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Exploring the correlation between votes for Bolsonaro and deaths by Covid-19 in Brazil, 2018-2022

Explorando a correlação entre votos em Bolsonaro e mortes por Covid-19 no Brasil, 2018-2022

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Abstract: The article describes the following aspects regarding the pandemic of Covid-19 in Brazil: 1. the positive statistical correlation between votes for Bolsonaro in the 2018's presidential elections and deaths caused by Covid-19, at the descriptive level of federal units; 2. the uncorrelated relation between votes for Bolsonaro and the popular adhesion to the vaccination campaign after June 2021; 3. the drop in death rates after June 2021 and the persistence of the correlation between proportional deaths and votes after it. Considering this empirical analysis, we suggest some paths for future historical and sociological research on the causal mechanisms for this apparent association.
Keywords: Covid-19; pandemic; elections of 2018 in Brazil; vaccination in Brazil; politics of pandemic in Brazil; social development in Brazil.

Resumo: O artigo descreve os seguintes aspectos referentes à pandemia de Covid-19 no Brasil: 1. a correlação estatística positiva entre votos para Bolsonaro nas eleições presidenciais de 2018 e mortes causadas por Covid-19, em nível descritivo das unidades federativas; 2. a inexistência de correlação entre os votos de Bolsonaro e a adesão popular à campanha de vacinação após junho de 2021; 3. a queda das taxas de mortalidade após junho de 2021 e a persistência da correlação entre óbitos proporcionais e votos após. Considerando essa análise empírica, sugerimos alguns caminhos para futuras pesquisas históricas e sociológicas sobre os mecanismos causais dessa aparente associação.

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Palavras-chave: Covid-19; pandemia; eleições de 2018 no Brasil; vacinação no Brasil; política de pandemia no Brasil; Desenvolvimento Social no Brasil.

Introduction

The election of a politician such as Jair Bolsonaro [1] in Brazil is a result of a complex confluence of past social and economic circumstances. His alleged 'nationalism' was just a façade, giving his Americanism and his sympathy for privatizations, regardless of the national origin of the resources brought to the Brazilian economy. Bolsonaro's victory would indeed lead to many practical consequences, particularly regarding the pandemic of Covid-19. During 2019, when the virus reached Brazil, the elected president and most of the federal policies denied the importance of the disease. They attacked quarantine, preventive measures, and then vaccination, all this on non-scientific grounds. This instance was reported daily by all Brazilian and international press and media. [2]

However, and beyond the huge inaction of the federal government during the first months of the pandemics, the spread of Covid-19 forced a social reorganization on provincial and municipal levels, regarding both prevention and treatment. This was started by state and municipal governments, which feared chaos. The federal government, despite the president's official declarations, had to follow suit and prepare for vaccination measures through

[1] 'Who is the 'Trump of the Tropics?: Brazil's divisive new president, Jair Bolsonaro -in his own words', CNBC, 29 October 2018. All reports were accessed in February 2022.
[2] See for example: 'Study finds that Brazil's Jair Bolsonaro carried out an 'institutional strategy to spread the coronavirus'. El País - English, 19 January 2021. 'Covid: Bolsonaro tells Brazilians to 'stop whining' as deaths spike', *BBC,* 5 March 2021. 'YouTube pulls videos by Bolsonaro for spreading misinformation on the virus', New York Times, 22 July 2021.

the Health Ministry, although this was never publicly supported by Bolsonaro. [3] The economic recession that came with municipal and provincial decisions to implement social isolation (GDP dropping -3.29% in 2020 according to the World Bank) led to higher unemployment rates, great stress on supply chains and then inflation (10.38% in 2021, and 9.5% in 2020, according to the IBGE [IPCA - personal consumption price index] [4]). These measures were not sufficient to avoid a high rate of deaths by the disease. Brazil would be one of the most affected nations in the world in terms of fatalities by Covid-19, with an average of 298,77 deaths per 100,000 inhabitants, according to the World Health Organization (February 2022). [5]

Deaths in pandemics depend on several variables, being a multivariate phenomenon: they involve the economic resources necessary for more hospitals and medicine; the nature of public policies; climate; demography; degree of urbanization; general attitudes towards prevention, quarantine and vaccine; wealth distribution; among others. Each of these variables has its role in avoiding or fostering fatalities. Given this assumption, the way how the pandemic was faced and tackled can be largely taken as a matter of economic and social development. This article focuses on a selected group of the above-mentioned variables, in order to contribute to the discussion of why there has been so many fatalities by Covid in Brazil. We analyse the relation between votes for Bolsonaro, which are taken as a broad and approximate expression of

[3] Tumelero shows that 'the Ministry of Health (MOH) was not the main information channel for the president at the beginning of the pandemic despite its central role in the national governance structure of public health emergencies'; see Tumelero (2021).
[4] See <www.ibge.gov.br>.
[5] See <https://www.who.int>. According to this source, the level of deaths in relative terms is very unequal across the globe. The United States reached around 274 deaths per 100,000 inhabitants and Russia 232; Sweden reached the level of 158 per 100,000, while Bulgaria 492 and Romania 316. Japan had an extremely low level of 16 deaths per 100,000.

political preferences and their correlated patterns of behavior, [6] and deaths by Covid-19. In more specific terms, we aim to describe the following empirical events:

1. *the positive statistical correlation between votes for Bolsonaro and deaths by Covid-19 in Brazil;*

2. *an absent correlation between votes for Bolsonaro and vaccination levels in Brazil, and an equal drop in death rates after June 2021 for all the Brazilian states, which was induced during the immunization;*

3. the maintenance of the correlation between votes for Bolsonaro and death rates after the scaling of the vaccination campaign, this result closely resembling the former obtained correlation for the whole period of 2018-2021.

The description and interpretation of these empirical events are taken as development issues. The fact that there has been an underlying and persistent association of deaths with the more Bolsonarist states even after the vaccination campaign suggests that the association is real and deserves not only an empirical analysis but an interpretation. These causation mechanisms for the association cannot be but that manifold, relying on multivariate causes. We assume the institutionalist premise of broader and connected relations between political preferences, attitudes toward life, state policies and therefore public

[6] 'Per comportamento elettorale si intende il processo di formazione e di espressione delle preferenze individuale in ordine alle alternative politiche sottoposte al vaglio del voto' [By electoral behavior we mean the process of forming and expressing individual preferences in relation to the political alternatives submitted to the scrutiny of the vote] (FISICHELLA, 1976, p.184). In this sense, and depending on each particular case, some political alternatives may be more or less adequate to the solution of specific problems. This includes both the behavior and actions of the elected politicians as well as those of the electors, as long as they share similar perspectives on a specific subject, such as measures to manage the difficulties posed by the pandemic.

health, to suggest some future interpretative roads for the empirical correlation between deaths and votes which we found.

The pandemic in Brazil

By March 2022 there were already many works with detached investigations of the several aspects of the Covid-19 pandemic in Brazil, particularly regarding its relations with the Brazilian public health system, and the behavior of the government during the pandemic (some of them will be quoted below). There were also several newspaper reports linking votes for Bolsonaro and fatalities by Covid, but only one of them investigated the relation of votes for Bolsonaro and fatalities by Covid. By March 2022 a search on Google Scholar shown that there were about 2,730 published academic works with the words 'Covid' and 'Brazil' in their titles (irrespective of their scientific accuracy). At the same time, there were twenty-eight articles with those words plus the word 'Bolsonaro' in their titles. However, until 13 March there was no published work investigating the possible connections between fatalities by Covid-19 and votes, as well as their eventual underlying causes.

