Percent Change (ADPC) was calculated based on the accumulated geometric average of the trends of the DPC, with equal weights for the lengths of each segment during the fixed interval. The significance tests used are based on the Monte Carlo permutation method and on the calculation of the daily percentage variation of the ratio, using the logarithm of the ratio (Kim *et al*., 2000). In order to compare the cumulative incidence curve of Brazil to the other countries, a parallelism and coincidence analysis was carried out. These two tests of comparability between time series curves compares two sets of trend data whose average functions are represented by Joinpoint Regression. This model tests whether two Joinpoint Regression functions are identical (coincidence test) and whether the two average regression functions are parallel (parallelism test). For those tests, the significance of 0.05 and the maximum number of 4.499 permutations were considered (Kim *et al*., 2004). The statistical analyses were performed using the Joinpoint Regression Program software, version 4.7.0.0.

RESULTS

The trend analysis of new cases of COVID-19 in the first 20 days in Brazil showed that the country has an average daily growth of 37.6%, which is higher than that recorded by China (19.7%) and similar to the rates in Switzerland (35.5%), the Netherlands (34.5%), Pakistan (31.9%), and Iran (33.4%) (Table 1). It appears that, among the countries that lead the prominent scenario in the pandemic of COVID-19, Brazil was the one that most quickly reached the accumulated incidence of 0.05 cases per 100 thousand inhabitants, reaching this mark in 17 days, whereas for Italy the period was of 23 days, for Spain 27 days, for the United States 44 days, for France 34 days, and for the United Kingdom 39 days (table 2). Brazil had an average growth rate of new cases of COVID-19 of 23.5%, while Italy, Norway, France, Switzerland, Spain, Austria, Denmark, the Netherlands, and the United States had an average growth of more than 30%, with emphasis on Spain with ADPC of 40.1% (table 2).

In comparing the ADPC of each country with that of Brazil, it showed that the average daily growth in the country is higher than Malaysia, Japan, Iran, and Lebanon, and lower than the United States and European countries – Italy, Norway, France, Switzerland, Spain, Austria, Denmark, and the Netherlands. By the parallelism and coincidence tests, all the countries analyzed presented different curves in comparison to Brazil, except for the United Kingdom, which presented a parallel and coincident curve (table 2). In figures 1 to 3, it is possible to observe the comparison between the accumulated incidence curves in Brazil with the other countries, according to the accumulated rate reached. Figure 1 shows the greatest similarity between the curve of Brazil and the other countries that had a truncated cumulative incidence of 10 cases per 100 thousand inhabitants.

DISCUSSION

The analysis of COVID-19 records in the first 20 days after the first notification, in each country, showed that the dissemination pattern assumed different aspects worldwide, even among countries on the same continent. The results indicated that the daily growth rate of the number of cases in Brazil is similar to that observed in Iran, the Netherlands, and Switzerland, however, it must be considered that in those countries, in the same period, the disease records exceeded 1.500 cases, while Brazil registered 290 infected persons. Studies with mathematical models to estimate the consequences of the pandemic have been widely produced. From these resources, it was possible to estimate that the impact of travel restriction measures would have a considerable effect on the spread of the disease, provided there was an association with other control measures and behavioral changes (Chinazzi *et al*., 2020) and, specifically in Wuhan, the adoption of such measures were able to reduce disease transmission from 2.35% to 1.05% in the following week (Kucharski *et al*., 2020). It should be noted that the countries that were part of the second epicenter of the pandemic, such as Italy, Spain, France and the United States, had a maximum of 16 cases of the disease in the first 20 days. Some countries chose not to impose restrictive measures when the first cases

Table 1 – Time trend for the occurrence of COVID-19 in Brazil and in 22 countries in the 20 days after the registration of the first case

