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Research letter

COVID-19 epidemic in Brazil: Where are we at?

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A B S T R A C T

Objective: To analyze the trends of COVID-19 in Brazil in 2020 by Federal Units (FU).

Method: Ecological time-series based on cumulative confirmed cases of COVID-19 from March 11 to May 12. Joinpoint regression models were applied to identify points of inflection in COVID-19 trends, considering the days since the 50th confirmed case as time unit.

Results: Brazil reached its 50th confirmed case of COVID-19 in 11 March 2020 and, 63 days after that, on May 12, 177,589 cases had been confirmed. The trends for all regions and FU are upward. In the last segment, from the 31st to the 63rd day, Brazil presented a daily percentage change (DPC) of 7.3% (95%CI: 7.2;7.5). For the country the average daily percentage change (ADPC) was 14.2% (95%CI: 13.8;14.5). The highest ADPC values were found in the North, Northeast and Southeast regions.

Conclusions: In summary, our results show that all FUs in Brazil present upward trends of COVID-19. In some FUs, the slowdown in DPC in the last segment must be considered with caution. Each FU is at a different stage of the pandemic and, therefore, non-pharmacological measures should be adopted accordingly.

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Introduction: Brazil was the first South American country to report a confirmed case of Coronavirus Disease 2019 (COVID-19), on February 26, 2020, in São Paulo state [1]. Since then, the country has presented a complex epidemiological scenario, with marked regional differences. Here, we aimed to analyze the trends of COVID-19 in Brazil in 2020 by Federal Units (FU).

Methods: We carried out an ecological time-series study based on cumulative confirmed cases of COVID-19 from March 11 to May 12. We used official data available at the Brazilian Ministry of Health webpage ([https://covid.saude.gov.br/](https://covid.saude.gov.br/)). Joinpoint regression models were applied to identify points of inflection in COVID-19 trends, considering the days since the 50th confirmed case as time unit. The magnitude of change in the number of cumulative cases in each segment (period between two inflections) was estimated through the daily percentage change (DPC), with a 95% confidence interval (95%CI). The number of segments was chosen according to the best fit indicated by the algorithm. The average daily percentage change (ADPC) represents the percentage change for the whole period. The analyses were performed using the National Cancer Institute’s Joinpoint software [2], assuming a 5% significance level.

Results: On March 11, Brazil reached its 50th confirmed case of COVID-19 and, 63 days after that, on May 12, 177,589 cases had been confirmed (28.9% in São Paulo state). We observed upward trends for all regions and FUs (Table 1). In the last segment, from the 31st to the 63rd day, Brazil presented a DPC of 7.3% (95%CI = 7.2;7.5) (Table 2).

At region level, the highest ADPC values were found in the North, Northeast and Southeast regions, São Paulo presented the greatest increase at the beginning of the epidemic (segment 1: DPC = 51.8%; 95%CI = 30.7;76.2). In the last segment, São Paulo had a DPC of 6.1% (95%CI = 5.8;6.3), with a 6-fold increase in 32 days. As São Paulo, Amazonas, Pernambuco, Ceará, and Rio de Janeiro at a more advanced stage of the epidemic (around 45-50 days after the 50th case), compared other states, such as Rondônia, Sergipe and Tocantins. Some FUs, such as Pará, Pernambuco, São Paulo, Paraná,
### Table 1