On 14 March 2022 the present article was uploaded on Research Gate as a pre-print study; on this very day the article 'Involvement of political and socio-economic factors in the spatial and temporal dynamics of COVID-19 outcomes in Brazil: A population-based study', written by Xavier *et al.*, had been independently published by *The Lancet* (Xavier *et al.* 2022). This article, written by eight Brazilian researchers, presented a complex analysis by which a 'regression tree with conditional inference was built to classify the outcome

variable according to the different levels of response [of deaths by Covid] of the contextual variables, and thus verify the effect of these contextual variables on COVID-19 death rates in Brazilian municipalities'. It concluded that:

> '[in] general, vulnerabilities related to income inequalities and health infrastructure shaped the dynamics of the first wave of COVID-19 in Brazil the most. Meanwhile, the second wave of COVID-19 was explicitly shaped by the partisan choice of municipalities. That is, municipalities that chose Bolsonaro as the country's president showed intensified COVID-19 mortality rates in the second wave' (XAVIER et al. p.14).

The independent publication of both studies on the same day was a curious coincidence; this, however, reinforced the suggestion of an association between votes and deaths by Covid in Brazil. The conclusions of both works were similar, as both stressed the possible association between votes for Bolsonaro and deaths by Covid-19 in Brazil. However, the methods were different, as well the specific conclusions. While the association between votes and deaths was found to exist in both works, we found that it existed throughout the whole period, and not only during the so-called 'second wave'. At the same time, we focused on the association between deaths and votes, and not on all factors that may explain the multivariate causes for death by Covid, suggesting the sociological underlying causes for the apparent association, which the mentioned article only briefly discussed (in the form of 'denialism', 'ideology', 'lack of integrated policies and national unity' and 'misinformation'). Considering this, the present paper can be partially considered as a reinforcement of the conclusions Xavier *et al.* 2022; however, by highlighting the permanent association between votes and deaths throughout the whole period, and also by suggesting some more specific roads for interpreting the

apparent association between votes and deaths, our article can help to improve the interpretation of the results achieved by the other paper as regards the underlying causes of the association between deaths and votes.

In any case, the conclusions reached by both articles are not surprising. Elected president of Brazil, Jair Bolsonaro (October 2018), disregarded the importance of Covid-19 since its beginning. The disease was publicly taken by him as an irrelevant phenomenon (as a 'little flu' [7]), with the federal government trying to dismiss any alarm. The causes for this stance, and its temporary acceptance by a part of the population, were manifold. They were partially rooted in the previously prevailing attitudes toward life in Brazil, such as superstitious interpretations of religion or disrespect for law, such as avoiding quarantine. At the same time, this had to do with the nature of the several Brazilian institutions which had *allowed* for the election of a politician such as Bolsonaro. [8] Additionally, the elected president and its team probably foresaw the negative economic and political consequences of the quarantine that was already being implemented in other nations during the first half of 2020. In this case, it seemed easier to declare that nothing serious would happen, so as to avoid not only quarantine, but a sudden rise of the uncertainty regarding the

[7] 'Bolsonaro calls coronavirus a 'little flu'. Inside Brazil's hospitals, doctors know the horrifying reality', CNN, 25 May 2020.
[8] Bolsonaro publicly declared that 'Pinochet should have killed more people' and similar sentences; see Carvalho (2018).

business affairs of the nation. [9] The president railed even against basic preventive measures such as the use of masks. [10]

During pandemics, people can obviously adopt all types of preventive measures and still get sick, and eventually die. In this case, other variables would be operating, in a complex scenario where reasons for the spread of the disease and eventually deaths are all but simple. The pandemic was accompanied by economic recession, unemployment, labour insecurity and increasing mental illness. [11] The public and the private health system became overburdened. [12] All these variables worked together to cause a higher number of fatalities. Given the complexity of this *multivariate* scenario, scientific analysis should, or could, operate both on general and specific levels, to detach - or not- statistical correlations between variables that help us to search for specific causes not only for the spread of the disease, but also for the absolute and relative amounts of infected and deaths.

In the case of Brazil, were political preferences, expressed here as votes for Bolsonaro, more positively correlated with deaths by Covid-19 in Brazil? If so, why? The first part of our article focused on the empirical analysis of the first question; the second part of the article aimed to suggest specific roads for its interpretation by future social research, going beyond the suggestions made by

[9] The opposite perspective of the Argentinean administration, with its strong measures for a forced quarantine, although avoiding an higher death rate, led to a huge economic downturn: Argentine reached an average of 125 deaths per 100,000 inhabitants from January 2020 to February 2022, but its GDP dropped 9.8% in 2021 (according to the World Health Organization and the World Bank, respectively). It is difficult to estimate which policies had the worst social costs, but Argentina and Brazil can be usefully compared as two cases of opposite extremes when coping with the pandemic.
[10] 'Bolsonaro Rails at Masks as Brazil's Covid Deaths Surge', New York Times, 10 October 2021.
[11] For mental health and Covid in Brazil, see Goularte et al. (2021).
[12] For a discussion of the health system during the pandemic see Cotrim et al. (2020).

Xavier *et al.* (2022). A general guidelines for a research program is delineated, although not implemented by obvious reasons of lack of space.

Empirical analysis

Votes and deaths

The dataset employed in this study is based on three official sources covering the pandemic estimates to each of the federal units of Brazil (states). Population figures are furnished by the IBGE (Brazilian Institute for Geographic and Statistics; see IBGE, 2021). The electoral results were compiled directly from the official archives extracted from the 'electronic ballot' bulletins maintained by the Brazilian Supreme Electoral Court (Tribunal Superior Eleitoral). These were summed from the municipal up to the state level (see TSE [2018]). The official dataset of Covid-19 pandemic is based on data furnished by the Ministry of Health, which is updated, maintained, and validated by academic institutions and the scientific community (see UFV [2022]). [13] The compiled data from these sources, related to the second round of the 2018's elections, is presented in Table 1. To avoid population-size biases the data employed in our analysis was normalized by each state population.

[13] Carvalho et al. (2021) argue that up to October 2020 '[a] total of 118,406 unexpected deaths by natural causes was observed during the COVID-19 pandemic'. Similar studies on under-reporting can be found in other scientific journals. We do not consider underreporting, assuming official numbers with respect to fatalities.

Table 1: Data collected to each of the 27 Brazilian federative units to: *) Demographics (2021) (IBGE 2021); **) Presidential elections in the second round (TSE 2018); ***) Covid-19 Brazil dataset (UFV 2022). All figures are based on data aggregated at the level of federative units. **Sources**: IBGE, 2021; TSE, 2018 and UFV, 2022.