Region/Country	Number of cases	Lower Endpoint Day	Upper Endpoint Day	ADPC[¥]	95% Confidence Interval	*p*
Europe						
Switzerland	2.201	Feb 26th	Mar 16th	35.5*	21.8 - 50.7	<0.05
Netherlands	1.705	Feb 28th	Mar 18th	34.5*	26.9 - 42.6	<0.05
Denmark	960	Feb 27th	Mar 17th	25.1	-1.9 - 59.5	0.1
Austria	959	Feb 26th	Mar 16th	34.7*	26.8 - 43.2	<0.05
Greece	331	Feb 27th	Mar 17th	12.6	-3.2 - 31.1	0.1
Estonia	205	Feb 27th	Mar 17th	11.7	-1.6 - 26.8	0.1
Romania	158	Feb 27th	Mar 17th	16.9*	4.4 - 30.8	<0.05
Croatia	49	Feb 26th	Mar 16th	15.4	-2 - 35.9	0.1
Belarus	36	Feb 28th	Mar 18th	6.5	-2.5 - 16.4	0.1
Georgia	33	Feb 27th	Mar 17th	5.4	-2.3 - 13.7	0.2
South America						
Brazil	290	Feb 27th	Mar 17th	37.6*	22.6 - 54.4	<0.05
Asia						
China	37.251	Jan 21st	Feb 9th	19.7*	3.0 - 39.1	<0.05
Pakistan	187	Feb 27th	Mar 17th	31.9*	7.6 - 61.6	<0.05
Singapore	47	Jan 24th	Feb 12th	5.9	-0.5 - 12.8	0.1
Japan	36	Feb 25th	Mar 15th	-2.9	-8.8 - 3.4	0.3
Thailand	32	Jan 21st	Feb 9th	1.1	-7.6 - 10.5	0.8
Middle East						
Iran	8.042	Feb 20th	Mar 11th	33.4*	27.2 - 39.8	<0.05
Bahrain	211	Feb 25th	Mar 15th	3.2	-9.5 - 17.8	0.6
Iraq	93	Feb 25th	Mar 15th	1.0	-8.8 - 11.9	0.8
Kuwait	80	Feb 24th	Mar 14th	-4.4	-14.7 - 7.2	0.4
Israel	75	Feb 22th	Mar 12th	11.0*	1.4 - 21.5	<0.05
Lebanon	66	Feb 22th	Mar 12th	15.1*	5.8 - 25.1	<0.05
Africa						
Algeria	49	Feb 26th	Mar 16th	9.8*	0.3 - 20.2	<0.05

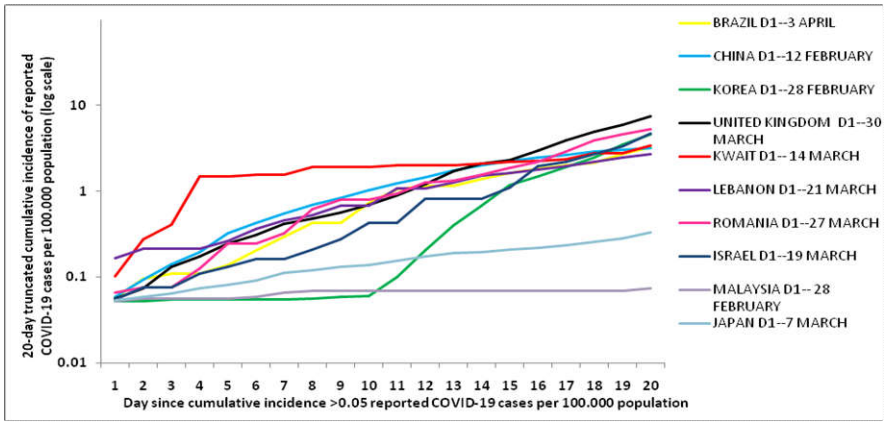

Figure 1 – Accumulated incidence of countries with less than 10 cases per 100 thousand inhabitants on the 20th day after reaching the accumulated incidence rate greater than 0.05 cases per 100 thousand inhabitants

