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Historical data series of COVID-19 in different countries

Série histórica da COVID-19 em diferentes países

Serie de datos históricos de COVID-19 en diferentes países

Nathália Lima Pedrosa, Nila Larisse Silva de Albuquerque

ABSTRACT

Objective: to examine cumulative cases of COVID-19 in Brazil, Spain, Italy, China, and USA. **Method**: in this ecological study, secondary data were used to produce time series of cumulative cases of COVID-19 over 28 days after the 100th case confirmed in each country (from Worldometer 2020 statistics). Linear, exponential, potential and logarithmic trend models were tested, and the best coefficient of determination (R^2) was chosen. In Brazil, the trend line was segmented into days 1-14 and 15-28. **Results:** on day 100, the USA had the highest number of cases and Brazil, the lowest. The trend lines were mostly exponential, with highest growth rate in the USA. In Brazil, the growth trend was slower in the second period. **Conclusion:** the calculated trend lines showed a worse prognosis for the USA. In Brazil, the cumulative number of cases grew more slowly in the second period of the study.

Descriptors: Coronavirus Infections. Pandemics. Epidemiology.

RESUMO

Objetivo: analisar casos acumulados da COVID-19 em Brasil, Espanha, Itália, China e EUA. **Métodos:** estudo ecológico, com uso de dados secundários. Realizou-se série temporal de casos cumulativos de COVID-19 por 28 dias, após o 100º caso confirmado de cada país (baseado nas estatísticas do *Worldometer* 2020). Modelos de tendência linear, exponencial, potencial e logaritmo foram testados, sendo escolhido o melhor coeficiente de determinação (R^2). No Brasil, a linha de tendência foi segmentada em 1º-14º dia e 15º-28º dia. **Resultados:** no 100º dia, os EUA possuíam maior número de casos e o Brasil, o menor. Houve linha de tendência em sua maioria exponencial, com maior velocidade de crescimento nos EUA. No Brasil, houve tendência de crescimento mais lento no segundo período. Conclusão: as linhas de tendência calculadas demonstraram pior prognóstico para os EUA. No Brasil, o crescimento do número cumulativo de casos foi mais lento na no segundo período do estudo.

Descritores: Infecções por Coronavírus. Pandemias. Epidemiologia.

RESUMEN

Objetivo: examinar casos acumulados de COVID-19 en Brasil, España, Italia, China y Estados Unidos. **Método:** en este estudio ecológico, se utilizaron datos secundarios para producir series de tiempo de casos acumulados de COVID-19 durante 28 días después del 100o caso confirmado en cada país (de las estadísticas del Worldometer 2020). Se probaron modelos de tendencia lineal, exponencial, potencial y logarítmica y se eligió el mejor coeficiente de determinación (R^2). En Brasil, la línea de tendencia se segmentó en los días 1-14 y 15-28. **Resultados:** el día 100, EE.UU. tuvo el mayor número de casos y Brasil, el menor. Las líneas de tendencia fueron en su mayoría exponenciales, con la tasa de crecimiento más alta en los EE. UU. En Brasil, la tendencia de crecimiento fue más lenta en el segundo período. **Conclusión:** las líneas de tendencia calculadas mostraron un peor pronóstico para EE. UU. En Brasil, el número acumulado de casos creció más lentamente en el segundo período del estudio.

Descriptores: Infecciones por Coronavirus. Pandemias. Epidemiología.

INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which is a novel betacoronavirus, is the causative agent of the COVID-19, a respiratory disease that has now spread to every continent on the planet. The SARS-CoV-2 was first discovered in Chinese health facilities[1].

Although the presumed mortality rate of COVID-19 is approximately 3%, which is relatively low when compared to SARS (9.6%) and MERS (35%)[2], the SARSCoV-2 is highly contagious and has now infected more patients than those diseases combined[3]. It is important to highlight that the actual mortality rate of COVID-19 is still unknown, due to the limitation of testing. However, it is assumed to be lower than those detected in most countries, as in general only moderate or severe symptomatic patients have been tested.