State	Population*	Bolsonaro**		Haddad**		Covid 19***	
		Votes	Votes / 1k inhab.	Votes	Votes / 1k inhab.	Deaths	Deaths / 100k inhab.
AC	906876	294899	325.2	86977	95.9	1914	211.1
AL	3365351	610093	181.3	912034	271.0	6509	193.4
AM	4269995	885401	207.4	875845	205.1	14059	329.3
AP	877613	185096	210.9	183616	209.2	2076	236.6
BA	14985284	2060382	137.5	5484901	366.0	28448	189.8
CE	9240580	1384591	149.8	3407526	368.8	25726	278.4
DF	3094325	1080411	349.2	463340	149.7	11280	364.5
ES	4108508	1276611	310.7	747768	182.0	13820	336.4
GO	7206589	2124739	294.8	1118060	155.1	25315	351.3
MA	7153262	886565	123.9	2428913	339.6	10588	148.0
MG	21411923	6100107	284.9	4382952	204.7	58346	272.5
MS	2839188	872049	307.1	465025	163.8	10071	354.7
MT	3567234	1085824	304.4	549001	153.9	14511	406.8
PA	8777124	1742188	198.5	2112769	240.7	17534	199.8
PB	4059905	782143	192.7	1451293	357.5	9914	244.2
PE	9674793	1661163	171.7	3297944	340.9	20808	215.1
PI	3289290	422095	128.3	1417113	430.8	7526	228.8
PR	11597484	4224416	364.3	1948790	168.0	41685	359.4
RJ	17463349	5669059	324.6	2673386	153.1	70668	404.7
RN	3560903	652562	183.3	1131027	317.6	7873	221.1
RO	1815278	594968	327.8	229343	126.3	6896	379.9
RR	652713	183268	280.8	72872	111.6	2112	323.6
RS	11466630	3893737	339.6	2263171	197.4	37479	326.9
SC	7338473	2966242	404.2	940724	128.2	20954	285.5
SE	2338474	364860	156.0	759061	324.6	6160	263.4
SP	46649132	15306023	328.1	7212132	154.6	161156	345.5
TO	1607363	356684	221.9	371593	231.2	4039	251.3

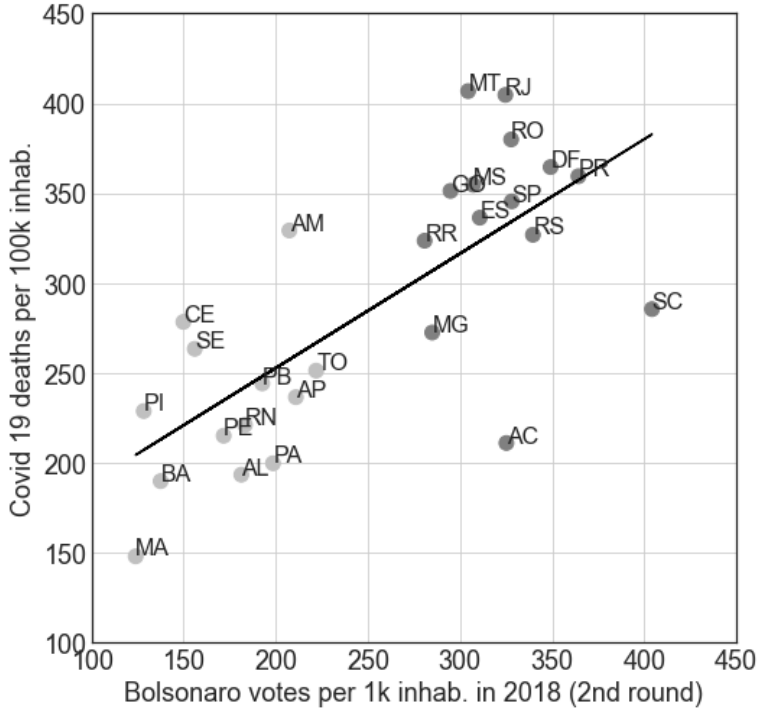
The making of the data set and the analysis were implemented computationally in current Python language and can be furnished by the authors to all interested parties. Results were also checked by means of the Eviews software.

Roughly 50% of the Brazilian population is composed of citizens who effectively vote. Therefore, the typical scale of votes relative to the population at each state is expected to be around 500 votes per 1 thousand inhabitants. If we consider the margin of 10% of non-valid votes, this implies that 450 votes per 1 thousand inhabitants (denoted 1k from now on) means an extremely high political adherence to a candidate. Therefore, this number sets the scale of our graphics. Covid death rates over all the pandemic until February 2022 in the Brazilian federative entities (states) reached values up to 400 deaths per 100k inhabitants, one of the largest in the world, and 2.35 times higher than the world average of 170 deaths per 100k (it also sets a scale mark). [14]

Bolsonaro and Haddad's votes per 100k inhabitants are, as expected, negatively correlated and therefore our analysis will be concentrated only in those votes given for Bolsonaro. Figure 1 plots the linear monotonic trend for deaths per 100k inhabitants and votes per 1k inhabitants to each of the Brazilian federative units, at the second round of the 2018 presidential elections. The result was also compared with a linear regression analysis estimated by means of the software Eviews. The obtained statistical tests and validation are discussed below. A summary is presented in Table 2.

[14] For deaths across the globe, see <www.who.int>.

Figure 1: Correlation analysis and linear trend for deaths per 100k inhabitants and votes per 1k inhabitants to each of the 27 Brazilian federative units at the second round of the 2018 presidential elections.



Sources: IBGE, 2021; TSE, 2018 and UFV, 2022.

Figure 1 shows a positive correlation between (1) votes for Bolsonaro (in the second round of the 2018 elections) and (2) the officially reported deaths, relative to the population, caused by Covid-19 over all the pandemic period (from the first reported death until February 2022). The linear fitting given by the least-square method is also highlighted. The R^2 coefficient of the linear adjustment is found to be 0.53; the Durbin-Watson coefficient is 1.93; the residuals are not autocorrelated in this sample, data variance being well represented by the linear trend. The slope coefficient is also shown to be consistent with a standard error of 0.12 (19%) in its estimation. The obtained t-value, under n-2 degrees of freedom for this coefficient is 5.3, with a suitable p-

value smaller than 0.001. The main statistical results for this regression are shown by table 1.

Table 2: Obtained linear regression for Figure 1, data from Table 1: y = 0.64 x + 126, where: x = Bolsonaro votes per 1k inhabitants in each state, y = official deaths per 100k by Covid-19. Observations: 27, i.e., the number of federative units in which the data of votes, population and Covid deaths reports are collected. The t-value/p-value shown are obtained to the calculated slope. See sections below for more details on multiple hypothesis tests and validation.

slope	0.64 (12)
R2 / R2 adj.	0.53 / 0.51
Durbin-Watson	1.93
(slope) t-value / p-value	5.29 / < 0.001

Sources: IBGE, 2021; TSE, 2018 and UFV, 2022.

Therefore, it can be pointed out from the results shown in Figure 1 that:

I) We found a positive monotonic trend between death rates and populational vote rates for Bolsonaro over the Brazilian federative units. The calculated Pearson correlation coefficient is 0.73 (R^2 of 0.53), the variance being well explained by the linear trend;

II) The most prominent deviations from the trend came from Santa Catarina (SC) and Acre (AC), due to their local specificities. For the sake of comparison, if they are removed as outliers from the dataset, the resulting R^2 reaches 0.74 (the Pearson correlation coefficient reaches 0.86);

III) There is a gap at approximately 250 votes for Bolsonaro per 1k inhabitants, which suggests that the federal units were divided into two characteristic groups: the less adherents to Bolsonaro -concentrated mainly in

the north and northeast of Brazil-, and the highly 'Bolsonarist' states in the south, southeast and the central-west regions. This matches the usual claims regarding the regional character of the political identities and polarization in Brazil. The average death rate calculated to the former group (rated by population, i.e., the centroid of distribution) is 220 deaths per 100k inhabitants, which is lower than the 340 deaths per 100k inhabitants calculated for the opposite group of states. Approximately 71% of the total average deaths separate these groups;

IV) The slope of the linear trend reveals that on average each increment in 100 votes per 1k inhabitants to a given state were shown to be consistent with an increase of 64 deaths per 100k inhabitants, such as observed later during the pandemic. This is found to be larger than the death rates for most of other countries with similar values for the Human Development Index. [15]