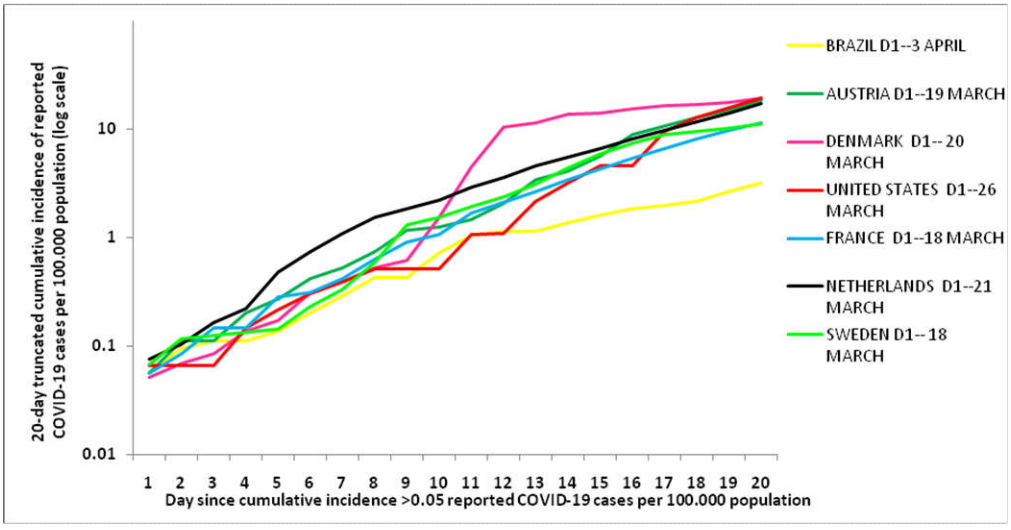

Figure 2 – Accumulated incidence in Brazil and in countries with between 10 and 20 cases per 100 thousand inhabitants on the 20th day after reaching the accumulated incidence rate greater than 0.05 cases per 100 thousand inhabitants

Table 2 – Trend analysis of COVID-19 in Brazil and in the twenty countries with high disease burden and comparison of the accumulated incidence of Brazil in relation to other countries

Country	*Trend Analysis*							Comparison Analysis				
	Time †	D1□		D20□□		ADPC¥	95% Confidence Interval	*p*	ADPC Difference¥¥	95% Confidence Interval	*p*	Parall.†	Coinc.††
		Date	Number of cases	Date	Number of cases								
China	3	Jan 24th	830	Feb 12th	44.730	23.5*	21.8; 25.2	<0.05	2.4	-1.4; 6.3	0.2	<0.05	<0.05
Korea	19	Feb 9th	27	Feb 28th	2.337	26.3*	25.0; 27.6	<0.05	-2.4	-6.1; 1.3	0.2	<0.05	<0.05
Malaysia	14	Feb 9th	17	Feb 28th	24	1.6*	1.0; 2.2	<0.05	23.0*	19.6; 26.4	<0.05	<0.05	<0.05
Japan	27	Feb 17th	68	Mar 7th	417	10.0*	8.6; 11.3	<0.05	14.0*	10.6; 17.4	<0.05	<0.05	<0.05
Italy	23	Feb 23rd	76	Mar 13th	15.113	31.5*	29.8; 33.2	<0.05	-5.7*	-9.4; -2.0	<0.05	<0.05	<0.05
Kuwait	0	Feb 24th	3	Mar 14th	100	19.5*	16.9; 22.1	<0.05	3.3	-3.1; 9.7	0.3	<0.05	<0.05
Sweden	27	Feb 28th	7	Mar 18th	1.167	29.6*	22.5; 37.2	<0.05	-5.0	-13.5; 3.6	0.3	<0.05	<0.05
Norway	1	Feb 28th	4	Mar 18th	1.308	36.2*	32.3; 40.2	<0.05	-5.1*	-9.4; -0.8	<0.05	<0.05	<0.05
France	34	Feb 28th	38	Mar 18th	7.652	31.7*	29.6; 33.9	<0.05	-6.8*	-10.7; -2.9	<0.05	<0.05	<0.05
Switzerland	2	Feb 28th	6	Mar 18th	2.650	38.7*	28.7; 49.6	<0.05	-14.2*	-20.2; -8.3	<0.05	<0.05	<0.05
Spain	27	Feb 28th	25	Mar 18th	11.178	40.1*	38.3; 41.9	<0.05	-14.7*	-18.5; 11.0	<0.05	<0.05	<0.05
Israel	7	Feb 29th	5	Mar 19th	427	26.2*	24.7; 27.7	<0.05	-3.1	-6.8; 0.6	0.1	<0.05	<0.05
Austria	3	Feb 29th	5	Mar 19th	1.646	36.4*	32.8; 40.0	<0.05	-8.7*	-12.7; -4.7	<0.05	<0.05	<0.05
Iran	10	Mar 1st	593	Mar 20th	18.407	19.7*	18.6; 20.7	<0.05	4.7*	1.2; 8.2	<0.05	<0.05	<0.05
Denmark	3	Mar 1st	3	Mar 20th	1.132	37.0*	32.6; 41.5	<0.05	-11.8*	-16.6; -7.1	<0.05	<0.05	<0.05
Lebanon	9	Mar 2nd	10	Mar 21st	163	15.5*	13.1; 18.0	<0.05	7.9*	4.3; 11.5	<0.05	<0.05	<0.05
Netherlands	3	Mar 2nd	13	Mar 21st	2.994	33.9*	32.1; 35.7	<0.05	-9.9*	-13.7; -6.0	<0.05	<0.05	<0.05
The United States	44	Mar 7th	215	Mar 26th	63.570	37.0*	34.4; 39.6	<0.05	-15.3*	-21.0; -9.7	<0.05	<0.05	<0.05
Romania	10	Mar 8th	13	Mar 27th	1.029	26.9*	24.0; 30.0	<0.05	-3.6	-9.4; 2.3	0.2	<0.05	<0.05
The United Kingdom	39	Mar 11th	371	Mar 30th	19.526	29.9*	27.8; 32.1	<0.05	-1.9	-5.3; 1.5	0.3	0.7	0.7
Brazil	17	Mar 15th	121	Apr 3rd	6.715	23.5*	21.1; 25.9	<0.05	-	-	-	-	-