The fact is that the recent COVID-19 pandemic is an ongoing crisis on an unprecedented scale[2]. Although the disease outbreak occurred in China, about one month later the first COVID-19 was detected on South Korea[4] and then the number of confirmed cases in the country increased rapidly [5]. Later, multiple COVID-19 cases were detected in Europe, as the first devastating effects occurred in Italy[6]. Subsequently, Spain became the other country with a major epidemic in Europe[7] and nowadays the cases are also increasing in speed in the United Kingdom[8].

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In March and April 2020, while the spread of the disease continued, China was apparently crossing the bridge and Italy, Spain, France, United Kingdom and the United States were the most affected countries[9,10]. In the same period, Brazil was in the world ranking of the top 20 countries based on the cumulative effect data from Covid-19[11].

In the United States, in April and May, New York City was the current epicenter of the disease [12-14]. In South America, Brazil has an increasing number of cases and number of deaths[15].

However, the main countries affected by the disease evolved differently, revealing the need to understand the growth of COVID-19 among them. Time-sensitive prevention and control measures depend on monitoring the epidemiological situation of COVID-19 in each country[16]. Knowing the epidemiological characteristics of SARS-CoV-19 can provide subsidies to formulate actions and generate hypotheses for future research. Analyse the difference in the growth of cases between countries allows a better understanding of the consequences of what has already been accomplished and what can be improved.

Based on that, this study aimed to analyse the cumulative cases of COVID-19 in five countries and to assess the change of the tendency line of Brazil after actions to reduce mobility.

METHOD

This is an ecological study using secondary data that analyzed the temporal series of cumulative cases of COVID-19 in Brazil, China, Italy, Spain and USA. Country selection was based on the scenario of rapid increase in cases between March and April 2020 (Spain, United States and Italy)[10-11, 16], the scenario of initial increase in cases in the same period with potential for rapid increase (Brazil)[15] and the choice of a country with deceleration of cases for comparison purposes (China)[16].

Data were obtained from the Worldometer website (www.worldometers.info), that publishes daily updates regarding COVID-19 number of confirmed cases and deaths. Worldometer is an independent provider of global statistics, with its data used in publications of books, scientific articles, or for use in research institutions. COVID-19 data is extracted from official country reports, directly from their government communication channels or from trusted local media sources[15].

Data were collected daily, in this website, of each country, by filling out an Excel spreadsheet, for the period from 18 January to 10 April 2020.

The assumption of normality was tested using the Shapiro-Wilk test. For Brazil, Spain, Italy and United States, we have analyzed the number of cumulative cases over 28 days. In this analysis, the milestone represented by the first day when each country has reported a number of cases equal or higher than 100 it was named as Day 1.

In the trend analysis per country, number of cases was considered a dependent variable and the day was considered an independent variable. In order to determine the best trend line model, it was chosen the one with the best coefficient of determination (R^2). Linear, exponential, potential and logarithmic trend models were tested. They were also verified as equations of the chosen models.

In Brazil, the trend line was segmented on the 1-14th day and on the 15-28th. On the 7th day after 100 cases, the Ministry of Health recognized the transmission of COVID-19 as community wide across the country, being a strategic measure to help implement non-pharmacological measures, including physical distance and quarantine, even though it has not been implemented homogeneously across the country[17]. Some actions were also carried out in some states of Brazil in the same period, (São Paulo, Rio de Janeiro and the Federal District, for example) such as closing shops, bars, restaurants, cinemas and schools[18] . For this study, we considered as an assumption that measures of social distancing (although heterogeneous in the country) have an effect on the number of new COVID-19 cases after seven days, what is supported by the mean incubation period of the disease[19]. Trend models were tested and the model with the highest determination coefficient (R^2) was chosen. Microsoft Excel and R software were used in the analysis.