Joinpoint analysis for accumulated cases of COVID-19 in Brazil by day, 2020

| Federative Units | Segment 1 | Segment 2 | Segment 3 | Segment 4 | Segment 5 | Segment 6 | ADPC % (95% CI) |
|------------------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| AR-D | DPC % (95% CI) | AR-D | DPC % (95% CI) | AR-D | DPC % (95% CI) | AR-D | DPC % (95% CI) | AR-D | DPC % (95% CI) |
| **Brazil** | 1-12 | 36.4*(35.3;37.5) | 12-24 | 15.6*(14.6;16.5) | 24-31 | 12.0*(9.7;14.3) | 31-63 | 7.3*(7.2;7.5) | ... | 14.2*(13.8;14.5) |
| **North** | 1-3 | 31.7*(25.3;40.0) | 3-7 | 20.9*(17.1;24.9) | 7-12 | 14.3*(12.0;16.6) | 12-18 | 21.8*(20.1;23.6) | 18-48 | 10.1*(10.0;10.2) | 48-51 | 5.8*(2.5;9.3) |
| **Amazonas** | 1-5 | 26.7*(22.8;30.7) | 5-10 | 13.6*(10.1;17.1) | 10-15 | 25.8*(20.0;29.8) | 15-23 | 9.9*(8.4;11.3) | 23-26 | 5.2 (-4.6;16) | 26-49 | 9.1*(8.9;9.3) |
| **Rocaina** | 1-11 | 15.4*(14.1;16.7) | 11-20 | 7.9*(6.3;8.6) | 20-30 | 10.3*(8.8;11.7) | 30-34 | 3.9 (-6.6;8.6) | ... | ... | ... | 10.3*(9.4;11.2) |
| **Amapá** | 1-7 | 19.0*(17.1;21.0) | 7-15 | 5.6*(4.2;7.0) | 15-19 | 13.1*(7.7;18.7) | 19-25 | 7.6*(5.2;9.9) | 25-28 | 17.0*(6.2;29.0) | 28-35 | 5.6*(4.3;7.0) |
| **Pará** | 1-5 | 27.2*(21.4;33.3) | 5-8 | 7.6 *(7-22.48) | 8-21 | 17.1*(16.1;18.1) | 21-40 | 10.4*(9;10.9) | ... | ... | ... | 14.0*(12.6;15.4) |
| **Tocantins** | 1-9 | 22.2*(20.2;24.4) | 9-18 | 15.4*(13.7;17.1) | ... | ... | ... | ... | ... | ... | ... | 18.0*(17.4;19.8) |
| **Acre** | 1-3 | 8.5*(14.1;16.1) | 3-8 | 21.0*(18.5;23.7) | 8-13 | 13.5*(11;16.0) | 13-16 | 6.9*(1.1;14.4) | 16-25 | 11.6*(10.8;12.4) | 25-29 | 4.7*(2.5;7.0) |
| **Northeast** | 1-3 | 9.0*(8;10.0) | 10-16 | 11.5*(9.1;13.9) | 16-23 | 6.4*(4.6;8.1) | 23-28 | 16.2*(12.7;19.8) | 28-34 | 12.7*(10.3;15.2) | 34-37 | 6.0*(9.9;11.3) |
| **Maranhão** | 1-5 | 34.2*(31.2;37.3) | 5-22 | 14.8*(14.5;15.1) | 22-38 | 10.8*(10.5;11.2) | 38-55 | 8.0*(7.7;8.2) | ... | ... | ... | 12.7*(12.5;13.0) |
| **Paráiba** | 1-6 | 18.1*(14.8;21.4) | 6-14 | 10.3*(8.5;12.2) | 14-24 | 13.0*(11.7;14.3) | 24-34 | 10.7*(9.6;11.8) | ... | ... | ... | 12.4*(11.6;12.3) |
| **Sergipe** | 1-11 | 12.7*(11.1;13.4) | 11-14 | 31.7*(9.79;57.8) | 14-23 | 15.1*(12.8;17.4) | 23-26 | 7.9*(-1.5;13.1) | ... | ... | ... | 15.1*(12.4;17.9) |
| **Alagoas** | 1-19 | 19.2*(18.6;19.8) | 19-30 | 6.4*(5.3;7.4) | ... | ... | ... | ... | ... | ... | ... | 14.2*(13.6;14.7) |
| **Bahia** | 1-9 | 15.9*(14.9;16.8) | 9-15 | 13.1*(11.2;15.0) | 15-23 | 7.5*(65.86) | 23-32 | 9.9*(9.0;10.8) | 32-51 | 6.7*(6.5;7.0) | ... | 9.6*(9.3;10.0) |
| **Southeast** | 1-3 | 31.0*(29.6;32.4) | 12-19 | 12.6*(9.7;15.7) | 19-22 | 23.4*(5.5;44.4) | 22-31 | 10.8*(9.0;12.7) | 31-62 | 6.0*(6.0;6.4) | 62-66 | 7.5*(6.4;8.6) |
| **Río de Janeiro** | 1-6 | 36.5*(33.2;39.8) | 6-25 | 12.5*(12.1;12.8) | 25-35 | 0.4*(2.0;6.5) | ... | ... | ... | ... | ... | 11.0*(10.7;11.3) |
| **Espírito Santo** | 1-7 | 17.3*(15.7;18.9) | 7-18 | 12.1*(11.4;12.8) | 18-22 | 20.7*(16.0;25.6) | 22-32 | 6.4*(5.6;7.2) | 32-35 | 13.1* (12.4;25.5) | 35-46 | 5.9*(5.4;6.5) |
| **Minas Gerais** | 1-16 | 12.3*(11.7;13.0) | 16-52 | 5.2*(5.0;5.3) | ... | ... | ... | ... | ... | ... | ... | 10.7*(10.0;10.5) |
| **Goiás** | 1-5 | 5.7*(2.4;9.0) | 5-13 | 12.5*(10.0;14.0) | 13-22 | 8.8*(7.6;10.0) | 22-28 | 4.0*(1.7;6.3) | 28-34 | 6.8*(6.5;7.2) | ... | 6.9*(6.7;7.2) |
| **Distrito Federal** | 1-9 | 14.8*(13.9;15.7) | 9-16 | 7.6*(6.2;8.9) | 16-39 | 4.2*(4.0;4.4) | 39-54 | 6.8*(6.5;7.2) | ... | ... | ... | 6.9*(6.7;7.2) |

AR-D: applicable range (day); DPC: daily percent change and AAPC: average daily percent change. *p < 0.05.
and Goiás showed a reduction in DPC in last segment in comparison with the previous one (Table 1).

**Discussion:** Although all FUs presented upward trends in the number of cumulative cases of COVID-19, 18 out of 27 FUs showed a reduction in the pace of the trend in the last segment. This may be related to the non-pharmacological measures adopted [3,4]. Despite the recent slowdown, 25 FUs still present significant upward trends. Some of them, such as Amazonas, Rio Grande do Sul, Mato Grosso, Mato Grosso do Sul and Distrito Federal even showed an increase in the DPC in the last segment. We highlight that the FUs are at different stages of the epidemic, which can also explain those differences.

Even though the FUs from the Southeast region presented most of the confirmed cases, the highest ADPC values were found in the Northeast and North regions. This is particularly troublesome because these regions present the lowest human development indices, and the highest proportion of poverty and low education rates in Brazil [5].

Some factors may have affected the infections of the curves, such as the availability of diagnostic tests and the sensitivity of the epidemiological and laboratory surveillance system [4,6]. As we used publicly available data, analyses were performed using the notification date rather than the symptoms onset date, as well as the cumulative cases instead of incident cases.

In future analyzes, other information will be added to investigate the infections in the curve of a given territory, such as the validity of municipal or state decrees (lockdown and other restrictive measures), the proportion of population isolation per day and the number of tests performed.

In summary, our results show that all FUs in Brazil present upward trends of COVID-19. In some FUs, the slowdown in DPC in the last segment must be considered carefully. Each FU is at a different stage of the pandemic and, therefore, non-pharmacological measures must be applied accordingly.

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