†Time: number of days from the first record of the disease to D1; □D1: first day when reaching the accumulated incidence rate of 0.05 cases per 100 thousand inhabitants; □□D20: twentieth day after reaching the accumulated incidence rate of 0.05 cases per 100 thousand inhabitants; ¥ADPC**:** Average Daily

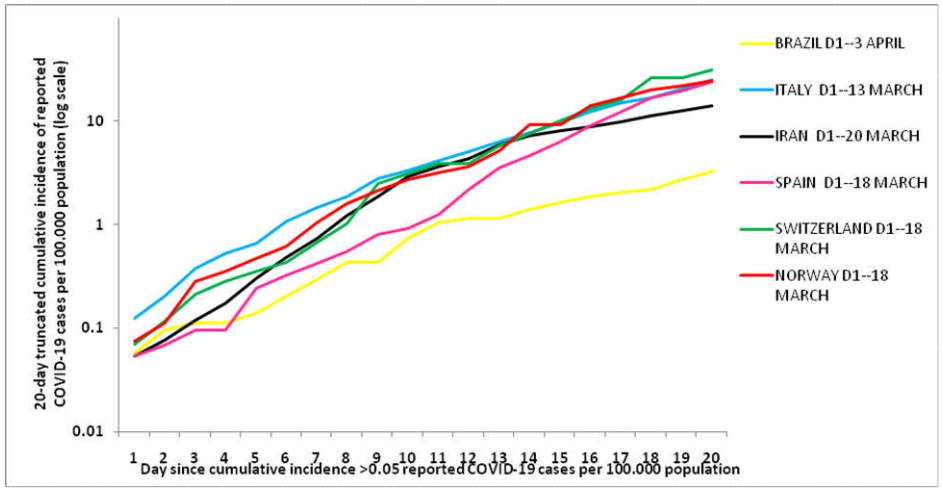

Figure 3. Accumulated incidence in Brazil and in countries with more than 20 cases per 100 thousand inhabitants on the 20th day after reaching the accumulated incidence rate greater than 0.05 cases per 100 thousand inhabitants

of the disease were registered, maintaining the routine of commerce and schools, as in the region of Lombardy, in Italy, and in the autonomous region of Madrid, in Spain. The delay in implementing the most restrictive control measures, mainly with regard to the isolation of cases and cities, identification and monitoring of contacts and implementation of health measures for travelers and border control, have made these two regions two important epicenters of the pandemic in Europe (Lima *et al*., 2020). At that time, the literature already pointed out that the most effective and efficient actions to deal with COVID-19 referred to social isolation, border control and expansion in the performance of diagnostic tests, which should be carried out together (Park *et al*., 2020; Kucharski *et al*., 2020; Colbourn, 2020; Prem *et al*., 2020). The expansion of tests for the detection of COVID-19 in these countries allowed them to know the burden of the disease on the population. However, the non-pharmacological intervention strategy was significantly important to mitigate the spread of the disease by COVID-19 in these countries, and thus, it is considered, until now, that social isolation is still the most effective method for this (Kim *et al*., 2020). The physical distance was designed to reduce the spread beyond the isolation area and also to prevent further importation of cases (Sjödin *et al*., 2020).