This study respected all the policies of research involving human. As the data source was a domain, it was not necessary to submit the study for an Ethic Committee review.

RESULTS

The day 1 (first day identified 100 or most cases) for Brazil, Italy, Spain, China and USA were, respectively, 03-14-20, 02-23-20, 03-02-30, 01-18-20 and 03-04-20. In the day 28 (day 28th after 100 or more cases), the number of cases of each country was 19,638, 53,578, 80,110, 49,970 and 186,979 cases, respectively.

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The Shapiro-Wilk test showed non-normal data. The cumulative growth curve of COVID-19 cases in countries is shown below (Figure 1). For the 28st day of epidemic after 100 cases, the USA was the country with the largest number of cases and Brazil, the smallest. For four countries, the exponential model was the one that best explained the cumulative increase in cases over 28 days (except China, with potential trend line). When analyzing the trend lines of cumulative cases, USA has a worse predict trend line for the accelerated increase in the number of cases detected over the days, followed by Spain and Italy.

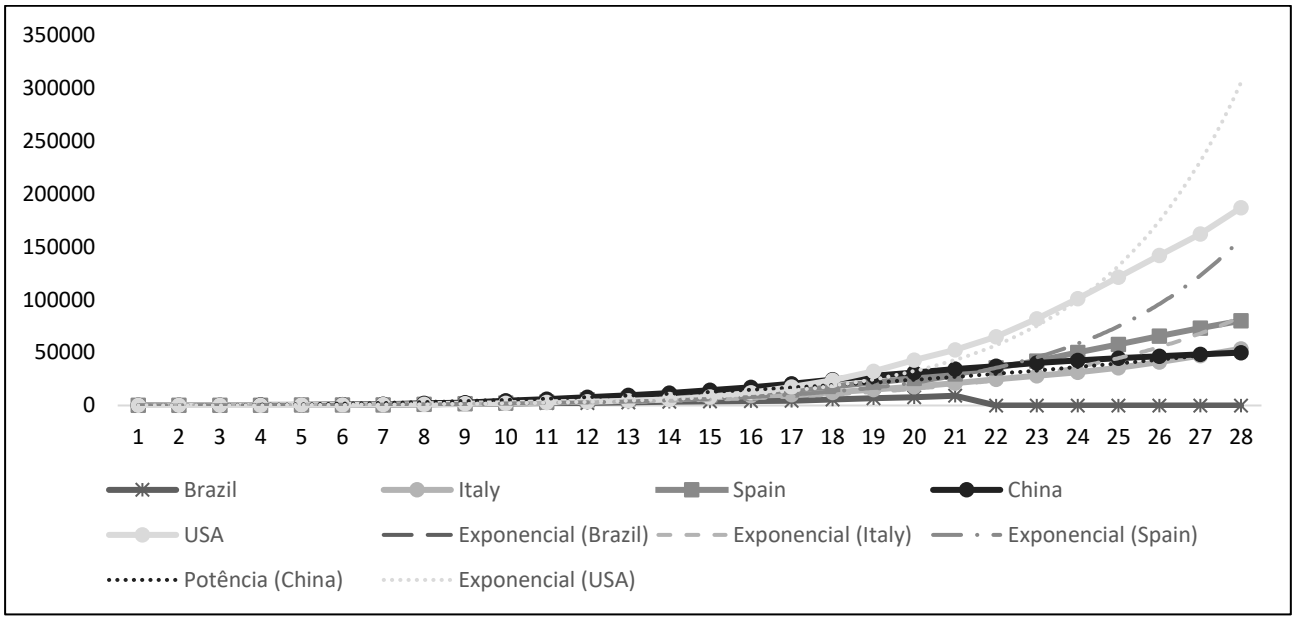

FIGURE 1 Historical series of COVID-19 cases by country (Brazil, Italy, Spain, China and USA), 2020.
Fonte: Worldometers (2020).