To ensure additional statistical validity for a correlation between the variables, we also tested three different correlation coefficients: Pearson, Spearman, Kendall (see Kendall, 1973 for details). Pearson is testing the direct linear correlation and Spearman and Kendall are testing possible deviations of the linear trend, though eventually retaining a monotonic trend between the variables. The hypothesis test evaluates the statistical significance of the deviation from the nullity of correlation coefficients (H0: the variables are not correlated, i.e., the correlation coefficients are compatible with zero). The t-values calculated under H0 to Student's t-distribution with n-2 degrees of freedom (Kendall, 1973) are presented in Table 3 and the obtained p-values of

[15] The Brazilian death rate per 100,000 inhabitants was (officially, at least) higher than in Mexico (278,54); India (37,02); South Africa (164,43); Egypt (22,98); Uruguay (196,33); Colombia (270,4); Ecuador (198,76). The only nations that surpassed the Brazilian rate of death per 100,000 were Peru, Bulgaria, Bosnia and Herzegovina, Romania, Montenegro, Croatia, Slovakia, Czechia, Georgia and North Macedonia. See < https://covid19.who.int >.

the two-tailed test under the t-distribution. The largest p-value is found to be 0.00657 to Kendall's correlation. Therefore, all of them are below the 1% threshold of the significance level and in each of them the null hypothesis is therefore rejected at confidence levels as high as 99%. Thus, there is statistical evidence for the correlation found in Figure 1, its linear form being reinforced by the concordance between Person and Spearman's coefficients.

Table 3: Statistical hypothesis tests for the monotonic trend between Bolsonaro's votes per 1k inhabitants and Covid-19 deaths per 100k over all the federative units, applying three different correlation coefficients and t-statistics under two tailed tests; 27 observations, as above mentioned.

	Pearson	Spearman	Kendall
Correlation coef.	0.727	0.706	0.510
t-value	5.2939	4.9844	2.9645
p-value	0.00002	0.000039	0.00657

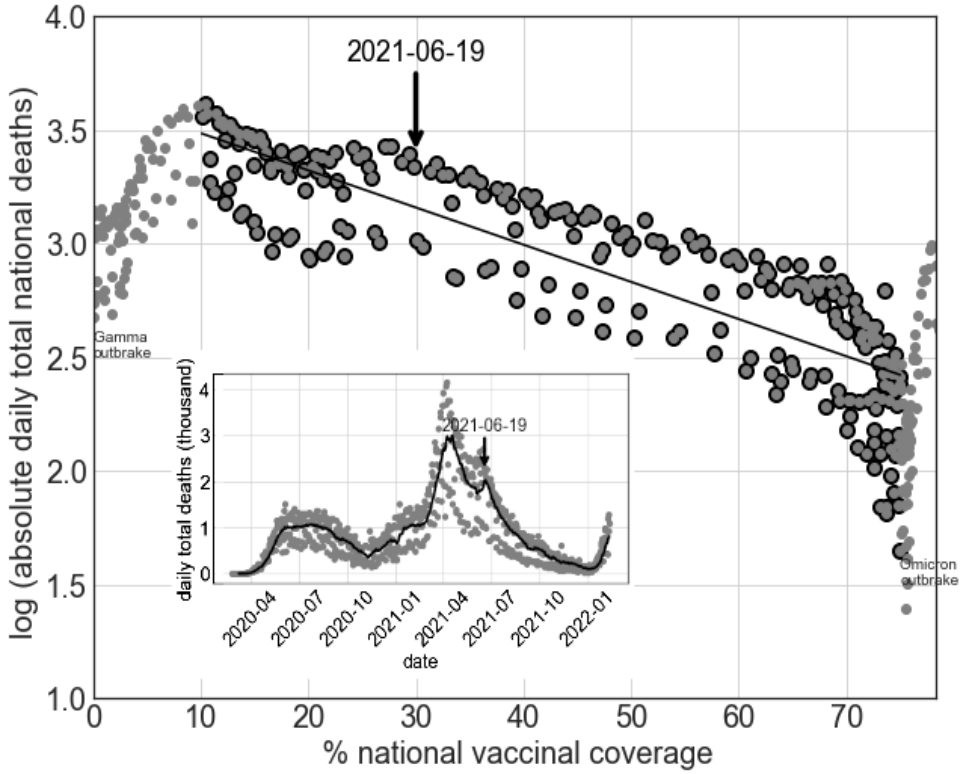
Sources: IBGE, 2021; TSE, 2018 and UFV, 2022.

The impact of vaccination

Vaccination is another variable usually claimed as relevant when revealing the political preference for Bolsonaro. Figure 2 shows an usual consensus: the advance of the national vaccination campaigns was expected to lower death rates over time. This was expressed as a negative exponential correlation between deaths and vaccines, shown by the linear trend adjusted to the logarithm of the death rates. This occurred specially between the outbreaks of Gamma (at the beginning of 2021) and Omicron (beginning of 2022) variants. The fast vertical drop before the emergence of the Omicron variable is

compatible with the saturation of immunization curves (regarding the first dose) for approximately 75% of the population (before the campaign was extended to include children). This is shown in Figure 3. As we see, the rising levels for vaccination were accompanied by a continuous decay of death rates, reaching the scale of $10^{1.5}$ (i.e., 32 daily deaths nationally) at the end of 2021, given the achieved collective immunization.

Figure 2: Total daily absolute deaths in Brazil (logarithmic scale) versus national coverage of vaccination. The trend line indicates the exponential decay after the national coverage of vaccination reaches 10%, calculated from the highlighted dots. Inset: evolution of total daily deaths over the whole period. 19 June 2021 denotes the surpass of 500 thousand deaths, a local peak to the moving average. This started a regime of monotonic decay in the moving average of deaths (until the Omicron outbreak by early 2022).



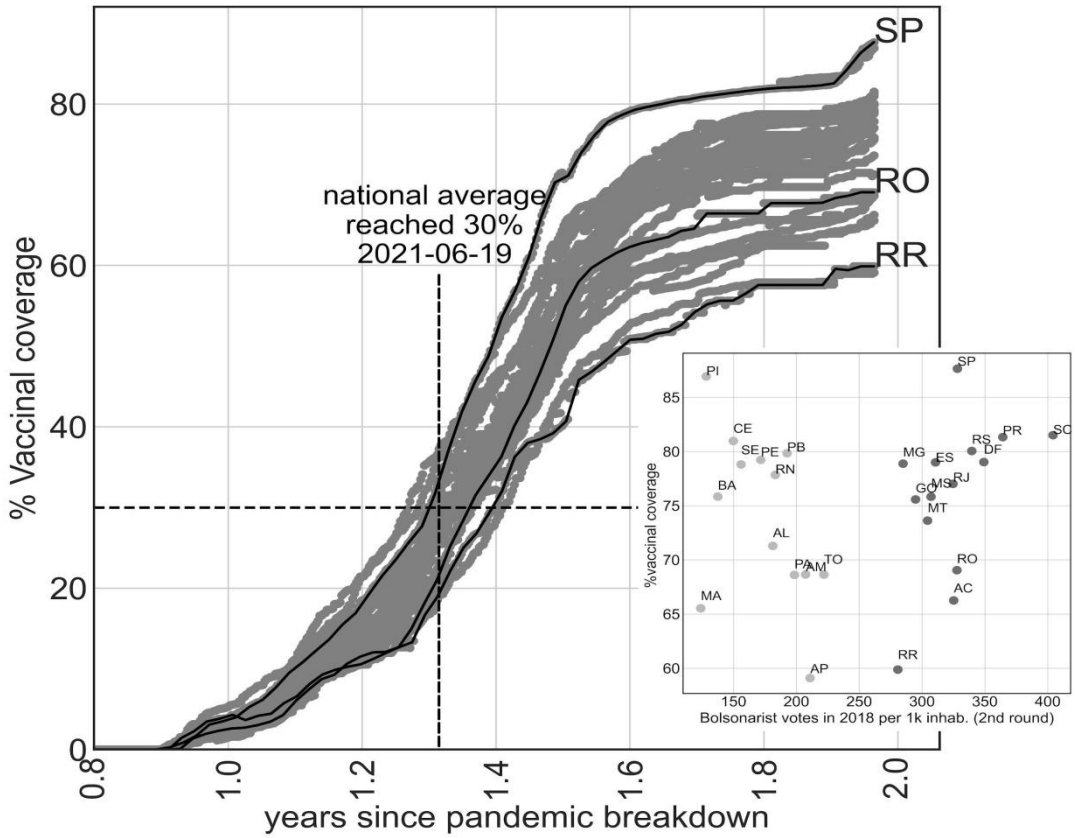
Source: based on UFV 2022.