The knowledge about the spread of COVID-19 in different countries, having as reference the first days of the epidemic, could have served as an experience for the Brazilian health authorities, so that there was planning of actions to suppress the evolution of the disease, in an organized way. the entire national territory, in order to avoid the accelerated growth in the number of cases and consequently, avoid the collapse of the health system. According to the Center for Disease Control and Prevention (CDC) of the United States for the effectiveness of non-pharmacological interventions during the pandemic, such as social detachment, there must be acceptance and participation of the population, and for that it is extremely important that communication between the authorities of the country and the population is honest, transparent and cohesive, so that in this way there can be confidence on the part of the population, and as a result, they begin to adopt control measures to mitigate the disease (Qualls *et al*., 2017; Garcia and Duarte, 2020; Bezerra *et al*., 2020)34. History shows the dangers of relaxing restrictions too early in a pandemic.

The data for the subsequent 20 days after each country reached the accumulated incidence rate of 0.05 cases per 100 thousand inhabitants showed that the daily growth rate of COVID-19 cases in Brazil differed from most of the countries analyzed, being lower than countries with the highest burden of the disease, such as Spain, Italy, the United States and France, and similar to the United Kingdom. Possible explanations for the Brazilian profile may be based on the rapid implementation of control measures and preparedness to face the pandemic instituted by the Ministry of Health of Brazil, considering that the declaration of Public Health Emergency of National Interest was published on February 3rd, 2020 (Croda and Garcia, 2020). On the other hand, the low availability of specific diagnostic tests, particularly RT-PCR in real time, is a crucial challenge for the detection of COVID-19 (Rodriguez-Morales *et al*., 2020), and the number of cases registered in the country may be the result of the low proportion of tests carried out in the general population since the first cases arose, and even after community transmission was established. Brazil faces the shortage of kits for the detection of agents (primers, probes, control, among others), and a small number of human resources trained to carry out tests, which generates a delay in the release of results produced locally, generating not only a delay in notification, but also an overload in reference laboratories (Martins *et al*., 2020). Regarding the similarity between the growth curves of COVID-19 in the United Kingdom and Brazil, it is noteworthy that the installation of the sustained transmission in the United Kingdom took place over a longer period, from the date of the first recorded case. This fact may explain the late adoption of restrictive control measures, such as social isolation, which may have contributed to the exponential growth of cases in the subsequent period (Mahase, 2020). On the other hand, the fact that Brazil registered community transmission in a shorter period stimulated the adoption of measures restricting the circulation of people since the first reported cases in the country. The adoption of these measures by the federal units may have been responsible for minimizing the impact of the disease in a preliminary scenario. Currently, Brazil is in the phase of suppression of the disease, in which more radical measures of social detachment have been implemented, for the entire population, with the aim of postponing as much as possible the explosion in the number of cases, long enough until the situation stabilizes. in the field of health care, testing procedures can be expanded and, eventually, some new effective therapeutic or preventive tool (eg. vaccine) is available (Werneck and Carvalho, 2020).

In this context, the actions of the Unified Health System (SUS) and the other areas of the social protection system are essential in an articulated way, in order to favor people to adherence to non-pharmacological interventions and minimize the harmful impacts of community measures. The protection of public health must be monitored by the decisions taken by managers. It is essential that these decisions are based on the best available evidence and communicated in a transparent manner, in order to promote public confidence. The guidelines of the authorities and people's adherence to non-pharmacological interventions will be decisive for the course of the COVID-19 epidemic in Brazil (Garcia and Duarte, 2020). The knowledge about the behavior of the spread of the disease in Brazil in relation to other countries, taking as a reference the scenario of sustained transmission of the pandemic, proved to be an extremely relevant tool for the evaluation of the actions already implemented, as well as for the planning of actions that seek to suppress the evolution of the disease.

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