The proportion of variability of the dependent variable (number of cases) that can be explained by the variability of the independent variable (consecutive day), defined by the R^2, was high in the exponential model for four countries, except China (potencial trend line) with different growth rates between countries (Table 1). While the Italy has a high rate of growth of cases (explained by the number of index greater than others), followed by Brazil, China there is a lower rate of growth (lower index in the equation).

TABLE 1: Trend line type, model and determinant coefficient (R^2) of tendency line of cumulative cases of COVID-19 in Brazil, Italy Spain, China, USA), 2020.

Country	Trend Line	Equation	R^2
Brazil	Exponencial	$213{,}43e^{0{,}18x}$	0,95
China	Potencial	$32{,}58x^{2{,}2}$	0,96
Italy	Exponencial	$240{,}83e^{0{,}21x}$	0,98
Spain	Exponencial	$151{,}63e^{0{,}25x}$	0,97
USA	Exponencial	$120{,}8e^{0{,}28x}$	0,99

When the number of cumulative cases in Brazil is analyzed in the first 14 days and after (Figure 2), both time intervals present a better prediction with an exponential trend line, with high values of determination coefficient (R^2 = 0.97 in 1-14th days; R^2 = 0.99 in the 15-28th days). It can be seen that there is a difference in the predictive equation for both periods. In the first, the trend curve is more pronounced in its speed of growth, reaching 100,000 cases accumulated around the 25th day, in case there are no changes. In the analysis from the 15th to the 28th day, there is a deceleration of the curve compared to the previous one; the forecast of reaching 100,000 cases will occur in approximately 40 days if there are no factors that change this curve.

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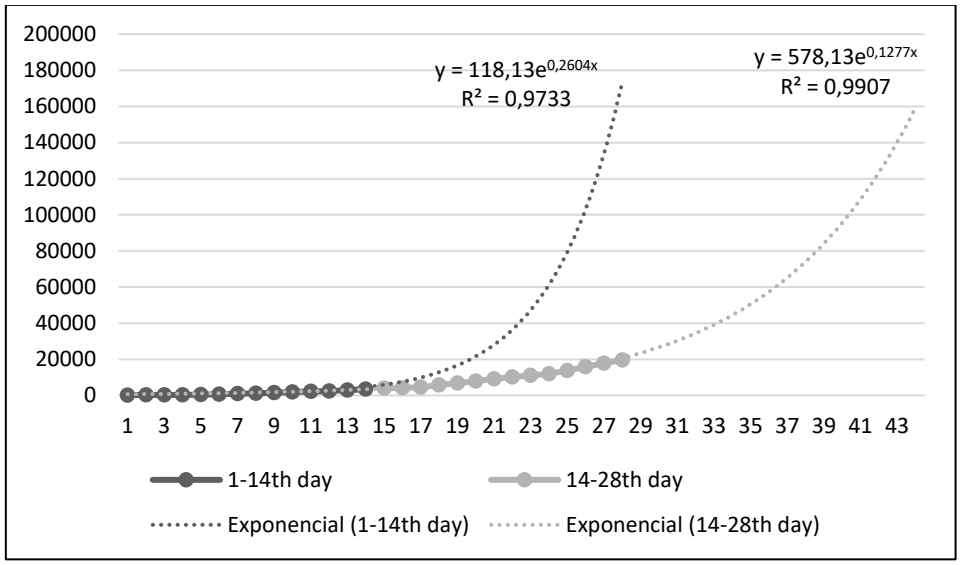

FIGURE 2: Historical series of COVID-19 cases in Brazil after detected 100 cases, 2020.
Fonte: Worldometers (2020).

DISCUSSION

This study showed the difference in the accumulation of cases detected with COVID-19 in five countries, with a trend line mostly exponential, with a worse prognosis for the USA, Spain and Italy, and a less accelerated growth in Brazil. Still, considering this country in the first 14 days after the 100th case and from the 15th to the 28th day, there is a trend line with a slower growth curve in the second period.