Figure 3 shows the vaccinal coverage evolution during 2021, also plotting the votes for Bolsonaro (on a state level) and the last reached vaccination levels

by February-2022. These graphics do not exhibit the previously verified grouping and correlation trends found between opposite electoral engagements in 2018's election. This is an indication that the so-called 'denialist' behavior (scaled upon the electorate), which is usually related to the Bolsonarist and far-right ideologies, was mitigated with respect to vaccination, as pointed out by Ricard and Medeiros (2020). This happened even when the Bolsonarist propaganda against vaccination was clear and seemed to be effective among supporters, as previously found by Gramacho and Turgeon M. (2021). Bolsonaro's propaganda motivated critiques from health experts, as shown for instance by Daniels (2021). These critiques were often repeated during public debates conducted by media vehicles.

It can be noticed that there is a remarkable exponential suppression of deaths given by the advance of vaccination coverage (Fig. 2). Additionally, there are fluctuations and relative delays in the progression of vaccination curves along the federative units (Fig 3), as well as the differences observed to saturation values (plateaus in the curves) of vaccination, which are found to be uncorrelated with the political preferences, as shown explicitly in the inset of Fig. 3.

Figure 3: The two blocks of states in 2018 (those less and those more Bolsonarist) are shown to be uncorrelated with respect to the dynamics and coverage of vaccination. Larger graph: daily evolution of vaccination coverage (first dose) over the years after the Covid-19 pandemic breakdown in all states (in gray) since the beginning of the national vaccination campaign. We highlight as examples of breaks in correlation and grouping three states with high alignment to Bolsonaro in the 2018's elections (RR, RO and SP). Smaller graph: saturation coverage of vaccination (first dose) in February of 2022 in each state versus Bolsonarist votes per 100k inhabitants in 2018, showing the inexistence of correlation (i.e., there is no monotonic trend).



Sources: IBGE, 2021; TSE, 2018 and UFV, 2022.

In addition, it should be observed that if by the end of 2021 Bolsonaro insisted on not being vaccinated, [16] most of his supporters now seemed to avoid this stance. Vaccination would in due time reach high levels. [17] This is found

[16] 'Brazil president turned away from football match after refusing COVID-19 vaccine', Sporting News, 10 October 2021.
[17] 73% by February 2022, same levels as in Western Europe and higher than most nations in Latin America (excluding Argentina, Chile, Uruguay, Ecuador and Cuba), as well as the United States, Mexico, all Africa, India and Eastern Europe. See < https://covid19.who.int >.

explicitly even in those states where Bolsonaro was preferred during the elections in 2018, and well known by majoritarian levels of acceptance, such as Santa Catarina (SC), Paraná (PR), and Rio Grande do Sul (RS). This reveals a difference regarding the previous findings of Gramacho and Turgeon (2021), which were obtained by sampling through a survey experiment. They claimed that supporters of Bolsonaro were more prone in rejecting vaccination.

Before the vaccination coverage reached around 30% (as highlighted in Figure 3), the amount of officially reported deaths crossed the 500 thousand line on 19 June 2021 (more exactly, 501,108 deaths after 480 days since the first Covid 19 reported death, 1044 deaths per day on average). [18] Moreover, on 19 June 2021 the national death rates also surpassed a local last peak (seen in the inset of Figure 2), starting to decrease monotonically henceforth (until the Omicron outbreak by January 2022). From now on the period between February 2020 and this date will be named as a *first period*. The *second period* relates to the scaling up of vaccination and the decrease in death rates: from 19 June 2021 until 11 February 2022 Brazil. There were 136 thousand deaths over the second period (136,359 in 237 days, 575 deaths per day on average).

Accordingly, 78% of deaths were already reached before the change in the dynamics of deaths reported by Covid-19 for the second period, a change that is directly reflecting the spread of vaccination. Thus, the correlation of deaths to all the pandemic and votes previously found for Bolsonaro in 2018 can be hypothesized as being mainly produced in the period before June 2021. Therefore, to search for differences between the behavior of federative units

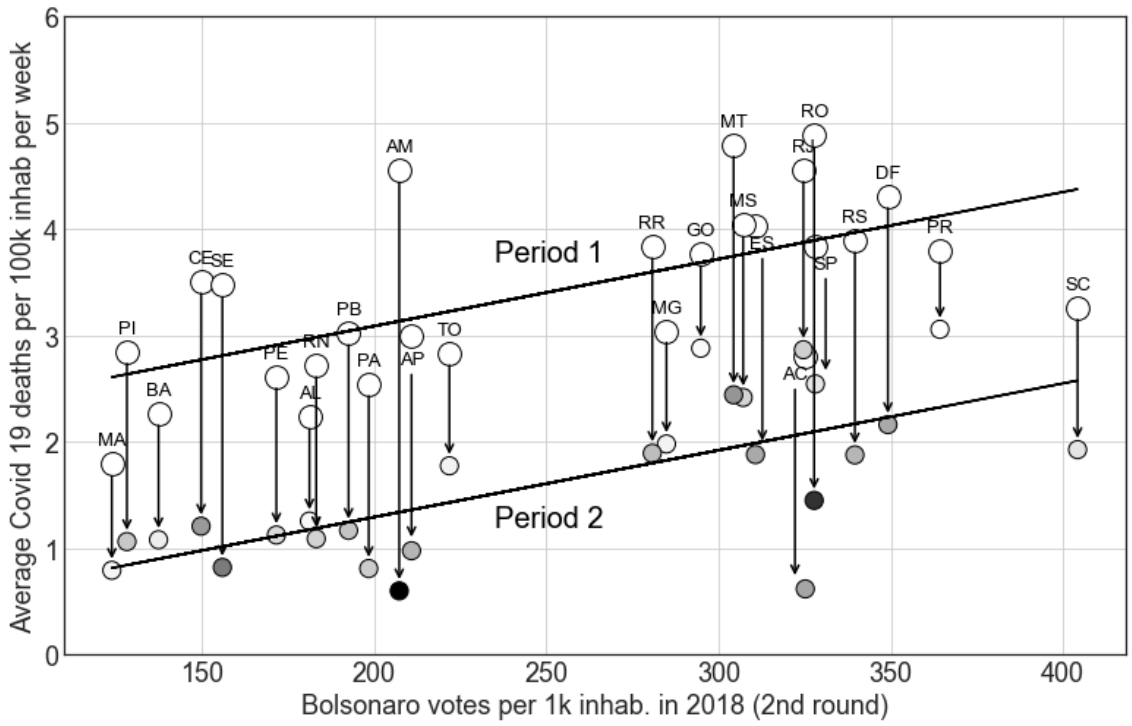
[18] 'Brazil Hits 500,000 Deaths by Covid', Folha de São Paulo, 19 June 2021 (in Portuguese).

between these two different moments, we show in the following section a segmented analysis between the above defined periods.