It's recommended that extension actions should be taken by health authorities in order to reduce the transmission of COVID-19 from person to person to control pandemic status[20].

The USA, in the study, was the country that showed acceleration of the cumulative cases over the days. Until 04-12-20, this country had more than 525,000 confirmed cases and more than 20,400 deaths, with the highest concentration in New York (157,000 cases). In this city, the epidemic has been marked by hospitalized for COVID-19 associated with a high frequency of mechanical ventilation, extrapulmonary dysfunctions and important hospital mortality[12, 14, 21].

Spain's exponential prediction model presented the second country with the highest rate of increase in cases in this study. On March 17, Spain had more than 11,000 cases and 491 deaths, being one of the biggest burdens of coronavirus disease in the world, which caused a weakness in the Spanish health system, with an inability to meet the growing demand. Additional financial investments are necessary to face this health crisis, since there has been an underinvestment in health since the 2008 crisis. It is also necessary to use behavioral sciences to maintain individual isolation behaviors for a longer time. In addition, coordination between national and local governments must exist for the health benefit of the population, rather than exploring the situation for political gains[22].

In a study, it's observed that from January to March the number of people detected with COVID-19 was similar in Italy and China (85,000 Italy vs. 80,000 China). However, mortality in Italy was higher[22-23]. However, when we observe the evolution of cumulative cases in both countries from the 100th case, the rate of growth in the number of cases is greater in Italy, which may suggest a faster overload of the health system in this country. Italy was the third, among the countries studied, that trend line with the highest acceleration of cases. In Europe, the European Center for Disease Prevention and Control (ECDC) made several recommendations to the Italian authorities in combating the spread of COVID-19. Thus, Italy blocked its northern Lombardy region (several clusters of cases of the disease) on March 8, 2020, with the extension of the block to the whole of the country the following day10. In our study, this date corresponds to 14-15 days after the 100th recorded case.

China, in turn, had the epicenter of the pandemic in the city of Wuhan, and on January 23, 2020 this region was quarantined, followed by a sanitary cord in Hubei province, in addition to a subsequent national blockade[24]. The

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quarantine in Wuhan occurred 6 days after the 100th case detected in China. However, speculation as to which factor alone may explain the non-exponential trend in the growth of cases requires investigation with rigorous methods.

Brazil, in this study, presented a predictive trend line with less accelerated growth than the other countries, in addition to a more pronounced deceleration after the 14th day of data monitoring. The country presented its first cases later than the others analyzed. Some measures, therefore, could be implemented earlier, such as adjusting the legal structure to perform isolation and quarantine[17].

WHO has presented guidelines that guide the provision of information to health professionals and the general population. It is necessary to give urgent importance to the actions of surveillance, optimization and acquisition of resources, in addition to professional training, especially in countries with moderate risk that may be poorly prepared[24]. Public health authorities should continue to monitor the situation closely, facilitating deeper learning about this new virus and the associated pandemic, and can find better strategies for responding to the spread of SARS-CoV-2[26].

This study has some limitations. Using secondary data can subnotificate cases. However, almost all countries COVID-19 testing capacity is low, with laboratory testing limited to acute respiratory syndrome and coming from regions or countries with many cases reported[27]. As isolation measures in Brazil were heterogeneous within the country, it was not possible to verify the impact of the measures by region. However, it is believed that the measures that have been installed have already served to cause an overall impact on the number of cases.

CONCLUSION

This study allowed a graphical visualization of the situation of cumulative cases in a similar parallel context (from the day of the hundredth case) of different countries and that they have an increase in speed. There is a difference in the speed of growth of the cases (demonstrated by the equation models), suggesting studies that investigate possible casualties through the heterogeneity of the speed of growth of the numbers of cases (quarantine measures, lockdown cities, availability of tests, among others).

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