Segmentation in two different pandemic moments and the persistence of the correlation of votes and deaths

As observed, the correlation analysis between the election of 2018 and death rates was segmented in two periods: the rising (period 1) and the downward (period 2) trends for the pandemic deaths. The difference in the time amount between them naturally inflates the death rate per 100k inhabitants in favour of the larger period. This bias is then corrected by normalizing the data for each period by the number of weeks (time) in each set. The resulting death rates (now the average per 100k inhabitants *per week*) produced a rather remarkable parallelism between the linear trends with respect to the adherence to Bolsonaro, seen in Figure 4. Therefore, even with a high adherence of Bolsonaro's electors to the vaccine over time, there was a *persistence of the correlation between death rates and Bolsonaro's votes in 2018*. This is shown by the maintenance of a linear trend in both periods regarding deaths and votes. In addition, the calculated slopes to the linear regressions are mutually compatible and explanatory with respect to the previously reported correlation.

Figure 4: Correlation between votes for Bolsonaro and relative death rates by pandemic weeks over the two periods. Period 1: before 2021-06-19 (large white circles), upper trend line (adjusted). Period 2: after 2021-06-19 (smaller colored circles), lower trend line (adjusted). Circles are colored by the difference between the former death rate in the first period and the observed in the second period; larger drops are colored darker. The behavior in the death rates is also pointed out by arrows.



Sources: based on IBGE 2021, TSE 2018 and UFV 2022.

The regression coefficients are summarized in Table 4. The statistical quality of linear adjustments moved to smaller levels as could be expected. There is a stronger grouping of less Bolsonarist states in the second period, as well as a more dispersive behavior in the complementary Bolsonarist block. Table 5 summarizes the hypothesis tests to the existence of correlation in each period, employing as Pearson, Spearman and Kendall correlation coefficients. The larger obtained p-value, to Kendall's correlation, is found as being 2,1% for period 1, which increases the significance level up to 2,1%; accordingly, the confidence level reaches a somewhat lower value (97.9%). However, this is enough to infer the existence of correlations for both periods regarding the

average death rates per 100k per week and the votes for Bolsonaro in 2018 with a rather good statistical confidence. The similarity between Pearson and Spearman's coefficients, especially to the period 1, reinforces once again the adequacy of a linear trend model. The similarities of correlations for both periods suggest underlying social behaviours between both periods. Finally, for period 2 the lower value for the Durbin-Watson coefficient points to an emergent autocorrelation effect, which is expected due to the stronger grouping of less Bolsonarist states concerning death rates. Hence, without major losses in the confidence of the correlation and its modelling as a linear trend, the models can be admitted for the sake of simplicity, including its general meaning, even at the cost of a somewhat smaller precision.

Table 4: Obtained linear regressions, y = 0.0063x + 1.8134, and y =0.0061x + 0.0343, respectively to the periods 1 and 2 shown in Fig. 4, 27 observations. Where: x: Bolsonaro votes per 1k inhabitant to each state, y: official deaths per 100k by Covid-19 per week.

	Period 1	Period 2
slope	0.0063 (2)	0.0061 (1)
R^2 / R^2 adj.	0.40 / 0.38	0.499 / 0.479
Durbin-Watson	2.189	1.387

Sources: IBGE, 2021; TSE, 2018 and UFV, 2022.

Table 5: Statistical tests performed to test the monotonic trends for period 1 and 2 between Bolsonaro's votes per 1k inhabitants and Covid 19 deaths per 100k per week (federative units) applying three different correlation coefficients and t-statistics under two tailed tests.

		Pearson	Spearman	Kendall
Period 1	coefficient	0.632	0.632	0.442
	t-value	4.0776	4.0776	2.4637
	p-value	0.0004	0.0004	0.0210
Period 2	coefficient	0.706	0.651	0.470
	t-value	4.9844	4.2881	2.6624
	p-value	0.00004	0.00024	0.0133

Sources: IBGE, 2021; TSE, 2018 and UFV, 2022.

The similar slopes of 0.006 deaths per 100k inhabitants (per week) per votes (1k inhabitants) for both periods are also explanatory of the regression previously obtained, considering the whole pandemic period (Fig. 1). By taking the product of this characteristic 0.006 slope to the 102 weeks, when they are independently calculated, the increase in deaths per 100k inhabitant is found to be 0.61 to each vote in Bolsonaro per 1k inhabitants, which is compatible with the value of 0.64 found for the regression in the Fig. 1. This reinstates the straightforward interpretation previously pointed out by statement IV above. The persistence of the slope shape between these periods suggests a resilient pattern for death rate increments. This persistent trend, despite being on a

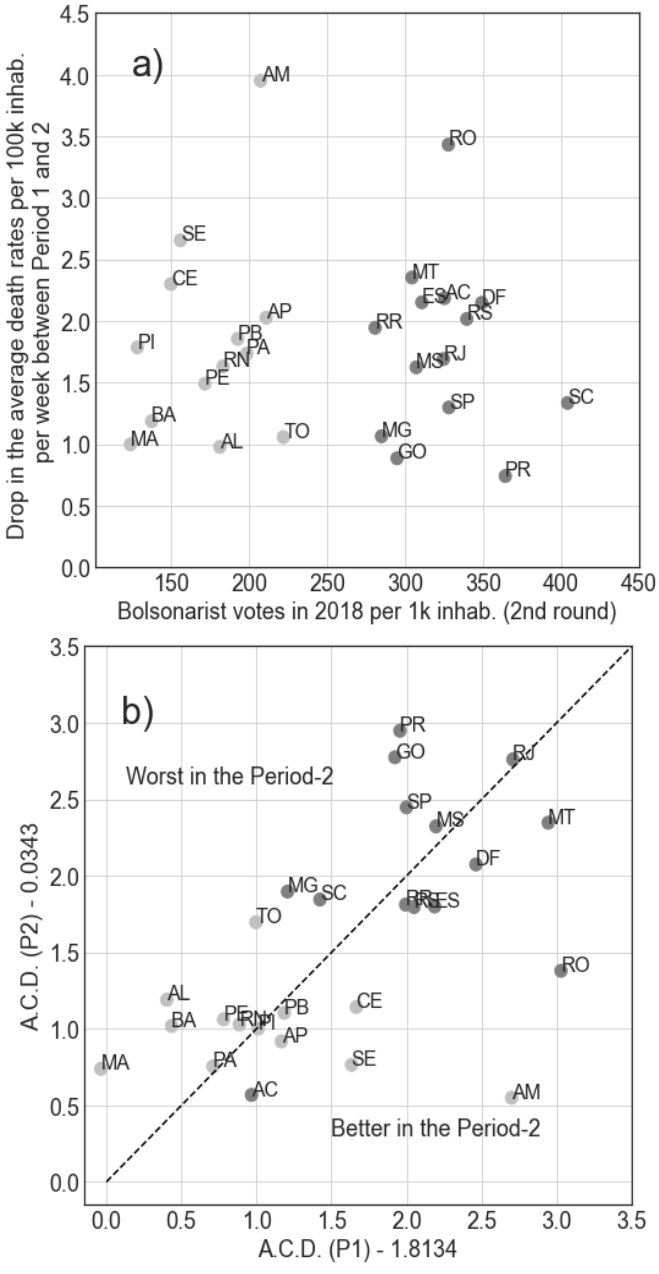
lower level of death rates in period 2, points to a process of social inertia, regardless of the uniform uncorrelated adhesion to the vaccination campaign.

Accordingly, the *drop* in the average death rates per state is suggested from the qualitative analysis of the arrows and the circle colours in Fig. 4. It is quantitatively explored in the following Figs. 5-a) and 5-b). As shown by Fig. 5-a), the drop in the weekly death rate in each state is not correlated to the 2018's majoritarian electoral alignment. In other words, both Bolsonaro's more and less permissive states in 2018 showed a similar decline in death rates, on average and with similar variances. This produced the rigid fall in the linear adjustments, without affecting the slope obtained by the regressions. This is in accordance with the former allegation that, regarding the vaccination campaign, the anti-vaccination discourse was not accepted by most of the population.

Figure 5 shows the change between better and worse performances to each state given its relative position to the trend line for each period. To do this, the fitted intercept was subtracted for the respective data of each period, for each of the Brazilian states. This procedure is feasible because the slopes are statistically the same, values being compared graphically. The dashed line indicates equality (the state kept its position relative to the trend line of each period). When the state is above the line it gets worse. The position below the dashed line means the opposite, i.e., the state performed better in period 2 and reduced the average number of deaths beyond the overall effect induced by the vaccination program. As examples, we can mention that some Bolsonarist states like Parana (PR) and Goiás (GO) got worse regarding its former position in period 1. At the same time, Roraima (RO) showed a pronounced deviation (drop) of death rates in the second period regarding its own previous

performance (in period 1), and states like Rio de Janeiro (RJ) behaved similarly regarding the trendline.

Figure 5: a) The difference (drop) in the death rate per 100k inhabitants per week from the first to the second chosen pandemic periods (arrows in the Fig. 4) is found to be uncorrelated to Bolsonaro's votes per inhabitant in 2018. **b)** A.C.D.: 'Average Covid Deaths' per week per 100k inhabitant for period 1 (P1) and period 2 (P2). The relative drop of calculated trend lines attributed to the vaccination was discounted by subtracting the adjusted intercept coefficients previously calculated (and presented in Table 4). The dashed line means an equivalent behavior relative to the trend lines in each period; when below the line, federative units reduced the death rates beyond the average vaccination effect. The opposite is obtained when states appear above the line. Dark grey markers show the states with more Bolsonarist votes in 2018, and light grey shows the less Bolsonarist states, as before.



It should be noticed that states like Paraná (PR) and Santa Catarina (SC) showed a lower drop in their death rates, even after reaching a high vaccinal coverage. Paraná is below the trend curve during period 1 but positioned itself above the trend line in period 2, while Santa Catarina kept its position below the trend line, though with a reduced deviation. This shows that even with death rates dramatically changing with vaccination, fluctuations occurred between both periods. This reflected the specificities of each state over the two different periods. However, there seem to be causations that were implicitly acting to maintain the correlation between votes and death rates. They were expressed by the similar values for the correlations regarding both periods. This aspect will now be explored in a preliminary vein in the last section.

Roads for a sociological research program

Xavier et al. included Bolsonaro's votes as one between other socioeconomic variables. By means of regression tree techniques, all Brazilian cities were grouped to the observed death rates. Despite its apparent sophistication, votes for Bolsonaro were translated in a binary variable of 'yes or no' regarding the question 'did he win there', having been considered only three times (in the inner nodes, with different weights due to different positions along the tree depth) in the final estimated tree. This means that the variable is affecting the grouping/classification of 1,675 out of the 5,570 Brazilian cities (i.e, 30%). In terms of the total population, this means only 22% of the population (46 million). Therefore, the general conclusion that 'municipalities

that chose Bolsonaro as the country's president showed intensified COVID-19 mortality rates in the second wave' does not follow directly from their empirical evaluation. By restricting our analysis to the vote variable concerning the total population, and by summing votes from cities up to the state levels, we gained both in simplicity and accuracy in claiming that Bolsonaro's votes are an adherent variable. According to our interpretation, votes rates are an expression of other unknown social variables, which cannot be obtained directly from statistical data at the present time. Given that, social theory is an adequate way to trace paths to understand the complex phenomenon which is revealed by the simple correlation between deaths and votes, including its persistence after the vaccination period. In light of this, we shall now suggest some roads for the interpretation of the above-mentioned suggested association between deaths by Covid and votes for Bolsonaro, which should be deepened by future social research.

John K. Galbraith once observed that 'effective government, education, and social justice [are] critically important' to achieve economic and social development (GALBRAITH, 1964, p.43). The relation between those who followed or similarly adopted Bolsonaro's prescriptions and deaths by Covid refers to a broader relation between culture, public health and social development. In this regard we can remember how Gunnar Myrdal once defined any *social system* as consisting of a 'great number of *conditions* that are causally interrelated, in that a change in one will cause changes in the other' (MYRDAL, 1968, p.1860). These conditions were classified by him in six broad categories: a) output and incomes; b) conditions of production; c) levels of living; d) attitudes toward life and work; e) institutions; f) policies. As far as we

can see, items (b), (d), (e) and (f) have all their role in suggesting an *association* between (i) political preferences and support for Bolsonaro and (ii) the role of the federal government over the pandemic. Departing from these premises, we can suggest causal chains for the relation between deaths by Covid and votes for Bolsonaro, which should be tested and eventually discarded by future research.

If we consider the general *conditions of production*, it could be suggested that most of the Bolsonarist employers -as well as employees or self-employed workers- could be more prone in avoiding measures of prevention. This may have occurred because following or supporting Bolsonaro's positions was the easiest way to maintain the existing levels of output. It is true that many economic conditions involved a large range of activities whose conditions should have been maintained simply to survive, such as the more urgent necessities of street vendors. In this case, necessity and not ideology had played the decisive role. Was this the case for most of the higher social classes which required their domestic servants to maintain in person services, violating the demand to increase social distance as claimed by health organizations? Was this worsened by the use of public transports and the uninterrupted working of manufacturing sectors, which were considered as vital activities? [19] We know that transport workers were one of the most affected groups in terms of infection and deaths. [20] This should be investigated with more detail by future sociological and historical research.

Under the notion of *attitudes toward life and work* we would expect to find similarities with the previous item, since the maintenance of the levels of

[19] For the case of São Paulo state, see Decree 64.881 on https://www.saopaulo.sp.gov.br/coronavirus/quarentena/
[20] See 'Deaths among bus drivers and gas station workers increased by 60% in the height of the pandemic in Brazil', El País Brasil, 5 April 2021.

economic activity, output and circulation were often adopted regardless of the risks of contamination and resulting deaths. Were more influenced by Bolsonaro's views on the pandemic more prone in avoiding preventive measures regarding the disease, not only regarding production conditions but also in social activities in a broader sense? It was widely reported by the Brazilian media that evangelical pastors and their supporters followed Bolsonaro's wrong views on vaccination, social distancing, and other preventive measures. This included the maintenance of cults during the pandemic, deemed by the government as 'essential activities'. Future research can estimate if and how this variable had also its share in a faster dissemination of the virus and the higher number of fatalities in the more Bolsonarist places.

Given that Bolsonaro became the elected president, the federal administration reflected his political views, with *institutions and policies* also probably having their specific role. In theoretical terms, even if a proper stance were disseminated by the federal government, the pandemic would have caused great impacts, given the relative novelty of the phenomenon. This is a broader question that surpasses the influence of Bolsonaro, referring to a complex sociological problem, that of the relation between social development and public health. [21] In fact, even if the government would have taken correct perspectives, the spread of the disease and the measures to cope with it would also depend on the way how these rules would be followed by the society. When it comes to the relation between votes for Bolsonaro and deaths, how exactly did 'denialism' and the delayed action of the very institutions to implement proper measures to cope with the pandemic act to boost death rates? Maybe the non-declared

[21] For a discussion, see Myrdal (1968), Desai and Potter (eds.) (2008) and Thirlwall (1999).

government's strategy was to induce mass contamination, so as to avoid the shutdown of economic activities, theoretically leading to 'herd immunization' and a normalization through time. The president headed the governmental apparatus to disseminate his own views on Covid; therefore, detailed empirical research should ask if and how political institutions in fact influenced the behavior of Bolsonaro's electors and supporters on a higher level than the others, by means of his declarations, official statements, fake news, and other similar actions.

In other words, future research would be able to investigate if and how Bolsonaro's policies and actions *influenced* the social system, leading to a type of 'causal interdependence between the various factors in the social system even outside the so-called "economic factors" ' (MYRDAL, 1968, p.1846). In fact, it would be odd to assume that the attitudes of an elected president did not have social impacts particularly over his supporters. [22] The institutionalized discourse of any government and then its *policies* have always a general (positive or negative) influence over the behavior and life of the society, including those who did not vote and support the elected administration but who are somehow influenced by the prevailing social climate in each moment of time. [23] Accordingly, it would be expected that those who *did vote* for Bolsonaro would be more prone to mimic his stance concerning the pandemic, with worse results for the state of public health. If it holds, sociological research should elucidate the following questions:

[22] 'It is true that [governments] are circumscribed by public opinion; they cannot go too far in advance of public opinion, or lag too far behind it. But it is also true that they help to determine public opinion. The speeches and writings of the well-known public figures, plus the decision of the legislature to take certain action, or equally its refusal to act, are part of the process by which public opinion is made' (LEWIS 1965, p.377).
[23] For the case of the United States, see NEELON et al. (2021).

a) by adopting the same attitudes of the president or other members of the government, how were people influenced in not taking preventive measures, widely assumed as effective inside the well-established international health protocols, such as the use of masks or social isolation?;

b) by trusting the official discourse against the vaccine, how many people refused to be vaccinated immediately (something which boosted death rates *per se* during the most dangerous period of the pandemic)? As we saw, this problem was surpassed over time, even though there were those who still refused vaccination for reasons that are not scientifically tested; [24]

c) following the successive declarations and 'recommendations' of the federal government or the president himself, did doctors prescribe drugs which were not scientifically tested in terms of its effectiveness (i.e., 'ivermectina', 'hydroxychloroquine' etc. [25])?;

d) did the absence of a federal policy of lockdown or even of quarantine have also its role in 'normalizing' inadequate behavior more among Bolsonarists than among other groups?

Investigation should evaluate if these types of behavior were to be felt more particularly among that share of the electors directly influenced by the

[24] By March 2022, 155.194.905 Brazilians achieved complete immunization, out of a total population of 210 million. See <http://especiais.g1.globo.com/bemestar/vacina/2021/mapa-brasil-vacina-covid/>.
[25] Bolsonaro encouraged the use of both substances, which were not scientifically tested. See for example 'Brazil Covid-19 inquiry told of Bolsonaro's blind faith in chloroquine', Reuters, 4 May 2021.

government because of their political preferences, as also daily observation frequently showed. [26]

In any case, beyond this general suggestion of a multivariate search for causal mechanisms, the empirical work presented here showed two more specific results: a lower correlation between *vaccination* and political preference for Bolsonaro after June 2021, and the persistent correlation between votes for Bolsonaro and fatalities by Covid. We suggest that the first phenomenon can be understood considering the following interrelated circumstances: 1. the emergence of political ruptures between governors previously aligned with Bolsonaro in 2018 and the president, during the pandemic period; in fact, most of Bolsonaro's supporters broke with the idea that they should not be vaccinated, following the recommendations of their respective governors (as in São Paulo state); [27] 2. The psychological impacts among the people of a high level of deaths by Covid-19 between March 2020 and June 2021. The high level of deaths reached in 2021, and the fear of dying which spread very rapidly over large shares of the population, led to a rush for the vaccine irrespectively of Bolsonaro. 3. The traditional acceptance of vaccination among the Brazilian population, regardless of Bolsonaro's opinions on the issue. It should be observed that the vaccination coverage was dependent

[26] This was indeed the very conclusion of the Brazilian Senate's commission of inquiry of the pandemic, which was conducted over 2020-2021. This official report was made without a direct influence of Bolsonaro and reached critical conclusions regarding the performance of the Brazilian government over the pandemic, including himself, which was held accountable for a share of the more than 600,000 deaths by Covid over the period (see Senado Federal do Brasil [Brazilian Senate] 2021, p.1033). The Federal Government was accused of causing, among others, avoidable deaths; homicides; violation of preventive measures regarding public health; use of false documents; dishonesty; nonfeasance; dissemination of fake news; wrongdoing in public office. For more details see Senado Federal (2021). Up to now, the resulting conclusions of this commission of inquiry did not lead to any legal consequences.

[27] This was particularly the case of São Paulo's governor João Doria. He supported Bolsonaro during the 2018 elections but broke with him owing to the president's instance on Covid-19. Accordingly, the state of São Paulo went ahead to implement the vaccination campaign; the federal government had to follow suit, despite Bolsonaro's own will.

on factors such as the availability of the medicine and the mobility of the populations to health units, which were expected to be sensitive to the economic characteristics of each federal unit. 4. The fall in Bolsonaro's popularity between 2019-2021, leading to a relative drop of the influence of his 'denialist' approach. [28]

Conclusion

Correlations do not necessarily imply real causation or association. However, without correlations, causation does not exist even as a hypothesis. The statistical correlation between votes for Bolsonaro and fatalities by Covid is real and proved to be statistically significant, as suggested also by Xavier et al. 2022. Accordingly, social research must deal with similar associations such as those between votes and deaths. Although the relation cannot be simply and automatically taken as a direct cause (that is, Bolsonarist adhesion implied observed death rates), it may be expressing, as a mathematical/social index, a compilation of social and economic indicators, with an unexpected simplicity. If we adopt Myrdal's notion of 'interdependence' of the variables of a given social system, the statistical correlations indeed seem to suggest that there is an association between Bolsonaro's influence, his administration, and a share of deaths by Covid in Brazil. To what degree is this a process that involved political sympathy toward the government, the adoption or reinforcement of its

[28] According to the opinion polls systematically carried out by Datafolha since 2019, those who considered Bolsonaro's government as 'bad' or 'terrible' went from 30% in April 2019 to 44% in June 2020, and to 53% in December 2021. Those who considered his government as 'good' or 'excellent' went from 33% in December 2019 to 37% in December 2020, then dropping to 22% in December 2021. See: 'Datafolha: Bolsonaro maintains the worst government's evaluation, with 53% of disapproval (in Portuguese), Folha de São Paulo, 17 December 2021.

misconceived perspectives toward Covid-19, and mistaken policies, leading to a higher level of deaths? It would be a merit of this work if it helped to foster more future research and debates around these issues.

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